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# Risk mitigation strategies for guaranteed maximum price and target cost contracts in construction – A factor analysis approach

Joseph H.L. Chan[1*]; Daniel W.M. Chan[2]; Albert P.C. Chan[3]; and Patrick T.I. Lam[4]

[1] *Research Associate, Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China (email: chljoseph@hotmail.com)*

[2] *Associate Professor, Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China (email: bsdchan@inet.polyu.edu.hk)*

[3] *Professor and Associate Dean, Faculty of Construction and Environment, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China (email: bsachan@inet.polyu.edu.hk)*

[4] *Associate Professor, Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China (email: bsplam@inet.polyu.edu.hk)*

**** Corresponding author: Joseph H.L. Chan***

Joseph H.L. Chan can be contacted at email: chljoseph@hotmail.com

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**Abstract**

**Purpose** – There is a lack of empirical research on risk mitigation strategies for those construction projects procured by guaranteed maximum price contracts (GMP) and target cost contracts (TCC). The paper aims to identify and analyse the risk mitigation strategies for GMP/TCC construction projects from the Hong Kong perspective.

**Design/methodology/approach** – A total of 94 industrial practitioners with both sound knowledge and abundant hands-on experience of the GMP/TCC methodology participated in an industry-wide empirical questionnaire survey to indicate their levels of agreement on those 18 risk mitigation strategies identified from reported literature and in-depth interviews which were later analysed by factor analysis.

**Findings** – The results of factor analysis revealed that the 18 individual risk mitigation strategies can be consolidated into 7 underlying grouped factors: (1) Relational contracting and mutual trust; (2) Clear contract provisions and well-defined scope of works; (3) Involvement of contractor in decision making process; (4) Right selection of project team; (5) Third party review of project design at tender stage; (6) Standard contract clauses for GMP/TCC schemes; and (7) Fair treatment of contractor.

**Research limitations/implications** – Although both GMP/TCC contracts have been increasingly popular in the construction market of Hong Kong, not all of these projects have been equally successful and some of them have been exposed to very high risks or uneven allocation of risks. A detailed analysis and an implementation of recommended effective risk mitigation strategies are essential to the success of GMP/TCC schemes.

**Originality/value** – The research findings of this study are expected to help the decision-makers to generate useful insights into risk mitigation strategies when administering GMP/TCC contracts at an early stage of project delivery and lay a solid foundation for further research on GMP/TCC in both local and international context.

**Keywords** Guaranteed maximum price contracts (GMP), Target cost contracts (TCC), Risk mitigation strategies, factor analysis, Hong Kong

**Paper type** Research paper

## Introduction

The construction market is often considered as being fraught with traditional adversarial relationships between employers and contractors, mainly because project participants feel bound to focus primarily on the success of their individual own businesses rather than the overall project itself. Guaranteed Maximum Price (GMP) and Target Cost Contracting (TCC) schemes are often recommended as effective means to motivate contractors in achieving better value for money and more favourable project performance by linking their individual own financial goals with the overall project objectives (Construction Industry Review Committee, 2001).

Overseas experience from both the United Kingdom and Australia (Trench, 1991; Walker *et al.*, 2000) indicated that GMP/TCC schemes can add value to project delivery under the condition that the risk factors are carefully identified, analysed, shared and managed. The disparities in management system, unfamiliarity with these procurement approaches of key project stakeholders, together with cultural background among the partners may make this difficult.

Despite the fact that both GMP and TCC contracts have been practised for a plethora of years, not all these projects are equally successful and some of the projects result in a high level of risk or an uneven allocation of risks. For example, Bogus *et al.* (2010) collected performance data from public water and wastewater facilities owners, in order to compare project performance based on cost and time growth. Their study found that contracts procured with the GMP approach are less likely to have cost growth and time growth, as compared to those with lump-sum provisions in the United States. However, Roja and Kell (2008) reported that the final construction cost of 75% of public school projects investigated in the northwest of the United States exceeded the contract GMP value, while the same phenomenon was found in about 80% of public non-school projects. These findings did not support the notion that GMP was really “guaranteed”. Thus, it is important to find ways to mitigate the risks which may affect the overall project performance of GMP/TCC schemes. This study is an attempt to fill up the gap of research in the area of risk mitigation measures for GMP/TCC schemes and provide some useful insights to both construction academics and industrial practitioners for mitigating risks inherent with such procurement strategies.

## Literature review

*Concepts of guaranteed maximum price and target cost contracting (GMP/TCC)*

According to Masterman (2002), GMP is an incentive-based procurement strategy which rewards the contractor for any savings made against the guaranteed price and penalises him when the sum is exceeded due to his/her own mismanagement or negligence based on a pre-determined share ratio.

The National Economic Development Office (1982) suggested that "target cost contracts specify a 'best' estimate of the cost of the works to be carried out. During the course of the works, the initial target cost will be adjusted by agreement between the client or his nominated representative and the contractor to allow for any changes to the original specifications". Trench (1991) held a similar perception that target cost contracting scheme is a contractual arrangement under which the actual cost of completing the works is evaluated and compared with an estimate or a target cost of the works, the differences within a cost band are shared between the client and the contractor according to a pre-agreed share ratio.

