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Preferred risk allocation in target cost contracts in construction

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Abstract

Purpose – The purpose of this paper is to identify the party most preferred to take the risks associated with the Target Cost Contracts and Guaranteed Maximum Price Contracts (TCC/GMP) in the Hong Kong context.
Design/methodology/approach – An empirical questionnaire survey was conducted with the relevant industrial practitioners to solicit their preferences of risk allocation in TCC/GMP construction projects in Hong Kong.
Findings – The survey findings indicated that risks on tender documentation and project design are better borne by clients, while construction related risks are perceived to be taken by contractors. The research findings are consistent with other similar studies on risk allocation in construction projects in general.
Practical implications – This paper has developed a preferred risk allocation scheme for the delivery of future TCC/GMP projects, taking Hong Kong as an example. It can serve as a useful guide for the decision makers to determine an optimal risk allocation at the planning stage of a TCC/GMP scheme.
Originality/value – This study is expected to benefit both academic researchers and industrial practitioners in generating an equitable risk sharing mechanism for TCC/GMP projects. It has provided sufficient empirical evidence, added to the growing body of knowledge and laid a solid foundation for further research such as an international comparison of various risk allocation schemes associated with this kind of contractual arrangement.

Keywords Target cost contracts, Guaranteed maximum price contracts, Procurement, Risk allocation, Construction industry, China, Contract costs

Paper type Research paper

Introduction

The problems associated with the traditional procurement approach are well regarded as cost overrun and adversarial working relationship between employer and contractor, especially in case of competitive fixed-price lump-sum contracts (Lahdenpera, 2010). It is suggested by Lahdenpera (2010) that gain-share and pain-share depending on the success of the entire project make the employer and contractor consider each other's views better and collaborate more efficiently. Ingirige and Sexton (2007) held similar notion that the objective of a target cost contract (TCC) is to motivate contracting parties to lower the cost incurred without affecting the quality or delivery to maximise the contractor's profitability and client's savings.
Infrastructure developments (e.g. roads, railways, metros, bridges, utility services, etc) play a vital role in influencing the economic viability and social welfare of every country. The complexity and dynamics of the decision making in infrastructure development and management has steadily increased over recent years. Target cost contracts have been widely applied to deliver and manage critical modern infrastructure systems and buildings, with the purpose of enhancing the effectiveness and efficiency of their service delivery.

There has been an increasing trend of application of TCC and GMP (being a variant of TCC) contracts in the private sector and quasi-government sector in Hong Kong over recent years, especially in the sector of public infrastructure works and facilities services (Chan *et al*., 2007a). Moreover, the Government of the Hong Kong Special Administrative Region (HKSAR) has introduced the New Engineering Contract Version 3 (NEC3) Option C (target cost with activity schedule) on a trial basis to an open nullah improvement works project in Sai Kung launched by the Drainage Services Department in August of 2009 (Cheung, 2008). TCC has been practised in the infrastructure sector projects of Hong Kong such as the Tseung Kwan O Railway Extension, Tung Chung Cable Car Project and Tsim Sha Tsui Metro Station Modification Works (Chan *et al.*, 2007a; Chan *et al.*, 2010a). The same procurement strategy was applied to the civil engineering works contracts of the South Island Railway Line in Hong Kong commenced in late 2010 (Mass Transit Railway Corporation, 2011). Interestingly, all these projects procured with TCC are civil engineering infrastructure works projects.

Other research studies reported that GMP was applied in public school projects as well as municipal water and wastewater facilities in the United States (e.g. Rojas and Kell, 2008; Bogus *et al.*, 2010). TCC was also adopted in mega-sized infrastructure works in the United Kingdom such as the New Terminal 5 of Heathrow Airport and some venues for the Olympic Games 2012 in London. Up to June of 2010, there have been 317 schemes of health services sector premises completed by the Department of Health of the United Kingdom as well under this procurement framework applying the New Engineering Contract Version 2 (NEC2) Option C (target cost with activity schedule) according to ProCure21 Guide (2010).

However, not every TCC/GMP project is equally successful in terms of time, cost and quality performances due to the fact that the employers traditionally apply exculpatory clauses to minimise their own obligations in the contracts. This onerous allocation of risks may not be of interest to the construction industry in the long run. The short-term benefits of shifting as many risks as possible to contractors in the contracts may create an atmosphere of hostility that generates a considerable number of contractual disputes and, even worse, a reluctance to tender for works in future (Zaghloul and Hartman, 2003).

Despite the emerging trend of application of TCC/GMP schemes, there has been very scarce amount of published literature touching on the risk allocation of TCC/GMP projects in Hong Kong. As Wong (2006) stated, TCC was usually applied to projects with high risks. Thus, this paper aims to identify the key risk factors associated with TCC/GMP construction projects and then determine the party best capable to take such risks in the Hong Kong context. Such study is expected to benefit both academic researchers and industrial practitioners in exploring the preferred risk allocation of TCC/GMP projects, and in providing a strong base for further research such as an international comparison of different risk allocation schemes accompanied by this kind of contractual arrangement in infrastructure development projects traditionally inherent with high risks.

