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# A CRITICAL ANALYSIS OF RISK MITIGATION MEASURES FOR TARGET COST CONTRACTS IN CONSTRUCTION INDUSTRY

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## Abstract
*A scarcity of empirical research has been observed on risk mitigation measures for those construction projects procured by guaranteed maximum price contracts (GMP) and target cost contracts (TCC) worldwide. This paper aims to seek and examine the risk mitigation measures associated with GMP and TCC (GMP/TCC) construction projects through an industry-wide empirical questionnaire survey launched in Hong Kong. Survey respondents were invited to delineate their levels of agreement on 18 individual risk mitigation measures identified from reported literature and in-depth interviews, and the views of client group were compared with those of contractor group. The survey results manifested that both the client group and contractor group are in general consistent in their views towards the risk mitigation measures for GMP/TCC contracts. However, the Mann-Whitney U Test revealed that they held different perceptions on 4 out of the 18 risk mitigation measures, and the findings may stem from different roles involved in the projects. The research findings are useful in providing industrial practitioners with valuable pointers towards effective risk mitigation measures of applying GMP/TCC schemes at an early stage of project delivery.*

**Keywords:** Guaranteed maximum price contracts (GMP), Target cost contracts (TCC), Risk mitigation measures, Construction industry, Hong Kong.

## INTRODUCTION

Traditional adversarial relationships are often encountered between employers and contractors within the construction market, primarily because various project stakeholders tend to focus mainly on the success of their individual own businesses instead of the overall project itself. By linking the individual own financial goals of the contractors with the overall

project objectives, both the Guaranteed Maximum Price (GMP) and Target Cost Contracting (TCC) schemes are often applied as effective means to motivate contractors in achieving better value for money and more favourable project outcomes (Construction Industry Review Committee, 2001). GMP/TCC schemes can add value to project delivery only if the key risk factors are carefully identified, analysed, shared and managed (Trench, 1991; Walker *et al.*, 2000).

Although both GMP and TCC contracts have been in use for several years, not all of these projects were successfully completed and some of them resulted in a high level of risk or an uneven apportionment of risks. For example, Roja and Kell (2008) found that the final construction cost of 75% of public school projects based in the northwest of the United States cost more than the contract GMP value at completion, while the same phenomenon was observed in about 80% of public non-school projects. Hence, it is essential to seek ways to mitigate the potential risks which may be detrimental to the overall project performance of GMP/TCC contracts. This study serves as an attempt to fill up the gap of research in the area of risk mitigation measures for GMP/TCC schemes.

## DEFINITIONS OF GMP/TCC

Carty (1995) defined GMP as "Both the contractor and owner agree that the contractor will perform an agreed scope of works (defined as best as possible) at a price not to exceed an agreed upon amount, the guaranteed maximum price (GMP) …… if these costs and the agreed upon contractor's profit are less than the GMP, the owner and contractor will share the savings in cost based upon an agreed formula. If the costs exceed the GMP without any changes to the defined scope, the contractor must solely bear the additional cost."

The National Economic Development Office (NEDO) (1982) suggested TCC to be "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. Any savings or overruns between target cost and actual cost at completion are shared between the parties to the contract."

## HIGHLIGHTS OF RESEARCH STUDIES ON GMP/TCC

An extensive review of published literature has sought a bunch of research studies in relation to GMP/TCC schemes over recent years. Matthews and Howell (2005) reported on a case study of a central chilled water plant in Orlando of the United States which was procured with a GMP arrangement and achieved a cost saving of around 10% because of the partnering efforts of the project team. Pryke and Pearson (2006) carried out three European case studies and advocated the application of a GMP arrangement to be an effective means to transfer risks to the employer associated with design development at post-contract award stage. Kaplanogu and Arditi (2009) explored the practice of pre-project peer review process of GMP of contractors in the United States via an empirical questionnaire survey. 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.