*Recent research studies on guaranteed maximum price and target cost contracting (GMP/TCC)*

There have been a considerable number of research studies focusing on GMP and TCC schemes in recent years. Matthews and Howell (2005) reported on a case study for both design and construction of a central chilled water plant in Orlando of the United States which was procured with a GMP arrangement. This case study reveals that a cost saving of around 10% was realised due to the concerted efforts of the project team on value engineering exercise. Pryke and Pearson (2006) launched three European case studies, including two cases from the United Kingdom and one case from France, to investigate the gain-share/pain-share mechanism developed under the prime contracting approach. Their study advocates that the application of a GMP arrangement in building contracts within the United Kingdom is an effective means to transfer risks to the employer associated with design development at post-contract award stage. Kaplanogu and Arditi (2009) investigated the practice of pre-project peer review process of GMP of contractors in the United States by means of an empirical questionnaire survey. Their findings indicate that it is necessary to carry out a pre-project peer review in GMP or lump sum contracts. It is also found that such a pre-project peer review is justified by contractors as its benefits include minimising the risk of underestimating the project cost, evaluating the appropriateness of project schedule and reviewing contract conditions and the like. Puddicombe (2009) established a regression model to explain the variations of project performance of applying different compensation schemes including GMP, cost-plus and lump sum contractual arrangements. The model indicates that GMP is suitable to be applied in projects with a high level of complexity, when compared with cost-plus and lump sum types of arrangement.

Badenfelt (2008) undertook a total of 16 interviews with the Swedish clients and contractors, followed by a case study, to determine the essential factors affecting the selection of sharing ratio in TCC. It is found that the perception of fairness, knowledge of TCC and long-term collaborative relationship could significantly influence the selection of sharing ratio under TCC. A more recent study by Badenfelt (2010a) suggested that long-term commitments should be introduced to minimise the negative effects of information asymmetries and to reduce the unnecessary project cost and design deficiency. Moreover, Badenfelt (2010b) conducted a longitudinal study of a large-scale laboratory construction project in Sweden. This research reveals that a business relationship solely built on mutual trust appears to be rare, even in trust-based collaborative setting, contracting parties should place more attention to trust-nurturing actions to ensure the smooth delivery of TCC. Lahdenpera (2010) considered the problem of late involvement in design of contractor under TCC, proposing a two-stage target cost arrangement to combine early contractor involvement and price containment. It is claimed by Lahdeenpera (2010) that this model can spur both the employer and the contractor to invest in the critical pre-implementation development phase. This mechanism is believed to be able to provide a means for various contracting parties to enter a co-operative working relationship which is of value for projects with special challenges and high uncertainty. There seems to be a lack of empirical research focusing on the risk aspect, especially the risk mitigation measures for GMP/TCC schemes which are considered to be suitable for projects with high complexity and risks. This assertion has reinforced the objective of this paper to provide useful insights into risk mitigation strategies under the GMP/TCC umbrella to both construction academics and industrial practitioners for reference and application.

**Research methodology**

The research study started with a comprehensive review of relevant materials from textbooks, academic journals, professional journals, conference proceedings, research reports, previous dissertations and internet information to capture background knowledge about the application and risk mitigation of GMP/TCC schemes. The objective of the literature review was to develop an overall framework for the research study and to prepare for the questionnaire survey.

*Development of empirical questionnaire*

Before designing the empirical survey questionnaire, seven semi-structured face-to-face interviews were launched from June and July of 2008 with senior industrial practitioners with direct hands-on experience in construction projects procured with GMP/TCC (Chan *et al.*, 2010a) to solicit their opinions on key risk factors, risk allocation and risk mitigation measures of this kind of projects. Based on the findings from the extensive literature review (Chan *et al.*, 2011) and those in-depth interviews, an empirical survey questionnaire was developed. An industry-wide questionnaire survey was undertaken between March and April of 2009 to collect the opinions and perceptions of relevant industrial practitioners on risk identification, risk assessment, risk allocation and risk mitigation associated with GMP/TCC construction projects in Hong Kong.

The survey form consisted of four major parts. The first part was about the respondents' general personal profiles. The second part focused on the risk identification and assessment in terms of the perceived level of severity and likelihood of occurrence of 34 listed risk factors in relation to GMP/TCC construction projects with a five-point Likert scale where 1 denoted "very low" and 5 denoted "very high" for severity, together with a seven-point Likert scale where 1 represented "very very low" and 7 represented "very very high" for likelihood. The respondents were also requested in this part to choose the party best capable to manage each of the key risks elicited (i.e. client, contractor or shared). The third part was concerned with risk mitigation measures for GMP/TCC construction projects in which respondents were invited to rate the effectiveness of 18 possible risk mitigation measures as postulated by the interviewees with a five-point Likert scale, where 1 indicated "least effective"; 3 indicated "effective" and 5 indicated "most effective". The fourth part was optional and the respondents were welcome to express their personal preference on future development and application of GMP/TCC contractual arrangements with their supporting reasons. Respondents were also requested to list out and score any other unmentioned risks derived from their personal discretion and actual experience. However, no new items were ultimately obtained from them. It should be noted that only the survey findings regarding the risk mitigation measures are reported and discussed in this paper due to length limitation. The results of other parts have been duly documented and disseminated in other publications, for example, on the first part of risk identification and assessment by Chan *et al.* (2011).