Literature review

Definitions of TCC and GMP

A target cost contract (TCC) is described as a risk sharing contract (Scott, 1997). Boyd (1985) opined that TCC is a contract in which payment is based on the actual cost of contractor with incentives for efficient performance in terms of time and cost against the targets set before the contract is awarded. Broome and Perry (2002) suggested that a target cost is introduced in this kind of project and any cost saving or overrun against the target cost is divided with pre-agreed and specified portions. Wong (2006) stated that the employer paid the actual cost for the work completed to the contractor during the construction stage. When the final construction cost, termed as the final total cost differed from the initial contract target cost, the variance would be split between the employer and the contractor according to a pre-determined gain-share/pain-share ratio as stipulated in the contract.

GMP can be considered as a lump sum price for a project in which the amount of money which the employer pays is the maximum price under the contract (Davis Langdon and Seah, 2003). Both Fan and Greenwood (2004) and Davis Langdon and Seah (2003) advocated that GMP is not a form of contract, but it is a condition which can be applied to any form of contract. Masterman (2002) defined GMP as an agreement which will reward the contractor for any savings made against the GMP and penalise him when this sum is exceeded because of his own mismanagement or negligence.

Rationale behind using TCC

The development of a construction project can never be accurately predicted, and thus the contracts for construction projects are considered to be incomplete (Turner, 2004). The incompleteness of contracts is attributed to the reality of transaction cost, bounded rationality and information asymmetries which make the employer and contractor design a complete contract (Spier, 1992). Badenfelt (2010b) stated that extent of contract completeness is important in determining what kinds of incentives to be adopted in a contract. Traditional fixed-price contracts have been restricted to projects with few uncertainties on both technology and economics. In practice, owing to information asymmetries, even a "risk neutral" contractor may not be willing to sign a fixed-price contract without offering a high price. However, the high cost of identifying unforeseen events makes it difficult to draft a very elaborate contract to deal with all kinds of uncertainties at the post-contract award stage (Crocker and Reynolds, 1993). Cost-plus contracts may avoid the problem of overpayment, provided that it is well documented, but the client may expose himself to the problem of cost

padding (Badenfelt, 2010b). In order to reduce the negative effect of cost-plus contracts, it becomes a common practice to replace a standard cost-plus contract with a target cost contract which is believed to reinforce the deep collaboration between the client and contractor (Bresnen and Marshall, 2000).

Agency theory suggested that outcome-based contracts can be effective in curbing agent opportunisms (Elsenhardt, 1989). In case of TCC (which can be considered to be an outcome-based contract), the contract can co-align the preference of the principal (the employer) and the agent (contractor), since the reward for both sides depends on the same actions, and reduces the conflict of self-interest between the employer and the contractor. It is further pointed out by Elsenhardt (1989) that information system can also curb opportunism since information systems inform the employer what the contractor is actually undertaking, the contractor will be less likely to deceive the employer. This may be one of the reasons why an open-book accounting arrangement is usually implemented together with TCC/GMP schemes.

Previous research studies on TCC and GMP

Nicolini *et al*. (2000) studied two successful pilot projects with TCC and commented that target costing may be one of the ways to support supply chain integration and improve profitability and quality of the construction industry within the United Kingdom. However, Rojas 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 observed on about 80% of public non-school projects. These findings did not support GMP to be really "guaranteed" as expected.

Perry and Barnes (2000) proposed methods of tender evaluation of TCC and suggested that the contractor's share of cost overrun and under spent should not be less than 50%. Broome and Perry (2002) and Badenfelt (2008) explored how the gain-share/pain-share ratio in TCC should be determined in the British and Swedish perspectives respectively.

Boukendour and Bah (2001) analysed GMP with option pricing theory and considered GMP as a hybrid of cost reimbursement contract and optional contract which hedge the owner from over-budget and provide him possibility of cost savings. Bower *et al.* (2002) examined three projects with different contractual arrangements, including one with TCC, to illustrate the effective use of incentive mechanisms. They concluded that contractual incentive structures should provide appropriate incentives for contractors to meet the targets of cost, schedule and quality; correctly allocate risks and allow a suitable level of client's involvement in the projects.

Both Walker *et al.* (2002) and Hauck *et al.* (2004) investigated the case of the Australian National Museum procured with TCC arrangement. Bubshait (2003) conducted a questionnaire survey on incentive/disincentive contracting with the clients and contractors of industrial projects from Saudi Arabia, and his findings supported the use of this kind of contract. Tang *et al.* (2008) conducted a similar research on incentive contracts in Mainland China through an empirical survey and a case study of the Three Gorges Project.

Pryke and Pearson (2006) launched case studies based in France and the United Kingdom to investigate the gain-share/pain-share arrangement implemented under a prime contracting procurement approach. Their study suggested that the use of GMP scheme has led to a change in attitude of contractors in handling variations occurring at the post-contract award stage which tended to increase the client's final out-turn cost. The contractors became more proactive in financial control of inappropriate variations when a proper financial incentive is installed with the implementation of GMP contracts. Wong (2006) introduced a computerised system for cost management in a cable car project in Hong Kong to facilitate a more efficient management of documentation in TCC projects. Chan *et al.* (2007b) reported on the findings of 8 structured interviews in respect of motives, benefits, difficulties, risks and success factors of TCC/GMP contracts and suitability to adopt those procurement strategies.