Badenfelt (2008) launched 16 interviews with the Swedish clients and contractors to identify the important factors influencing the selection of sharing ratio under TCC. Another recent study by Badenfelt (2010) revealed that a business relationship solely built on mutual trust appears to be rare in Sweden, and more attention should be placed by contracting parties to trust-nurturing actions to facilitate a smooth delivery of TCC. Lahdenpera (2010) examined the problem with late involvement in design of contractor in TCC, and proposed a two-stage target cost arrangement to combine early contractor's involvement and price containment.

Despite plentiful literature about the application of GMP/TCC contracts in construction, there seems to be a shortage of empirical research looking into the "risk aspect", especially the risk mitigation measures for GMP/TCC schemes which are generally perceived to be applicable to projects with high levels of complexity and risks. This observation has paved the way for conducting this study with the purpose of generating useful insights into risk mitigation strategies under the GMP/TCC umbrella towards industrial practitioners for reference and implementation.

## DEVELOPMENT OF SURVEY INSTRUMENT

A comprehensive review of relevant materials from textbooks, academic journals, professional journals, conference proceedings, research reports, previous dissertations and internet information was first undertaken to capture background knowledge about the application and risk mitigation of GMP/TCC contracts worldwide. The literature review helped establish an overall framework for the research study and to prepare for the template of the survey questionnaire.

A total of seven semi-structured face-to-face interviews were carried out between June and July of 2008 with senior industrial practitioners with direct hands-on experience in procuring GMP/TCC construction projects in Hong Kong (Chan *et al.*, 2010a) to glean their opinions on key risk factors, risk allocation and risk mitigation measures for implementing GMP/TCC projects. Then an empirical survey questionnaire was compiled according to the findings from literature review (Chan *et al.*, 2010b) and those in-depth interviews. An industry-wide questionnaire survey was subsequently launched from March to April of 2009 to solicit 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 was made up of four major sections. The first section was about the respondents' general personal profiles. The second section was concerned with the risk identification and assessment of 34 listed key risk factors in relation to GMP/TCC construction projects. The third section focused on the risk mitigation measures for GMP/TCC contracts 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 "effective" and 5 "most effective". The fourth section was optional and the respondents were requested to show their personal preference on future development and application of GMP/TCC contractual arrangements with their supporting reasons. It should be stressed that only the survey findings in relation to the risk mitigation measures are reported and discussed in this paper due to length limitation. The results of other sections will be duly documented and disseminated in other publications in

near future, for example, on the first section of the development of a fuzzy risk assessment model (Chan *et al.*, 2011).

Altogether, 300 self-administered blank survey forms were delivered to individual construction professionals and project stakeholders in Hong Kong through both postal mail and electronic mail between March and April of 2009. The target survey respondents were first determined from previous research studies on GMP/TCC procurement strategies in Hong Kong undertaken by the authors (Chan *et al.*, 2007). A total of 94 valid and duly completed survey forms were returned in June of 2009 for further statistical analysis. The 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.*, 2010b). Since all of the major active practitioners in applying GMP/TCC had been included in the list of target respondents of the questionnaire survey, it was discerned 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 perceived as representative of the survey population given the limited number of construction projects completed under GMP/TCC schemes in Hong Kong (about 20 as cited by Chan *et al.*, 2007).

Table 1 serves as a summary of the profiles of the 94 respondents. More than 80% of the respondents have already derived working experience of at least 5 years within the construction industry, their opinions and data collected from the survey are regarded as representative and reliable. The collective opinions from all of the survey respondents will be presented in this paper, and the views of client group will also be compared with those of contractor group because they are the key players in driving the GMP/TCC procurement process. A four-level data analysis framework (Chan *et al*., 2010b), including descriptive statistics, Kendall's concordance test, Spearman's rank correlation test and Mann-Whitney U Test, will be applied to investigate the intra-group agreements and inter-group comparisons for this survey.