A total of 300 self-administered blank survey forms were dispatched to individual construction professionals and project stakeholders associated with the Hong Kong construction industry by means of both postal mail and electronic mail between March and April of 2009. The target survey respondents were first identified from previous research studies on GMP/TCC procurement strategies in Hong Kong undertaken by the authors (Chan *et al.*, 2007a). Altogether, 141 valid and duly completed survey forms were returned in June of 2009, yielding a response rate of 47%. Among these 141 responses, 47 respondents declared that they had "No hands-on experience in procuring GMP/TCC construction projects" and they were advised not to complete the survey forms and returned the forms for record. The remaining 94 respondents either have acquired direct hands-on experience in participating GMP/TCC projects or they declared to have basic understanding of the underlying principles of GMP/TCC schemes even though without the direct exposure to GMP/TCC contracts before (Chan *et al.*, 2011). As all of the key active players in adopting GMP/TCC had been included in the list of target respondents of the questionnaire survey, it was considered that their opinions and perceptions could substantially represent the GMP/TCC project pool in Hong Kong over the past decade of 1999-2009. Hence, the chosen sample was regarded as representative of the survey population given the limited number of construction projects procured with the GMP/TCC approaches in Hong Kong (about 20 as cited by Chan *et al.*, 2007a). Table I serves as a summary of the profiles of the 94 respondents. More than 80% of the respondents have already derived a wealth of working experience of at least 5 years within the construction industry, their opinions and data collected from the survey are considered representative and reliable.

**Table I.** Personal profiles of survey respondents

| Category | Respondents | |
|---|---|---|
| | Frequency | Percentage |
| *Role in the project* | | |
| Client organization | 33 | 35.1% |
| Main contractor | 22 | 23.4% |
| Architectural consultant | 2 | 2.1% |
| Engineering consultant | 3 | 3.2% |
| Quantity surveying consultant | 19 | 20.2% |
| Project management consultant | 2 | 2.1% |
| Subcontractor | 2 | 2.1% |
| Academic | 9 | 9.6% |
| Others | 2 | 2.1% |
| TOTAL | 94 | 100% |
| *Grouping by role in the project* | | |
| Client | 33 | 35.1% |
| Contractor | 27 | 28.7% |
| Consultant | 34 | 36.2% |
| TOTAL | 94 | 100% |
| *Experience level in construction* | | |
| Below 5 years | 17 | 18.1% |
| 5-10 years | 11 | 11.7% |
| 11-15 years | 11 | 11.7% |
| 16-20 years | 12 | 12.8% |
| Over 20 years | 43 | 45.7% |
| TOTAL | 94 | 100% |

## Discussion of survey results

### *Overall ranking of the risk mitigation measures*

The mean scores of each of the 18 listed risk mitigation measures for all respondents were computed and ranked in descending order of significance as portrayed in Table II. As the number of attributes (measures) considered were larger than seven, the chi-square value would be used as a near approximation instead of the Kendall's coefficient of concordance to measure the agreement of different respondents on their rankings of risk mitigation measures for GMP/TCC as a whole based on the mean scores. According to the degree of freedom (18

- 1 = 17) and the allowable level of significance (5%), the critical value of chi-square from table was found to be 28.870 (Siegel and Castellan, 1988). For all respondents, the actual computed chi-square value of 178.308 was well above the critical value of chi-square of 28.870. This result indicates the null hypothesis that "Respondents' sets of rankings are unrelated (independent) to each other" has to be rejected. Consequently, there is sufficient evidence to conclude that there is significant degree of agreement among all respondents on the rankings of the risk mitigation measures for GMP/TCC. This concordance test ensures the data and opinions collected from the questionnaire survey to be valid and consistent for further analysis.

The mean values for the 18 measures as rated by all respondents ranged from 2.64 to 3.90. Since all the mean values are above 2 (fairly effective), it can be interpreted that the respondents believed the suggested risk mitigation measures to be effective and feasible in general but with different levels of agreement only. They ranked "Right selection of project team" as the most effective risk mitigation measure for GMP/TCC construction projects. Chan *et al.* (2010b) suggested that the selection of a competent project team is essential to overall project success of a target cost contract, since inexperienced or claim conscious contractors may jeopardise the smooth implementation of the GMP/TCC procurement process. Gander and Hemsley (1997) shared a similar perception that the recruitment of an experienced project team was crucial to the success of a GMP/TCC project as an inexperienced one could generate a lack of clarity for his roles and obligations. The client needs to constitute a project team who is receptive to innovative ideas, particularly the main contractor has to be proactive and willing to communicate with other project participants based on the collaborative partnering concepts.

A right selection of project team could be achieved by pre-qualification of contractors. Eriksson *et al.* (2009) launched an 18-month longitudinal case study to investigate the ways in which construction clients can overcome the barriers to partnering implementation by adopting purposeful procurement procedures in Sweden. It is found that pre-qualification of main contractors and subcontractors was made in the case and it functioned well in the case study. A similar pre-qualification exercise was reported from a case study of the underground railway station modification works procured with a target cost contract in Hong Kong (Chan *et al.*, 2010b).