Furthermore, Chan *et al.* (2008) also evaluated the effectiveness of partnering on an underground railway extension project with TCC arrangement in Hong Kong via another study, recommending both partnering and TCC to be the essential ingredients of project success. Kaplanogu and Arditi (2009) explored the practice of pre-project peer reviews in construction companies of the United States, suggesting that this kind of review was critical in reducing the risk of a proposed new GMP project.

Badenfelt (2010a) advocated a bundle of informal control mechanisms performed by project participants participating in a TCC project in Sweden. Another recent study by Badenfelt (2010b) reported on eight case studies of construction projects and IT projects in Sweden. It was found that social norms and work-related values and attitudes of key negotiators affect project outcomes considerably. Rose and Manley (2010) launched 4 case studies applying financial incentives (including TCC arrangement) in Australia and concluded that financial incentives could incorporate rewards across all key organisations contributing to team performance and a reward amount should be sufficient enough to be valued by potential receipts. They further perceived that the benefits derived from financial incentive mechanisms could be maximised with equitable risk allocation, early contractor's involvement in design, value-driven tender selection, relationship workshop and future job opportunities. Chan *et al.* (2010a) reported on a case study of an underground railway station modification works procured with TCC in Hong Kong, which was completed ahead of schedule by 7 months and with a cost saving of 5%. Moreover, Chan *et al.* (2010b) sought some key risk factors and generated some effective risk mitigation measures for TCC/GMP contracts in construction based on a series of in-depth interviews with some senior industrial practitioners having abundant direct hands-on experience with TCC/GMP in Hong Kong.

Despite an adequate amount of existing literature about the practices of TCC/GMP in overseas countries, empirical research studies on the "risk aspect" of these contractual arrangements are very limited especially in the Hong Kong context. There is a scarcity of published literature (as shown in Table 1) focusing on the risk allocation of TCC/GMP construction projects which are claimed to be applied to projects with high risks. This finding derived from previous literature review reinforces the objective of this paper by developing an optimal risk allocation scheme for TCC/GMP construction projects in Hong Kong and filling up the knowledge gap of risk management of the TCC/GMP procurement strategies.

Table 1. Some previous research studies on TCC/GMP between 2000 and 2010

Authors	Year	Journal	Country	Focus
Nicolini *et al.*	2000	BJM	United Kingdom	Two case studies of TCC in the United Kingdom
Perry and Barnes	2000	ECAM	United Kingdom	Tender evaluation of TCC
Boukendour and Bah	2001	CME	United Kingdom	Analysis of GMP with option pricing theory
Bower *et al.*	2002	JME	United States	Comparison of incentive features of 3 case studies
Broome and Perry	2002	IJPM	United Kingdom	Determination of share ratios of TCC with utility theory
Walker *et al.*	2002	SCMgt	Australia	Case study of the Australian National Museum Project procured with TCC arrangement
Bubshait	2003	IJPM	Saudi Arabia	Perceptions of owners and contractors on incentive/disincentive contracting in industrial projects
Hauck *et al.*	2004	JCEM	Australia	Case study of the Australian National Museum Project procured with TCC arrangement
Pryke and Pearson	2006	BRI	United Kingdom and France	Case studies to investigate the gain-share /pain-share arrangement implemented under a prime contracting procurement approach
Wong	2006	ITcon	Hong Kong	Study on a computer system for cost monitoring in cable car project with TCC
Chan *et al.*	2007b	JFMPC	Hong Kong	Report of interview findings on motives, benefits, difficulties, risks, success factors and suitability of adopting TCC/GMP
Roja and Kell	2008	JCEM	United States	Comparison of cost growth performance between construction at risk with GMP and design-bid-build approach in school projects
Chan *et al.*	2008	JME	Hong Kong	Case study of an underground railway extension project with TCC arrangement
Tang *et al.*	2008	JCEM	China	Perceptions of stakeholders on incentives in the Chinese Mainland construction industry
Badenfelt	2008	ECAM	Sweden	Derivation of share ratio in TCC
Kaplanogu and Arditi	2009	ECAM	United States	Timing, benefits, effectiveness of pre-project peer reviews in GMP and lump sum contracts
Badenfelt	2010a	CME	Sweden	Informal and formal control mechanisms performed by project participants in a TCC project
Badenfelt	2010b	IJPM	Sweden	8 case studies of IT and construction projects to reveal strategies at macro and micro levels
Rose and Manley	2010	ECAM	Australia	4 case studies applying financial incentives (including TCC arrangement)
Chan *et al.*	2010a	Facilities	Hong Kong	Case study of a underground railway station modification and extension works project procured with TCC arrangement

Notes: BJM: British Journal of Management; BRI: Building Research and Information; CME: Construction Management and Economics; ECAM: Engineering, Construction and Architectural Management; IJPM: International Journal of Project Management; JCEM: Journal of Construction Engineering and Management; JFMPC: Journal of Financial Management of Property and Construction; JME: Journal of Management in Engineering; and SCMgt: Supply Chain Management: An International Journal.

Research methodology

The research study reported herein was modified based on El-Sayegh (2008) which focused on risk assessment and risk allocation in the construction industry of the United Arab Emirates. In El-Sayegh (2008)'s study, the survey respondents were asked about the proper allocation of 42 identified risks. A similar approach was adopted in the present study and the target survey respondents were invited to determine the party (whether client or contractor) who is best capable to manage a particular risk associated with TCC/GMP contracts or equally shared between them, according to their lessons learned from previous TCC/GMP experience. A general principle is that each risk should be allocated to the party who is best capable to manage it at the least possible cost (Cooper *et al.*, 2005). In other words, an optimal risk allocation is not to pass all risks to either party, but to seek a solution minimising both the total management costs of the client and contractor organisations (Ke *et al.*, 2010).