***Table 1:*** *Personal profiles of survey respondents*

| Category | Respondents | |
|---|---|---|
| | Frequency | Percentage |
| *Grouping by role in the project* | | |
| Client | 33 | 35.1% |
| Contractor | 27 | 28.7% |
| Consultant (i.e. architects, engineers, quantity surveyors, project managers, etc) | 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% |

## PRESENTATION OF SURVEY RESULTS

### Overall ranking of the risk mitigation measures for GMP/TCC projects

The mean scores of each of the 18 listed risk mitigation measures as rated by all respondents were calculated and they were ranked in descending order of the mean scores as reported in Table 2. The mean values for the 18 measures ranged from 2.60 to 3.90. Since all the mean values are above 2 (fairly effective), the respondents believed the suggested risk mitigation measures to be effective and feasible in general but with different levels of agreement only. Item 16 "Right selection of project team" was ranked as the most effective risk mitigation measure for GMP/TCC construction projects. Chan *et al.* (2010c) advocated that the selection of a competent project team is crucial to overall project success of a target cost contract, as inexperienced or claim-conscious contractors may jeopardise the smooth implementation of the GMP/TCC procurement process. Gander and Hemsley (1997) also concurred the recruitment of an experienced project team as crucial to the success of a GMP/TCC project since an inexperienced one could generate a lack of clarity for his roles and obligations.

The respondents ranked Item 3 "Clearly defined scope of works in client's project brief" as the second 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.*, 2010b), it is not astonishing that respondents indicated that a clear definition of scope of works at project commencement could effectively mitigate risks inherent with GMP/TCC projects during site construction. This finding is in line 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 reduce the potential risks arising from subsequent design changes. Thus, it is essential to define the scope of works as detailed and accurate as possible at the initial project stage and to keep scope changes or necessary variations to a minimum.

The third most effective risk mitigation measure was Item 12 "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.*, 2007). 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. Moreover, 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.*, 2010c). Mutual trust and close working relationship are thus essential in reducing the possible risks under a teamwork culture.

***Table 2:*** *Rankings and results of Kendall's concordance test of risk mitigation measures for GMP/TCC construction projects*

| ID | Risk Mitigation Measures for GMP/TCC | All respondent group | | | Client group | | | Contractor group | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean | Rank | N | Mean | Rank | N | Mean | Rank |
| 16 | Right selection of project team | 60 | 3.90 | 1 | 33 | 4.00 | 1 | 27 | 3.78 | 1 |
| 3 | Clearly defined scope of works in client's project brief | 60 | 3.73 | 2 | 33 | 3.79 | 2 | 27 | 3.67 | 6 |
| 12 | Mutual trust between the parties to the contract | 60 | 3.70 | 3 | 33 | 3.67 | 4 | 27 | 3.74 | 3 |
| 6 | Confirming a contract GMP value or target cost after design documents are substantially completed | 60 | 3.63 | 4 | 33 | 3.70 | 3 | 27 | 3.56 | 11 |
| 4 | Prompt valuation and agreement on any variations as they are introduced | 60 | 3.58 | 5 | 33 | 3.52 | 5 | 27 | 3.67 | 6 |
| 14 | Proactive participation by the main contractor throughout the GMP/TCC process | 60 | 3.57 | 6 | 33 | 3.48 | 6 | 27 | 3.67 | 9 |
| 15 | Reasonable sharing mechanism of cost saving / overrun of budget between client and contractor | 60 | 3.55 | 7 | 33 | 3.42 | 9 | 27 | 3.70 | 4 |
| 8 | Early involvement of the main contractor in design development process | 60 | 3.53 | 8 | 33 | 3.39 | 10 | 27 | 3.70 | 5 |
| 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 | 60 | 3.50 | 9 | 33 | 3.42 | 7 | 27 | 3.59 | 10 |
| 11 | Sufficient time given to interested contractors to submit their bids for consideration | 60 | 3.47 | 10 | 33 | 3.24 | 12 | 27 | 3.74 | 2 |
| 2 | Clearly stated circumstances in which agreed GMP value or target cost can be adjusted in contracts | 60 | 3.45 | 11 | 33 | 3.27 | 11 | 27 | 3.67 | 6 |
| 18 | Establishment of adjudication committee and meetings to resolve potential disputed issues | 60 | 3.39 | 12 | 33 | 3.42 | 7 | 27 | 3.35 | 13 |
| 5 | Proper risk register with responsible parties assigned and agreed | 60 | 3.17 | 13 | 33 | 3.24 | 12 | 27 | 3.07 | 16 |
| 7 | Development of standard contract clauses in connection with GMP/TCC schemes or methodology | 60 | 3.12 | 14 | 33 | 3.00 | 15 | 27 | 3.26 | 15 |
| 1 | Application of price fluctuation clause in the contract | 60 | 3.07 | 15 | 33 | 2.82 | 16 | 27 | 3.37 | 12 |
| 13 | Open-book accounting regime provided by main contractors in support of their tender pricing | 60 | 3.03 | 16 | 33 | 3.09 | 14 | 27 | 2.96 | 17 |
| 10 | Implementation of relational contracting within project team | 60 | 2.97 | 17 | 33 | 2.69 | 17 | 27 | 3.30 | 14 |
| 9 | Employing a third party to review the project design in compliance with prevailing building regulations and buildability at tender stage | 60 | 2.60 | 18 | 33 | 2.36 | 18 | 27 | 2.89 | 18 |
| | Number (N) | | 60 | | | 33 | | | 27 | |
| | Kendall's coefficient of concordance (W) | | 0.124 | | | 0.175 | | | 0.109 | |
| | Actual calculated chi-square value | | 122.149 | | | 95.221 | | | 48.284 | |
| | Critical value of chi-square from table | | 28.870 | | | 28.870 | | | 28.870 | |
| | Degree of freedom (df) | | 17 | | | 17 | | | 17 | |
| | Significance level | | <0.001 | | | <0.001 | | | <0.001 | |
| | $H_0$ = Respondents' sets of rankings are unrelated (independent) to each other within each group<br>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). | | | | | | | | | |