The second most effective risk mitigation measure as perceived by the respondents was "Mutual trust between the parties to the contract". It is found that partnering concepts were introduced in parallel in a number of GMP/TCC construction projects in Hong Kong (Chan *et al.*, 2007a). The methodology of TCC is usually applied in projects with high risks (Wong, 2006), so mutual trust between the employer and the contractor would be necessary to cope with the risks associated with the projects. In addition, because of the unique arrangement of the target cost contracting approach based on joint determination and agreement between the client and the contractor on the allocation of major risks, the client recognised the essence of realistic target cost estimates, which would include appropriate risk contingencies under the pain-share/gain-share mechanism (Chan *et al.*, 2010b). Mutual trust and close working relationship are therefore critical in managing and reducing the possible risks under a teamwork culture.

Hartman (2000) proposed a trust model which enables adetailed understanding of the concepts of trust. According to this model, there are three types of trust as to how people place their trust on another party in construction projects; namely competence trust, integrity trust and intuitive trust. Zaghloul and Hartman (2003) suggested that partner's competence trust can be gained by observable proofs such as track records and hands-on experience of previous similar projects. Integrity trust is built on the willingness of a party to protect the interest of another party over the construction projects (Wong and Cheung, 2004). The intuitive trust is the perception which is not highly affected by the instant performance of the parties; instead, it is affected by the long-term relationship between the partners (Wong and Cheung, 2004). Khalfan *et al.* (2007) provided some recommendations for trust building within the construction industry. Their study advocated that trust could be developed by repeated fulfilment of communications through actions and outcomes. If a person can consistently prove himself to be reliable, he/she will be trusted. Kadefors (2004) recommended that soft goals focusing on relations and work processes can be established in partnering projects to help reduce the negative effect of formal contractual rules on the behaviours of project participants. Since project partnering is employed in most GMP/TCC construction projects in Hong Kong (Chan *et al.*, 2007a), the above-mentioned strategies are applicable to projects procured with GMP/TCC schemes as well.

**Table II.** Results of the overall ranking for risk mitigation measures for GMP/TCC

| **Risk mitigation measures for GMP/TCC** | **Frequency** | **Mean** | **Standard deviation** | **Rank** |
|---|---|---|---|---|
| Right selection of project team | 94 | 3.90 | 0.843 | 1 |
| Mutual trust between the parties to the contract | 94 | 3.73 | 1.109 | 2 |
| Clearly defined scope of works in client's project brief | 94 | 3.67 | 1.010 | 3 |
| Early involvement of the main contractor in design development process | 94 | 3.64 | 0.960 | 4 |
| Proactive participation by the main contractor throughout the GMP/TCC process | 94 | 3.61 | 0.895 | 5 |
| Prompt valuation and agreement on any variations as they are introduced | 94 | 3.60 | 0.872 | 6 |
| Reasonable sharing mechanism of cost saving / overrun of budget between client and contractor | 94 | 3.59 | 0.999 | 7 |
| Confirming a contract GMP value or target cost after design documents are substantially completed | 94 | 3.56 | 0.887 | 8 |
| Sufficient time given to interested contractors to submit their bids for consideration | 94 | 3.54 | 0.991 | 9 |
| Tender interviews and tender briefings to ensure tenderers gain a clear understanding of scope of works involved and necessary obligations to be taken in the project | 94 | 3.48 | 0.864 | 10 |
| Clearly stated circumstances in which agreed GMP value or target cost can be adjusted in contracts | 94 | 3.46 | 0.980 | 11 |
| Establishment of adjudication committee and meetings to resolve potential disputed issues | 93 | 3.27 | 0.946 | 12 |
| Open-book accounting regime provided by main contractors in support of their tender pricing | 93 | 3.24 | 1.136 | 13 |
| Proper risk register with responsible parties assigned and agreed | 94 | 3.23 | 0.977 | 14 |
| Implementation of relational contracting within the project team | 92 | 3.14 | 1.033 | 15 |
| Development of standard contract clauses in connection with GMP/TCC schemes or methodology | 94 | 3.04 | 1.004 | 16 |
| Application of price fluctuation clause in the contract | 94 | 2.90 | 0.928 | 17 |
| Employing a third party to review the project design in compliance with prevailing building regulations and buildability at tender stage | 94 | 2.64 | 0.937 | 18 |
| Number (n) | 94 | | | |
| Kendall's coefficient of concordance (W) | 0.115 | | | |
| Actual calculated chi-square value | 178.308 | | | |
| Critical value of chi-square from table | 28.870 | | | |
| Degree of freedom (df) | 17 | | | |
| Asymptotic level of significance | <0.001 | | | |
| $H_0$ = Respondents' sets of rankings are unrelated (independent) to each other | | | | |
| Reject $H_0$ if the actual chi-square value is larger than the critical value of chi-square from table | | | | |
| Note: Items were rated on a 5-point Likert scale (1 = Least effective; 2 = Fairly effective; 3 = Effective; 4 = Very effective; and 5 = Most effective). | | | | |