The empirical survey

The identification of key risk factors in this study was launched through an extensive literature review, accompanied by a series of face-to-face interviews with a number of selected industrial practitioners possessing eminent hands-on TCC/GMP experience in Hong Kong between June and July of 2008 (Chan *et al.*, 2010b), where risk factor was defined as "an event, activity or situation that could lead to the possibility of suffering some loss if happened" (Jha and Devaya, 2008). The interviews were found useful in acquiring a deep understanding of major TCC/GMP risk factors, as well as in facilitating the development and refinement of the empirical research questionnaire. A comprehensive list of 34 key risk factors inherent with TCC/GMP construction projects was then developed and distributed to four industrial experts with extensive hands-on TCC/GMP experience for review and validation as a pilot test. Ultimately, they were satisfied with these listed risk factors and no adverse comments were received from this pilot survey.

An empirical survey form was then designed to solicit the perceptions of construction experts on the 34 identified risks encountered with TCC/GMP construction projects in Hong Kong. The survey form consisted of four parts. The first part was about the respondents' personal profiles. The second part focused on the perceived level of severity to the project and likelihood of occurrence of the 34 listed risk factors in relation to TCC/GMP projects, and the respondents were also requested to choose the party best capable to manage each of the key risks identified (i.e. client, contractor or shared). The third part was concerned with the effectiveness of some recommended risk mitigation measures for TCC/GMP projects. The fourth part was optional and the respondents were welcome to express their personal preference on adopting TCC or GMP scheme in future together with their supporting reasons. However, only the major findings regarding the risk allocation of the 34 risk factors indicated in the second part on the survey questionnaire are reported and discussed in this paper due to length limitation.. In order to provide a more complete picture of the results of this survey, the assessment rankings of the 34 listed risk factors in descending order of their risk impact (i.e. severity multiplied by likelihood) are summarised in Table 2. Their detailed discussions and proper explanations can be referred to another journal article by Chan *et al.* (2011). The research results of other parts will be documented and disseminated through other publications in near future.

Table 2. Impact of Risk Factors Encountered with TCC/GMP Schemes by all Survey Respondents (Chan *et al.,* 2011)

ID	Risk Factor	Mean	Rank
5	Change in scope of work	16.41	1
17	Insufficient design completion during tender invitation	15.46	2
20	Unforeseeable design development risks at tender stage	14.54	3
6	Errors and omissions in tender document	14.51	4
21	Exchange rate variations	14.49	5
29	Unforeseeable ground conditions	14.25	6
1	Actual quantities of work required far exceeding estimate	13.97	7
32	Lack of experience of contracting parties throughout TCC/GMP process	13.91	8
22	Inflation beyond expectation	13.81	9
3	Unrealistic maximum price or target cost agreed in the contract	13.76	10
4	Disagreement over evaluating the revised contract price after submitting an alternative design by main contractor	13.51	11
7	Difficult for main contractor to have back-to-back TCC/GMP contract terms with nominated or domestic subcontractors	13.31	12
26	Global financial crisis	13.19	13
18	Poor buildability / constructability of project design	13.11	14
2	Delay in resolving contractual disputes	13.11	15
9	Loss incurred by main contractor due to unclear scope of work	13.07	16
16	Delay in work due to third party	12.64	17
28	Inclement weather	12.43	18
8	Inaccurate topographical data at tender stage	12.40	19
19	Little involvement of main contractor in design development process	12.36	20
15	Selection of subcontractors with unsatisfactory performance	12.17	21
31	Difficult to obtain statutory approval for alternative cost saving designs	12.16	22
33	Impact of construction project on surrounding environment	12.15	23
12	Poor quality of work	12.07	24
11	Technical complexity and design innovations requiring new construction methods and materials from main contractor	11.92	25
23	Market risk due to the mismatch of prevailing demand of real estate	11.86	26
24	Change in interest rate on main contractor's working capital	11.33	27
34	Environmental hazards of constructed facilities towards the community	11.17	28
13	Delay in availability of labour, materials and equipment	11.03	29
25	Delayed payment on contracts	10.81	30
30	Change in relevant government regulations	10.80	31
10	Difficult to agree on a sharing fraction of saving / overrun of budget at pre-contract award stage	10.72	32
14	Low productivity of labour and equipment	10.09	33
27	Force Majeure (Acts of God)	8.66	34

Results and discussions

A total of 300 self-administered blank survey forms were dispatched to target individual construction professionals and project stakeholders associated with the construction industry of Hong Kong, including those working for developers, consultant firms, main contractors, trade subcontractors, quasi-government organizations and relevant government works departments between March and April of 2009 by means of postal mail and electronic mail.

They were welcome to add any other new unmentioned risk factors on the survey form based on their personal discretion and actual experience, but no additional risk was finally suggested by them. The completed survey forms were collected through postal mails, electronic mails, fax and personal networking. One hundred and forty-one valid and duly completed forms were returned in June of 2009, generating a response rate of 47%. Among these 141 responses, 47 respondents declared that they had "No hands-on experience in procuring TCC/GMP 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 TCC/GMP projects or they declared themselves having basic understanding about those TCC/GMP forms of procurement via conferences, seminars, workshops, journals and sharing from their counterparts even though without the direct exposure to TCC/GMP contracts before (Chan *et al.* (2011), so only the data and opinions obtained from these 94 responses were used for further data analysis.