## Results of Kendall's concordance analysis

The second step of data analysis is to perform a Kendall's test of concordance to gauge the agreement of different respondents on their rankings of the risk mitigation measures for GMP/TCC within a particular respondent group (*Chan et al*., 2010b). As the number of

attributes (i.e. risk mitigation measures) considered was 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 28.87 (Siegel and Castellan, 1988). For all respondents, the actual computed chi-square value of 122.149 was much greater than the critical value of chi-square of 28.87. 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. The same result (actual calculated value of chi-square larger than critical value of chi-square) is found in both the client group and contractor group. This concordance test ensures the data and opinions collected from the questionnaire survey to be valid and consistent for further analysis.

**Results of Spearman's rank correlation test**

With the purpose of comparing the perceptions between the client group and contractor group, the next step of data analysis is to conduct a Spearman's rank correlation test. The Spearman's rank correlation coefficient is a statistical tool to test the strength of relationship between the rankings of two respondent groups (Olawale and Sun, 2010). The level of association between the client group and contractor group on their rankings of the 18 risk mitigation measures for GMP/TCC schemes was gauged by the Spearman's Rank Correlation Coefficient ($r_s$). The coefficient, $r_s$ , ranges between –1 and +1. A value of +1 indicates a perfect positive correlation, while a value of –1 indicates a perfect negative correlation (Fellows and Liu, 2008). If the Spearman's rank correlation coefficient ($r_s$) was statistically significant at 5% significance level, the null hypothesis that "No significant correlation on the rankings between the two groups" can be rejected. It can then be concluded that there is significant association between the two groups on the ranking exercise.

The level of agreement amongst the respondents on the ranking exercise was tested via the Spearman's rank correlation test as portrayed in Table 3. The results reflected that the null hypothesis that no significant correlation on the ranking between the client group and contractor group is rejected at 1% significance level. This results in significant correlations in general on the rankings of risk mitigation measures between the two respondent groups and they shared similar perceptions on the ranking exercise as a whole (e.g. Item 16 both ranked as the 1st, Item 7 as the 15th and Item 9 as the 18th).