"Clearly defined scope of works in client's project brief" was considered as the third most effective risk mitigation measures. Since "change in scope of works" was regarded as the most significant risk in the same survey (Chan *et al.*, 2010a), it is not surprising that respondents believed that clearly defining the scope of works at project commencement could effectively mitigate risks inherent with GMP/TCC projects during site construction. This finding is consistent with that in a recent study from the United Kingdom (Olawale and Sun, 2010), suggesting that clear distinction between a design change and a design development item well at the outset of a construction project could mitigate the potential risks due to subsequent design changes. With design development being a continuously evolving process in GMP/TCC contracts, interpretation of changes whether they arise out of design development or they are classified as GMP/TCC variations could lead to potential disputes if not readily resolved (Gander and Hemsley, 1997). Thus, it is important to define the scope of work as detailed and accurate as possible at the initial project stage and to keep scope changes or necessary variations to a minimum.

Improvement in the briefing process at an early stage of project development may be one of the possible solutions to define a clearer scope of works in GMP/TCC projects. According to Yu *et al.* (2007), briefing is a process in which the client requirements are identified and articulated at an early design stage of a construction project and it is very important to the success of construction projects. Inadequacy of briefing may be attributed to the lack of comprehensive framework for identifying the requirements of employers. Shen and Chung (2006) conducted a comprehensive investigation of the practice of project briefing in Hong Kong and suggested that the application of value management and information technology may help improve the briefing process and identify the needs of the client at the early stage of projects.

"Early involvement of the main contractor in design development process" is discerned as the fourth most effective measure to mitigate risks associated with GMP/TCC schemes. Early contractor's involvement is defined as an arrangement for engaging the contractor from the early design stage of a project and allows the contractor to contribute his construction expertise to the design (Song *et al.*, 2009). Mosey (2009) held a view that it has long been recognised that design contributions should not be made only by consultants, but also by main contractors and specialist contractors in order to achieve a complete and functional design. Song *et al.* (2009) documented a case study of early contractor's involvement in the United States. Their study revealed that observed benefits of early contractor's participation include improved drawing quality, timely materials supply and prompt information flow. It was also concluded that early involvement of contractor led to reduction of project duration, because of the improved design and capitalisation of contractor's knowledge and experience. The finding is supportive to that of this study in risk mitigation of GMP/TCC projects, since the contractor's knowledge and experience on both design and construction could be applied to GMP/TCC schemes for enhancing the overall buildability of project design (Chan *et al.*, 2010b). Hence, it is recommended that involvement of contractor at the early design stage of GMP/TCC projects may help mitigate the risk of excessive number of design changes at the post-contract stage.

"Proactive participation of the main contractor throughout the GMP/TCC process" was ranked as the fifth most effective risk mitigation measures in this study. Proactive participation of main contractor is definitely beneficial to the overall project delivery of GMP/TCC contracts. In fact, the early warning clause under the NEC3 (New Engineering Contract Version 3) Option C (and D) is a contractual clause to encourage the proactive participation of the contractor and project manager to give early warning to the project team for matters which could increase the total of the price; delay completion; delay meeting a key milestone date and/or impair the performance of the works. The project team would attend a "risk mitigation" meeting to seek plausible solutions for reducing the impact of various possible risks together. Such a mechanism is found to be an effective means for risk mitigation built in the NEC3 through the development of a proper risk register with responsible parties assigned and agreed. In addition, a case study undertaken by Bayliss *et al.* (2004) demonstrated that teambuilding activities such as a shared site office and mutually agreed project objectives could be useful in creating shared values between different project team members. The case study investigated by Eriksson (2009) also offered similar findings that the participation and commitment of all key project participants enhance the value creation which is beneficial to the overall performance of a complex construction project of a manufacturing plant for pharmaceutical products in Sweden.

*Factor analysis of risk mitigation measures*

Factor analysis is considered as a statistical technique to identify a relatively small number of individual factors which can be used to represent the relationships among sets of many interrelated variables (Norusis, 1993). It was used to analyse data from the survey questionnaire and identify the underlying cluster of risk mitigation measures for implementing GMP/TCC. On top of the descriptive statistics in the previous section, factor analysis was conducted to reduce the 18 individual risk mitigation measures into a more manageable number of "underlying" grouped factors.

Two analytical techniques, which are the Principal Components Analysis (PCA) and Promax rotation, were employed in factor analysis of this study. PCA was used to identify the underlying clustered factors and to determine the interdependence of variables due to its simplicity and distinctive characteristic of data-reduction capacity for factor extraction. PCA can generate a linear combination of variables which account for as much of the variance present in the data as possible. The 18 individual risk mitigation measures were consolidated into 7 underlying grouped factors after factor analysis. The total percentage of variance explained by each factor was examined to determine how many factors would be required to represent that set of data. Principal factor extraction with Promax rotation and Kaiser normalisation were carried out through the SPSS FACTOR program on the 18 items of risk mitigation measures from a sample of 94 responses. Promax is one of the most commonly used oblique rotation methods (DeCoster, 1998; Biber, 2009) which has been adopted by a multitude of researchers (e.g. Lam *et al.*, 2008; Kärnä *et al.*, 2009). Therefore, Promax rotation method was finally applied to this study for further discussion. Table III contains the details and initial statistics for each of the 18 items. The total variance explained by each factor was listed in the column under "factor loading". The percentage of variance explained and the cumulative percentage of variance explained are also indicated in Table III.