Such screening enabled the researchers to make sure that the respondents have gained fundamental understanding of TCC/GMP procurement approach in order to assure the value and creditability of survey results. Given the fact that there have been only 17 construction projects procured with TCC/GMP in Hong Kong so far up to 2007 (Chan *et al*., 2007b), the majority of related key project team members in adopting TCC/GMP had been included in the sample of this survey, their opinions and feedback could substantially represent the TCC/GMP project pool in Hong Kong over the past decade of 1999-2009. The chosen sample was thus considered to be representative, sufficient and reliable.

Since the research study aims to seek the party best capable to manage each of the identified risks under TCC/GMP contracts according to the hands-on experience and perceptions of each individual, which should be independent of the roles involved in the projects (i.e. whether clients, contractors or consultants), their opinions should be lumped together for a holistic analysis. Therefore, the views of 94 respondents are presented on a collective basis in the paper, taking a similar approach by Ke *et al.* (2010) used in their work on risk allocation of PPP projects in Mainland China. Table 3 provides a summary of the personal profiles of survey respondents. More than 70% of the respondents have gained a wealth of working experience of more than 10 years. The respondents worked in different kinds of organisations, representing the views of clients, consultants and contractors.

Table 3. Personal profiles of survey respondents

Category	Respondent		Category	Respondent	
	Frequency	Percentage		Frequency	Percentage
Nature of organisation			*Number of TCC/GMP construction projects involved*		
Client organisation	33	35.1	1-2 projects	34	36.2
Main contractor	22	23.4	3-4 projects	12	12.8
Architectural consultant	2	2.1	More than 4 projects	9	9.6
Engineering consultant	3	3.2	Have obtained basic understanding of the underlying principles of TCC/GMP schemes	39	41.5
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%**	**Total**	**94**	**100%**

Grouping by nature of organisation			*Experience level in construction industry*		
Client group	33	35.1	Below 5 years	17	18.1
Contractor group	27	28.7	5-10 years	11	11.7
Consultant group	34	36.2	11-15 years	11	11.7
			16-20 years	12	12.8
			Over 20 years	43	45.7
Total	**94**	**100%**	**Total**	**94**	**100%**

The survey respondents were requested to choose the "party best capable to manage the risk" corresponding to each of the listed risk factors, with the measurement scale shown below:

Table 4. Meanings of choices on the survey form

1	Client (100%)	Client is best capable to manage the risk.
2	Client > Contractor	Client is more capable than Contractor to manage the risk.
3	Client = Contractor	Both Client and Contractor are equally capable to manage the risk.
4	Contractor > Client	Contractor is more capable than Client to manage the risk.
5	Contractor (100%)	Contractor is best capable to manage the risk.

Risk sharing in TCC may be referred to the establishment of sharing ratio between the employer and the contractor from some earlier research studies (Scherer, 1964; Cummins, 1977). However, a multitude of previous studies in the field of construction management referred "risk allocation" as the perception of respondents on the expected/ideal allocation of individual risks. For example, Andi (2006) conducted a questionnaire survey to collect the opinions of industrial practitioners on expected and actual risk allocations in the Indonesian construction projects. Li *et al*. (2005) reported on the findings of a survey on perception on risk allocation of 46 risk factors in PPP/PFI projects in the United Kingdom. The "preferred" risk allocation was determined by the level of majority opinions. El-Sayegh (2008) also adopted this approach in his study about risk allocation in construction projects of the United Arab Emirates.

The preferred risk allocation in this article is referred to the "perceived party best capable to manage the risk" which is for the party which has more than 50% of vote for such risk, applying the same principle from previous studies on risk allocation in construction by Li *et al.* (2005) and El-Sayegh (2008). With the principle that the party best capable to manage the risk should bear such risk, the interpretations of findings are illustrated as follows:

Table 5. Interpretation of survey findings

Case	**Result**	**Perceived party best capable to manage the risk**
Case 1	Total percentage of Choice 1 plus Choice 2 > 50%	Client
Case 2	Total percentage of Choice 4 plus Choice 5 > 50%	Contractor
Case 3	Percentage of Choice 3 > 50%	Shared
Case 4	None of Cases 1 to 3	Negotiated

Agreement of respondents within experienced group and non-experienced group

As observed in Table 3, some of the survey respondents (frequency = 39 out of a total of 94) did not have direct hands-on experience in TCC/GMP projects (but have obtained basic understanding of the underlying principles of TCC/GMP schemes) and they were classified as the non-experienced group. Experienced group were those who have participated in TCC/GMP projects before. A statistical test on the difference of opinions amongst the respondents within each of the two survey groups (i.e. within experienced group and within

non-experienced group) should be first conducted. As Ke *et al.* (2010) suggested, a Kendall's concordance test is performed to gauge the agreement of different respondents on their preferences of risk allocation within a particular survey group. This statistical analysis aims to ascertain whether the respondents within an individual group respond in a consistent manner or not.