***Table 3:*** *Results of Spearman's rank correlation test on the risk mitigation measures for GMP/TCC construction projects between client group and contractor group*

| Comparison of Rankings | $r_s$ | Significance Level | Conclusion |
|---|---|---|---|
| Client's ranking vs Contractor's ranking | 0.625 | 0.006 | Reject $H_0$ at 1% significance level |

$H_0$ = No significant correlation on the rankings between the two groups
$H_a$ = Significant correlation on the rankings between the two groups
Reject $H_0$ if the actual significance level (p-value) is less than the allowable value of 5%

**Results of Mann-Whitney U Test**

The final step of data analysis is to detect any differences in perception on individual risk mitigation measures by means of the Mann-Whitney U Test. The Mann-Whitney U Test is a non-parametric statistical test which is applied in hypothesis testing involving two independent variables (Gibbons and Chakraborti, 2003). It is performed to test if there is any statistically significant difference in the median values for each attribute under study between any two respondent groups. This same technique was adopted in a recent research by Wibowo and Mohamed (2010) to test whether there was statistical difference between perception towards criticality of risks of regulators and operator in water supply projects in Indonesia. This test is used because it is distribution free and thus requiring no assumption of normality of data sets (Wibowo and Mohamed, 2010). The Mann-Whitney U Test was applied in this study to test the null hypothesis that "There is no significant difference in the median values of the same risk mitigation measure between the respondents from client group and contractor group" and the medians can be represented by mean ranks (Sheskin, 2007).

Level of significance ($\alpha$) for testing these hypotheses was set at 5%. The results can be interpreted by the Z-value and p-value. When the actual calculated p-value is less than the pre-defined significance level of 5%, then the null hypothesis ($H_0$) can be rejected. Thus, it can be concluded that there is a significant difference in the median values of that risk mitigation measure between the two respondent groups (Sheskin, 2007).

The results of Mann-Whitney U Test are shown in Table 4. It can be seen that the two groups of respondents had statistically different perceptions towards 4 out of the 18 risk mitigation measures. The contractor group considered Item 1 "Application of price fluctuation clause in the contract" more important than the client group. This finding may stem from the fact that there was a significant increase in the materials price when the survey was conducted (i.e. first half of 2009). The contractors suffered a lot for such increase in materials price if the price fluctuation clause was not applied. So the contractor group would believe the price fluctuation clause to be very effective in mitigating risks in GMP/TCC schemes.

The two groups of respondents also held different views towards Item 9 "Employing a third party to review the project design in compliance with prevailing building regulations and buildability at tender stage". This risk mitigation measure is similar to that found from those interviews undertaken in the United Kingdom by Olawale and Sun (2010) that employing a design manager to manage the design process and review related information as it comes in. Again, the contractor group perceived this risk mitigation measure as more effective than the client group did. Perhaps, the contractor group may advocate that the lack of buildability of project design would unnecessarily delay the overall project duration and affect the progress of subsequent portions / phasing of works. The contractor's resources may be wasted in preparing for works which is actually difficult to construct, due to the deficient initial project design.

***Table 4:*** *Results of Mann-Whitney U Test between the client group and contractor group on the risk mitigation measures for GMP/TCC construction projects*