The appropriateness of employing factor analysis was assessed in this study. The sample size is considered sufficient to conduct factor analysis as it complies with the ratio of 1:5 for number of variables involved to necessary sample size as suggested by Lingard and Rowlinson (2006), i.e. 18 risk mitigation measures multiplied by 5 samples required for each factor = at least 90 samples for assuring sufficient sample size to proceed with factor analysis. The number of samples collected is 94 in this study and the condition is met. Various statistical tests were also undertaken to examine the appropriateness of factor analysis for factor extraction. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Barlett's test of sphericity for the extraction factors can be used. The KMO value ranges from 0 to 1, where 0 implies the sum of partial correlations is large relative to the sum of correlation, and thus factor analysis would not be appropriate (Norusis, 1993). A value close to 1 indicates that the patterns of correlations are relatively compact and factor analysis would generate distinct and reliable individual factors. According to Norusis (1993), the KMO value should be greater than the acceptable threshold of 0.50 for a satisfactory factor analysis to proceed.

**Table III.** Results of factor analysis on the 18 risk mitigation measures for GMP/TCC schemes

| No. | Item | Factor loading | Eigenvalue | Percentage of variance explained | Cumulative percentage of variance explained |
|---|---|---|---|---|---|
| **Factor 1 – Relational Contracting and Mutual Trust** | | | | | |
| 10 | Implementation of relational contracting within the project team | 0.828 | 4.661 | 25.893 | 25.893 |
| 13 | Open-book accounting regime provided by main contractors in support of their tender pricing | 0.725 | | | |
| 11 | Sufficient time given to interested contractors to submit their bids for consideration | 0.662 | | | |
| 12 | Mutual trust between the parties to the contract | 0.591 | | | |
| **Factor 2 – Clear Contract Provisions and Scope of Works** | | | | | |
| 2 | Clearly stated circumstances in which agreed GMP value or target cost can be adjusted in contracts | 0.771 | 2.003 | 11.127 | 37.020 |
| 1 | Application of price fluctuation clause in the contract | 0.671 | | | |
| 3 | Clearly defined scope of works in client's project brief | 0.662 | | | |
| 6 | Confirming a contract GMP value or target cost after design documents are substantially completed | 0.661 | | | |
| **Factor 3 – Involvement of Contractor in Decision Making Process** | | | | | |
| 18 | Establishment of adjudication committee and meetings to resolve potential disputed issues | 0.754 | 1.449 | 8.047 | 45.067 |
| 15 | Reasonable sharing mechanism of cost saving / overrun of budget between client and contractor | 0.730 | | | |
| 8 | Early involvement of the main contractor in design development process | 0.709 | | | |
| **Factor 4 – Right Selection of Project Team** | | | | | |
| 16 | Right selection of project team | 0.853 | 1.337 | 7.430 | 52.497 |
| 14 | Proactive participation by the main contractor throughout the GMP/TCC process | 0.808 | | | |
| 5 | Proper risk register with responsible parties assigned and agreed | 0.556 | | | |
| **Factor 5 – Third Party Review of Project Design at Tender Stage** | | | | | |
| 9 | Employing a third party to review the project design in compliance with prevailing building regulations and buildability at tender stage | 0.801 | 1.132 | 6.290 | 58.786 |
| **Factor 6 – Standard Contract Clauses for GMP/TCC Schemes** | | | | | |
| 7 | Development of standard contract clauses in connection with GMP/TCC schemes or methodology | 0.701 | 1.054 | 5.853 | 64.639 |
| **Factor 7 – Fair Treat of Contractor** | | | | | |
| 4 | Prompt valuation and agreement on any variations as they are introduced | 0.833 | 1.002 | 5.569 | 70.208 |
| 17 | Tender interviews and tender briefings to ensure tenderers gain a clear understanding of scope of works involved and necessary obligations to be taken in the project | 0.653 | | | |

| | | |
|---|---|---|
| KMO measure of sampling adequacy: | | 0.732 |
| Barlett's test of sphericity: | Approximate chi-square value: | 478.547 |
| | Degree of freedom: | 153 |
| | Significance level: | 0.000 |
| Cronbach's alpha reliability coefficient: | | 0.816 |

The KMO value of factor analysis in this study is 0.732 which is much higher than the acceptable threshold of 0.50. The Barlett's test of sphericity is used to test the hypothesis that the correlation matrix is an identity matrix, which indicates that there is no relationship among the items (Pett *et al.*, 2003). The value of the test statistic for Barlett's sphericity is large (chi-square value = 478.547) and the associated significance level is small (p-value = 0.000), implying that the population correlation matrix is not an identity matrix. The Cronbach's alpha reliability coefficient was used for checking internal consistency (reliability) between 0 and 1, based on the average inter-item correlation. The usual rule is that if the alpha value is larger than 0.70, according to Nunnally (1978), it can be concluded that the adopted measurement scale is reliable. In this study, the overall alpha value for the 18 risk mitigation measures was found to be 0.816, implying that there is good internal consistency (reliability) in terms of the correlations among the 18 factors, and the adopted measurement scale is reliable. Due to the fact that the requirements of KMO value and the Barlett's test of sphericity are both achieved, it can therefore be concluded that factor analysis was appropriate for this research and can be proceeded with confidence and reliability.