However, the Kendall's coefficient of concordance (W) is only suitable when the number of attributes does not exceed 7 (Siegel and Castellan, 1988). Chi-square should be used as a near approximation instead if the number of attributes is greater than 7. The critical values of chi-square are referred to the table found in Siegel and Castellan (1988). The actual calculated chi-square values within the experienced group and non-experienced group are 661.186 and 408.221 respectively, and they are both higher than 67.985 (i.e. the critical value of chi-square derived from the table with a degree of freedom of 33) at the 5% significance level. This statistical result implies that the assessment by various respondents on their risk allocation preferences within each of the two survey groups is found to be consistent and they are essentially applying the same standard in allocating the respective risk factors.

Agreement of respondents between experienced group and non-experienced group

Independent two-sample t-test was applied to test the agreement on the preference of allocation of each listed risk factor between the experienced group and non-experienced group as adopted by Ke *et al*. (2010). The result of the statistical test shown in Table 6 indicated that there are no statistically significant differences on the preference of risk allocation in TCC/GMP projects between the experienced group and non-experienced group (all of the actual calculated significance levels larger than the critical value of 5%). It was concluded that the two sets of opinion data can be lumped together for further analysis and the survey findings are regarded as being consistent, reliable and representative.

Risks to be allocated to client

Eight risks to be allocated to client as depicted in Table 6 include:
- Change in scope of work;
- Errors and omissions in tender document;
- Inaccurate topographical data at tender stage;
- Insufficient design completion during tender invitation;
- Poor buildability / constructability of project design;
- Lack of involvement of main contractor in design development process;
- Unforeseeable design development risks at tender stage; and
- Consequence of delayed payment to contractor.

After a careful observation, such eight risks may be classified into three groups, i.e. contractual risks, design risks, together with economic and financial risks.

"Change in scope of work", "Errors and omissions in tender document" and "Inaccurate topographical data at tender stage" could be considered as contractual risks encountered with TCC/GMP construction projects. "Change in scope of work" is regarded as a significant risk in TCC/GMP projects. According to a study by Cox *et al*. (1999) in the United Kingdom, it was revealed that change in employer's requirements was one of the most frequently cited reasons for design changes in their cases explored. This risk was perceived as better taken by

client. The finding is consistent with another study on risk allocation by Ojo and Ogunsemi (2009) that the risk "change in work" was perceived to be allocated to client. Another two risks are both related to tender preparation. The respondents considered that the risks should be allocated to client. One of the possible reasons for this finding is that these three risks are under control on the client's side. For example, most errors and omissions in tender documents are caused from the consultant's side which represents the client's interest. Similarly, inaccurate topographical data at tender stage is often provided by the client to contractor. The client has full control of this risk, although the client does not guarantee the accuracy of such data in most cases. According to Turner (2004), a contracting strategy should not only provide an incentive to deal with potential risks, but also should be flexible to accommodate contingencies such as late design changes and design variations. In most real-life cases of TCC/GMP, the contractor is entitled to have compensation for the occurrence of such risk factors (Fan and Greenwood, 2004; Chan *et al.*, 2008).

"Insufficient design completion during tender invitation", "Poor buildability / constructability of project design", "Little involvement of main contractor in design development process" and "Unforeseeable design development risks at tender stage" are all design risks and all of them are preferred to be taken by client. This finding is understandable and in line with those observations from previous research studies (e.g. Kartam and Kartam, 2001; Andi, 2006) as the entire design work is usually carried out by an independent team of design consultants (e.g. architects, structural engineers, building services engineers, etc) due to their inherent expertise and professional training, who represent the clients' intent and interests, while the contractor is passive in design changes under the traditional construction practices in Hong Kong. The clients would be in a more advantageous position to manage these design risks.

The last risk which should be allocated to client was "Consequence of delayed payment to contractor". Again, the finding echoes the previous study on risk allocation in the construction industry (Andi, 2006) and standard form of contracts such as the NEC3 Option C stating that interest is paid on late payment if a certified payment is late or a payment is late because the Project Manager does not issue a certificate which he should issue.

By observation, it is not difficult to see that there is a common point on the risks perceived to be better allocated to client – they are all under the control of client (e.g. change in scope of works, errors and omissions in tender document, delayed payment on contracts and the like.) The findings appear to match with the fault standard and management standard as suggested by Grove (2000). According to the fault standard, the time and cost impacts of those risks caused through the faults of a party should be borne by that party. Obviously, the faults of client cause those risks mentioned above, and thus the survey result matches the fault standard. On the other hand, the philosophy of the management standard states that a risk should belong to the party who is best able to evaluate and control it (Grove, 2000). The client can exercise full control of all of the risks mentioned in this part (e.g. insufficient design completion during tender invitation, change in scope of work, etc). The survey result is therefore considered to be reasonable and reflective of the real-life situations.