| Risk Mitigation Measures for GMP/TCC | Respondent Group | Mean Rank | Significance Level |
|---|---|---|---|
| **1. Application of price fluctuation clause in the contract** | **Client** | **26.42** | **0.036*** |
| | **Contractor** | **35.48** | |
| 2. Clearly stated circumstances in which agreed GMP value or target cost can be adjusted in contracts | Client | 27.59 | 0.128 |
| | Contractor | 34.06 | |
| 3. Clearly defined scope of works in client's project brief | Client | 31.45 | 0.622 |
| | Contractor | 29.33 | |
| 4. Prompt valuation and agreement on any variations as they are introduced | Client | 29.73 | 0.688 |
| | Contractor | 31.44 | |
| 5. Proper risk register with responsible parties assigned and agreed | Client | 31.94 | 0.457 |
| | Contractor | 28.74 | |
| 6. Confirming a contract GMP value or target cost after design documents are substantially completed | Client | 31.15 | 0.734 |
| | Contractor | 29.70 | |
| 7. Development of standard contract clauses in connection with GMP/TCC schemes or methodology | Client | 28.58 | 0.326 |
| | Contractor | 32.85 | |
| 8. Early involvement of the main contractor in design development process | Client | 28.36 | 0.273 |
| | Contractor | 33.11 | |
| **9. Employing a third party to review the project design in compliance with prevailing building regulations and buildability at tender stage** | **Client** | **26.58** | **0.044*** |
| | **Contractor** | **35.30** | |
| **10. Implementation of relational contracting within project team** | **Client** | **25.16** | **0.013*** |
| | **Contractor** | **35.74** | |
| **11. Sufficient time given to interested contractors to submit their bids for consideration** | **Client** | **26.59** | **0.043*** |
| | **Contractor** | **35.28** | |
| 12. Mutual trust between the parties to the contract | Client | 29.88 | 0.752 |
| | Contractor | 31.26 | |
| 13. Open-book accounting regime provided by main contractors in support of their tender pricing | Client | 31.52 | 0.606 |
| | Contractor | 29.26 | |
| 14. Proactive participation by the main contractor throughout the GMP/TCC process | Client | 29.08 | 0.457 |
| | Contractor | 32.24 | |
| 15. Reasonable sharing mechanism of cost saving / overrun of budget between client and contractor | Client | 28.95 | 0.429 |
| | Contractor | 32.39 | |
| 16. Right selection of project team | Client | 32.47 | 0.305 |
| | Contractor | 28.09 | |
| 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 | Client | 28.95 | 0.419 |
| | Contractor | 32.39 | |
| 18. Establishment of adjudication committee and meetings to resolve potential disputed issues | Client | 30.80 | 0.670 |
| | Contractor | 28.98 | |

* Risk mitigation measures with a significance level of less than 0.05 which indicates significant statistical differences

The contractor group also rated Item 10 "Implementation of relational contracting within project team" higher than the client group did. According to Chan *et al*. (2007a), partnering spirit is essential to the overall success of GMP/TCC projects. The partnering spirit incorporated in relational contracting enhances the willingness to achieve co-operation between the contracting parties and ensures a smooth operation of the projects.

Finally, the two respondent groups shared different views on Item 11 "Sufficient time given to interested contractors to submit their bids for consideration". This finding is not surprising since it is the contractor to submit the bids, the client may like to have the overall project duration as short as possible and may be less concerned about the tendering period. A reasonable tendering period would allow interested contractors to gain a basic understanding

of the special features and contractual requirements of the project such as the methodology of GMP/TCC contractual arrangements (Chan *et al*., 2010a). The tenderers would probably recognise potential risks involved in the projects concerned before contract award, and this would certainly reduce the risks such as change in scope of works at the post contract award stage.

## CONCLUSIONS

An empirical questionnaire survey was launched on some risk mitigation measures for GMP/TCC schemes which are still at a germinating stage of development in the construction industry of Hong Kong. The three most effective individual risk mitigation measures as perceived by those industrial practitioners are: (1) Right selection of project team; (2) Mutual trust between the parties to the contract; and (3) Clearly defined scope of works in client's project brief.

Following the descriptive analysis of the survey results, the Kendall's concordance test indicates that the responses in both the client group and contractor group are in general consistent within their respective groups. The result of Spearman's rank correlation test further suggests that the rankings of risk mitigation measures between the two groups are also consistent statistically as a whole. The Mann-Whitney U Test shows that the contractor group perceived 4 out of the 18 risk mitigation measures as much more effective than the client group did in the survey.

With the survey results of this study in mind, industry leaders and decision makers have secured sufficient evidence and useful pointers to determine whether to adopt GMP/TCC contracts in future projects or not. It is hoped that this research study could be served as a first step towards generating valuable solutions for mitigating potential risks associated with the GMP/TCC contractual arrangements which are discerned to be suitable for projects with high risks (Wong, 2006). Further research could be undertaken in future via case studies to confirm the applicability and effectiveness of those suggested practical strategies for mitigating the potential risks inherent with GMP/TCC schemes worldwide.

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