Seven underlying factors were extracted in this case, representing 70.2% of the total variance in responses, which is higher than the minimum requirement of 60% as advocated by Malhotra (1996). SPSS drops the factors from "8" to "18" as their eigenvalues are less than 1.0. It means that they are less influential than the seven observed underlying clustered factors. The 18 original risk mitigation measures were all included in one of these 7 underlying grouped factors. All loadings of the 18 individual risk mitigation measures were higher than 0.50 as suggested by Holt (1997). The higher the absolute value of the individual factor loading, the more a particular individual factor contributes to the underlying clustered factor (Proverbs *et al.*, 1997). The values reflect the degree of contribution of individual factors to each underlying grouped factor. It is observed that the factor loadings and the interpretation of the individual factors extracted were reasonably consistent and sufficient.

*Interpretation of the underlying grouped risk mitigation measures*

The grouped risk mitigation measures were analysed in descending order of significance to determine underlying features that linked them. In order to facilitate the explanation of the results of factor analysis, it is necessary to assign an identifiable, collective label to the groups of individual factors of high correlation coefficients, as each of the underlying grouped factors is an aggregation of individual factors (Sato, 2005). It is however stressed that the suggested label is subjective and other researchers may come up with a different label.

**Factor 1 – Relational Contracting and Mutual Trust**

Factor 1 is composed of four items primarily focusing on relational contracting and mutual trust between contracting parties. As may be seen from Table III, the factor loadings on this factor are relatively large amongst all the 18 items. They include "Implementation of relational contracting within the project team"; "Open-book accounting regime provided by main contractors in support of their tender pricing"; "Sufficient time given to interested contractors to submit their bids for consideration"; and "Mutual trust between the parties to the contract". All of these items are in common that they are all related to the underlying relationship between project team members. Zaghloul and Hartman (2003) considered that mutual trust and contracting method are closely related and this relationship is of paramount importance to effective project management and contract administration. As Tay *et al.* (2000) suggest, a close relationship between all the contracting parties is one of the most important factors towards project success for TCC. Another study by Chan *et al.* (2007b) concluded that partnering could be implemented together with GMP/TCC methodology to make the project successful. Partnering, being a form of relational contracting, could improve communication flow, enhance mutual trust, help resolve disputes and improve working relationship between project participants (Chan *et al.*, 2004). It is therefore considered that the application of relational contracting with mutual trust between key project stakeholders could help to mitigate potential risks inherent with GMP/TCC projects which are usually pertaining to design changes and scope of works as a result of improved information flows and working relationship between different parties involved.

**Factor 2 – Clear Contract Provisions and Scope of Works**

Factor 2 includes four items which are all concerned with tender and contract documents. A recent study by Chan *et al.* (2010a) showed that change in scope of works, nature of variations, clarity of tender documents are the key risk factors associated with GMP/TCC construction projects in Hong Kong. Corresponding to such risks, having clear provisions in the contract and scope of works in client's project brief would probably reduce the amount of contractual disputes due to nature of variations and scope of works. Fan and Greenwood (2004) point out, it is advisable for employers to specify circumstances under which agreed GMP value or target cost can be adjusted in contracts, in order to minimise the disputes or claims at the post-contract award stage.

**Factor 3 – Involvement of Contractor in Decision Making Process**

Three items comprise elements of Factor 3 regarding the involvement of contractor in decision making. The items concerned include "Establishment of adjudication committee and meetings to resolve potential disputed issues"; "Reasonable sharing mechanism of cost saving / overrun of budget between client and contractor"; and "Early involvement of the main contractor in design development process". Chan *et al.* (2010b) observed that the GMP/TCC style of procurement in conjunction with the partnering spirit promote deeper collaboration between the client and the main contractor. Regular partnering review meetings and the adjudication committee operating under the GMP/TCC umbrella establish a solid platform to discuss any difficulties encountered and resolve any confrontational issues. This finding is also in line with those in a recent study about financial incentive mechanisms in Australia conducted by Rose and Manley (2010). It is found that contractor's involvement in design could improve the integration of design and construction due to the contribution of contractor's expertise to project buildability. Another earlier study indicates that early involvement of contractor in projects could improve the certainty of construction outcomes (Sidwell and Kennedy, 2004).

**Factor 4 – Right Selection of Project Team**

Factor 4 is made up of three items namely "Right selection of project team"; "Proactive participation by the main contractor throughout the GMP/TCC process"; and "Proper risk register with responsible parties assigned and agreed". Chan *et al.* (2010b) launched a case study of an underground railway station modification project in Hong Kong. It is found that a right selection of project team, which can be achieved by pre-qualification of contractors, is an essential element to facilitate mutual trust and effective communications between project stakeholders. Strong leadership and proactive contractor are significant in dealing with any unexpected issues and potential disputes. The decisions made by all parties involved would either break or make the strategy and processes crucial for project success (Avery, 2006). The risks on inexperienced project stakeholders jeopardising the GMP/TCC procurement process could be therefore considerably reduced with the right selection of a competent project team.