Table 6. Preferred allocation of risk factors in TCC/GMP construction projects in Hong Kong

Risk factor		Risk allocation				Independent 2-sample t-test	
		Client	Shared	Contractor	Allocated to	t-value	Sig. level
5	Change in scope of work	80.9%	13.8%	5.3%	Client	.356	.723
6	Errors and omissions in tender document	64.5%	15.1%	20.4%	Client	-1.721	.089
8	Inaccurate topographical data at tender stage	61.3%	22.6%	16.1%	Client	-.750	.455
17	Insufficient design completion during tender invitation	79.6%	16.1%	4.3%	Client	.041	.967
18	Poor buildability / constructability of project design	50.5%	22.6%	26.9%	Client	.570	.570
19	Lack of involvement of main contractor in design development process	68.8%	12.9%	18.3%	Client	-.250	.803
20	Unforeseeable design development risks at tender stage	65.6%	24.7%	9.7%	Client	.612	.542
25	Consequence of delayed payment to contractor	73.4%	18.1%	8.5%	Client	.925	.359
7	Difficult for main contractor to have back-to-back TCC/GMP contract terms with nominated or domestic subcontractors	8.7%	13.0%	78.3%	Contractor	1.335	.185
12	Poor quality of work	6.5%	17.2%	76.3%	Contractor	.916	.364
13	Delay in availability of labour, materials and equipment	2.1%	17.0%	80.9%	Contractor	.719	.474
14	Low productivity of labour and equipment	1.1%	10.6%	88.3%	Contractor	.175	.862
15	Selection of subcontractors with unsatisfactory performance	4.3%	23.4%	72.3%	Contractor	-1.239	.218
24	Change in interest rate on main contractor's working capital	5.4%	24.7%	69.9%	Contractor	-.015	.988
2	Delay in resolving contractual disputes	25.8%	64.5%	9.7%	Shared	-1.251	.214
4	Disagreement over evaluating the revised contract price after submitting an alternative design by main contractor	26.9%	57.0%	16.1%	Shared	-.058	.954
10	Difficult to agree on a sharing fraction of saving / overrun of budget at pre-contract award stage	16.1%	77.4%	6.5%	Shared	-.756	.451
22	Inflation beyond expectation	19.1%	51.1%	30.9%	Shared	-1.332	.186
26	Global financial crisis	11.8%	83.9%	4.3%	Shared	-1.977	.051
27	Force Majeure (Acts of God)	10.8%	78.5%	10.7%	Shared	-.027	.979
28	Inclement weather	7.5%	57.0%	35.5%	Shared	.534	.594
30	Change in relevant government regulations	35.5%	60.2%	4.3%	Shared	-1.787	.077
32	Lack of experience of contracting parties throughout TCC/GMP process	20.4%	59.1%	20.5%	Shared	1.276	.205
1	Actual quantities of work required far exceeding estimate	41.3%	32.6%	26.1%	Negotiated	.029	.977
3	Unrealistic maximum price or target cost agreed in the contract	38.3%	41.5%	20.2%	Negotiated	1.482	.142
9	Loss incurred by main contractor due to unclear scope of work	45.2%	29.0%	25.8%	Negotiated	-.218	.828
11	Technical complexity and design innovations requiring new construction methods and materials from main contractor	12.8%	41.5%	45.7%	Negotiated	.466	.643
16	Delay in work due to third party	23.4%	44.7%	31.9%	Negotiated	-1.879	.063
21	Exchange rate variations	18.1%	42.6%	39.3%	Negotiated	-1.320	.190
23	Market risk due to the mismatch of prevailing demand of real estate	45.7%	41.5%	12.8%	Negotiated	-1.209	.230
29	Unforeseeable ground conditions	32.6%	42.4%	25.0%	Negotiated	-1.177	.242
31	Difficult to obtain statutory approval for alternative cost saving designs	29.8%	37.2%	33.0%	Negotiated	.081	.936
33	Impact of construction project on surrounding environment	17.2%	44.1%	38.7%	Negotiated	1.496	.138
34	Environmental hazards of constructed facilities towards the community	24.5%	44.7%	30.8%	Negotiated	1.386	.169

Risks to be allocated to contractor

As revealed from Table 6, six risks were discerned to be better managed by contractor, namely:

- Difficult for main contractor to have back-to-back TCC/GMP contract terms with nominated or domestic subcontractors;
- Responsibility for quality;
- Delay in availability of labour, materials and equipment;
- Low productivity of labour and equipment;

- Selection of subcontractors with unsatisfactory performance; and
- Change in interest rate on main contractor's working capital.

Four of these six risks to be better allocated to contractor (i.e. "Responsibility for quality", "Delay in availability of labour, materials and equipment", "Low productivity of labour and equipment", and "Selection of subcontractors with unsatisfactory performance") are related to site operation. More than 70% of the respondents believed that these four risks should lie on contractor in TCC/GMP projects as observed from Table 5.

This finding is rational since contractors are the actual constructors by nature, they would be better positioned to manage the construction risks encountered during site operation. Based on the results obtained from their fuzzy risk allocation model by Lam *et al*. (2007), the risk of subcontractor failure in controlling the quality of work should be allocated to contractor. Another study by Andi (2006), suggesting that poor quality of work, delay in availability of labour, materials and equipment and selection of subcontractors with unsatisfactory performance should be allocated to contractor, supports the current findings reported in this paper.