**Factor 5 – Third Party Review of Project Design at Tender Stage**

Factor 5 consists of only one item (i.e. "Employing a third party to review the project design in compliance with prevailing building regulations and buildability at tender stage"). This measure could offer a chance for the employer to review the project design before tender documentation and hence reducing the likelihood of occurrence of errors and omissions in both tender and contract documents. This risk mitigation measure is similar to that suggested by Olewale and Sun (2010). One of the risk mitigation measures for design changes in construction projects is to appoint a design manager to manage design changes and review related information as it comes in. Chan *et al.* (2010a) launched seven in-depth interviews with industrial practitioners with abundant hands-on experience in GMP/TCC construction projects, indicating that a third party review of project design to comply with current building regulations and buildability at tender stage is discerned as one of the effective strategies for mitigating risks as advocated by their interviewees.

**Factor 6 – Standard Contract Clauses for GMP/TCC Schemes**

Similar to Factor 5, Factor 6 is only made up of one item. The launch of standard contract clauses for GMP/TCC schemes is considered as a significant element of successful project delivery for GMP/TCC projects (Chan *et al.*, 2007a). Despite the fact that the NEC3's Engineering and Construction Contracts have been established for several years (including Option C – Target Cost with Activity Schedule and Option D – Target Cost with Bills of Quantities), their application is rather limited in Hong Kong. Up to the moment at which this paper was drafted, only one single case of using the NEC3 Option C is observed (Cheung, 2008). In case of GMP projects, it is found that developers tend to apply their own in-house standard contracts with amendments to accommodate the GMP methodology (Chan *et al.*, 2007a). Ting (2006) recommended that developing a standard form of contract for GMP scheme in Hong Kong would enhance the receptivity of such procurement option.

**Factor 7 – Fair Treat of Contractor**

Factor 7 comprises two items looking at fair treat of contractor, namely "Prompt valuation and agreement on any variations as they are introduced" and "Tender interviews and tender briefings to ensure tenderers gain a clear understanding of scope of works involved and necessary obligations to be taken in the project". Bower *et al.* (2002) opined that incentivisation of a contract requires a clear understanding of what to be achieved at the outset of project. It is thus important to arrange a tender interview and a tender briefing to make sure that interested tenderers acquire a clear understanding of scope of works and the GMP/TCC operational mechanism for the project concerned. Tender interviews can enable the tenderers to really understand and recognise the potential risks involved in the project before contract award. Tender briefings should be comprehensive, transparent and fair to all of the propsective bidders. Prompt valuation of variations could probably mitigate the potential disputes and intractable claims about quantum and nature of variations. In case of any disagreements on such valuation, the contracting parties could refer to the dispute resolution mechanism promulgated in the contract as soon as possible to avoid affecting other construction works at construction stage. The above two items appear to be fair to both sides of client and contractor and hopefully can keep the number of disputes or claims to minimum.

## CONCLUSIONS

An empirical questionnaire survey was launched with relevant industrial practitioners to solicit their perceptions on some recommended risk mitigation measures for GMP/TCC schemes which are still at a germinating stage of development in the construction industry of Hong Kong. The five most effective individual risk mitigation measures as perceived by those industrial practitioners encompass: (1) Right selection of project team; (2) Mutual trust between the parties to the contract; (3) Clearly defined scope of works in client's project brief; (4) Early involvement of the main contractor in design development process; and (5) Proactive participation by the main contractor throughout the GMP/TCC process. Following the descriptive analysis of the survey results, factor analysis was employed to crystallise seven underlying clustered risk mitigation measures. It was found that these underlying grouped risk mitigation measures mainly focus on relationship management (e.g. "Relational contracting and mutual trust" and "Involvement of contractor in decision making process") and tendering process (e.g. “Clear contract provisions and scope of works”, “Third party review of project design at tender stage” and “Standard contract clauses for GMP/TCC schemes”). This finding is logical since the success of implementing GMP/TCC forms of contractual arrangement is heavily dependent on partnering spirit and well-defined scope of works at the outset of project (Chan *et al.*, 2010b).

With the identified risk mitigation measures for GMP/TCC methodology in mind, industry leaders and decision makers are bestowed sufficient evidence and useful pointers to determine whether to adopt GMP/TCC contracts in future projects or not. Moreover, a set of corresponding useful practical strategies for the reduction of possible risks arisen have been generated for implementation by the industrial practitioners. A wider application of GMP/TCC across a broad spectrum of the entire construction industry is anticipated with the purpose of achieving more favourable project outcomes with some effective risk mitigation strategies in place. It is hoped that this research study has served as a first step towards developing plausible solutions for mitigating potential risks associated with the GMP/TCC contractual arrangements which are claimed to be suitable for projects with high risks (Wong, 2006). Further research could be launched in future to verify the applicability and effectiveness of those risk mitigation measures for GMP/TCC schemes advocated in other western countries where such procurement methods are more maturely developed such as the United States, United Kingdom and Australia to draw an international comparison between the East and the West.

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