More than 75% of the respondents perceived that "Difficult for main contractor to have back-to-back TCC/GMP contract terms with nominated or domestic subcontractors" was better managed by contractor. About 70% of the respondents considered "Change in interest rate on main contractor's working capital" should be allocated to contractor. These findings are congruent again with the management standard of risk allocation suggested by Grove (2000). The main contractor is the sole party who can exercise control over the contractual issues with the subcontractors. Regarding the change in interest rate on main contractor's working capital, the contractor is the party whom the loss suffers from in the first instance if the risk does materialise. This falls on one of the Abrahamson's principles which are a classic risk allocation principle (Abrahamson, 1984). One may concern about the risk of termination of contract due to client's bankruptcy. In Hong Kong, the clients applying the TCC/GMP procurement strategies are the relevant works departments of the HKSAR Government, quasi-government organisations, leading private property developers and large-scale major construction contractors (Chan *et al.*, 2010b). Bankruptcy of clients may not be a significant risk. However, the situation may not be the same in other parts of the world. In case of client's bankruptcy, obviously, the contractor has to take this risk. In most construction contracts in Hong Kong, there are proper contractual mechanisms in place to deal with this risk. The payment owed to the contractor by the client may be regarded as a debt in this case.

Risks to be shared between client and contractor

Nine risks were perceived to be better shared between client and contractor. Through a closer examination, these nine risks may be sub-divided into two types: (1) risks out of control of both parties; and (2) risks which both parties have potential to generate. Risks out of control of both parties cover:

- Inflation beyond expectation;
- Global financial crisis;
- *Force Majeure* (Act of God)
- Inclement weather; and
- Change in relevant government regulations.

When compared with the risk/obligation allocation model mentioned in the "No Dispute Report" (National Building and Construction Council, 1989) published in Australia, the findings for "Inflation beyond expectation", *Force Majeure* (Act of God)", "Inclement weather" and "Change in relevant government regulations" match well with the model, indicating that the findings are sensible and logical in general. The fuzzy risk allocation model proposed by Lam *et al.* (2007) suggested that risks on inflation and inclement weather should be shared between client and contractor as well. In practice, inclement weather is a ground of granting extension of time in most construction contracts in Hong Kong, while the contractors have to predict any cost implications for such risk. Inflation risk is shared when fluctuation clause is applied in the TCC/GMP projects. Perhaps, the rationale behind such contractual clause is that both parties cannot control the level of severity and likelihood of occurrence of such risks. As it is unfair to ask either party to take these risks, they ought to be shared between the two parties under the contract.

"Delay in resolving contractual disputes", "Disagreement over evaluating the revised contract price after submitting an alternative design by main contractor", and "Lack of experience of contracting parties throughout TCC/GMP process" were risks which both client and contractor have contribution to their occurrence. For example, "delay in resolving contractual disputes", the delay can be caused by both parties in the process of preparation of claims and/or assessment of claims. This risk was perceived as a shared risk in the study of Andi (2008).

Regarding the risk factor "Difficult to agree on a sharing fraction of saving / overrun of budget at pre-contract award stage", the issues on the sharing fraction are subject to negotiation between the two parties in case of negotiated tendering employed in the TCC/GMP projects. Chan et al. (2007b) opined that inexperienced clients and contractors may jeopardise the TCC/GMP process. This risk appears to be inevitable in Hong Kong, since the number of TCC/GMP projects completed is rather scarce in the local construction market. The risk is discerned to be shared possibly due to the fact that the client can make a decision on whether to apply the TCC/GMP procurement strategies in a certain new project or the contractor can decide on whether to bid for those projects procured with TCC/GMP contractual arrangements.

Conclusions

An in-depth understanding of the significant risks is an imperative in project delivery with TCC/GMP contractual arrangements. Inadequate consideration of risk allocation may result in failure in achieving the stated project objectives upon completion. Literature review indicated that previous research studies on the risk management of TCC/GMP scheme are rather limited. This paper has attempted to fill up the knowledge gap of risk management in TCC/GMP construction projects. This study adopted an empirical questionnaire survey to examine the preferred risk allocation of TCC/GMP projects, concluding that the risks under client's control such as risks on tender documentation and project design are suggested to be borne by client and construction risks are perceived to be taken by contractor. Such findings are in line with previous similar research studies on risk allocation in construction projects in general and are consistent with the management standard and fault standard of risk allocation as advocated in the Grove (2000)'s report in particular.

The survey findings could serve as a useful reference for desirable risk allocation for future TCC/GMP contracts in construction. Given the fact that TCC/GMP schemes are extensively applied in infrastructure projects worldwide including Hong Kong (Walker *et al*, 2002; Rojas and Kell, 2008; Chan *et al.*, 2008; Bogus *et al*., 2010; Chan *et al.*, 2010a), the findings of this study should be relevant and essential to both construction academics and industrial practitioners in the field of infrastructure development and management. The research study has engendered some research evidence to capture the lessons learned from previous TCC/GMP construction projects for generating best practice guidelines for equitable (preferred) risk allocation in future target cost-based projects especially in those infrastructure developments often associated with high risks, both locally and overseas.

Further qualitative investigations such as face-to-face interviews and in-depth case studies of various TCC/GMP projects may be undertaken in future to verify the suitability of preferred risk allocation in reality and to substantiate the propositions derived from the current study, together with the possible reasons behind these allocation preferences. Moreover, the same research methodology and questionnaire survey may be launched in some western countries like the United Kingdom, United States and Australia to glean opinions of relevant project stakeholders for international comparisons between the East and the West in respect of their similarities and differences. Limitations of the research study lie in the conclusions drawn being indicative rather than conclusive, as merely 94 completed survey questionnaires were received and analysed owing to a limited number of TCC/GMP construction projects in Hong Kong. Notwithstanding, the survey findings would be valuable for future studies in this area.

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