Journal of Construction Engineering and Management

Key Relational Contracting Practices Affecting the Performance of Public Construction Projects in China

--Manuscript Draft--

Manuscript Number:	COENG-2054R3
Full Title:	Key Relational Contracting Practices Affecting the Performance of Public Construction Projects in China
Manuscript Region of Origin:	CHINA
Article Type:	Technical Paper
Manuscript Classifications:	2.03000: Project Delivery; 2.07000: Procurement; 2.10000: Partnering
Keywords:	Relational Contracting, Public Construction Projects, Strategy, Beijing, Hong Kong
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Suggested Reviewers:	
Opposed Reviewers:	
Additional Information:	
Question	**Response**
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Dear Editor

I am pleased to resubmit the paper for your consideration for publication. We have taken in the additional comments of reviewers and editor.

Yours sincerely,
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Key Relational Contracting Practices Affecting the Performance of Public Construction Projects in China

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Abstract

Relational contracting (RC) is based on the recognition of mutual benefits and win-win scenarios that are achieved through more cooperative relationships among the contracting parties in a project. While RC principles are less difficult to apply in private sector projects, it has not been established if public sector projects can enjoy the full benefits of RC. This study aims to investigate the effective RC practices that are found in China's public construction projects. The specific objectives are to: (1) evaluate project performance levels in terms of cost, time, quality and client

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satisfaction; (2) investigate the extent to which RC practices were adopted; and (3) identify the RC practices that lead to better performance. Due to the large geographical area of China, the surveys conducted were confined to Beijing and Hong Kong. A structured questionnaire was designed to collect qualitative data. The results show that: (1) public construction projects achieved significant success in quality performance and client satisfaction but not in budget and schedule performance; and (2) RC practices were adopted to varying extents in public projects. The findings contribute to knowledge by identifying the specific RC practices that could boost project performance significantly. Another contribution to knowledge is the discovery that the Relational Contract Theory is applicable to public projects notwithstanding the need to keep relations at arm's length. A framework to manage public projects using the RC approach is recommended for adoption in Hong Kong and other countries that adopt project management style along PMI's framework. A different framework is recommended for adoption in Beijing and places that have a centrally planned and controlled economic system so as to help public projects achieve better project performance.

Subject headings: Relational Contracting, Public Construction Projects, Strategy, Beijing, Hong Kong

Introduction

Relationships among contracting parties include formal transactions and relational links. Formal contracts spell out the rights, responsibilities, and liabilities of the parties concerned. In a formal contract, parties act in an atomized manner, looking out for their own personal interests (Williamson, 1975). Relational contracting (RC) is based on the recognition of mutual benefits and win-win scenarios that are achieved through more cooperative approaches, such as partnering, alliancing, joint venturing, long-term contracting, joint risk-sharing mechanisms, integrated project delivery, and other collaborative working arrangements (Rahman and Kumaraswamy, 2004a; AIA, 2007). While RC principles are less difficult to apply in projects initiated by the private sector (Kumaraswamy, 2010), the gap in knowledge is that it is not known if public sector projects can also enjoy the full benefits of RC, such as risk and cost reduction, and better project performance (Akintoye and Main, 2007).

The term “RC practices” in this paper refers to “relational practices” or practices based on good relationship management, which are RC-type or RC-based, even though the actual contracts may not have incorporated any formal RC approaches.

China is a legitimate geographical region to investigate, as seen in many previous studies (examples are: Lu et al., 2008; Tai et al, 2009; Chan et al., 2009a; Zhao et al., 2011). Due to its strong economic growth and need for national development, there are many opportunities for architectural, engineering and construction (A/E/C) firms to operate in China's construction industry. However, the Chinese market is full of pitfalls as well. It is fragmented, heterogeneous, risky and highly competitive (Chen and Messner, 2009). To perform well in the Chinese market, knowledge of the types of RC practices that lead to project success may be important. Hence, the aim of this study is to investigate effective RC practices in China's public construction projects. The specific objectives are to: (1) evaluate public project performance levels in terms of cost, time, quality, and client satisfaction; (2) investigate the extent to which RC practices are adopted; and (3) identify the RC practices that lead to better performance of public projects in China.

Due to China's large geographical area, the scope of this study is confined to public construction projects in Beijing and Hong Kong. The capital city of Beijing was chosen for study as it has a significant number of completed public projects for the 2008 Olympics and also because it is representative of how a centrally planned economy

operates. Hong Kong, a former British colony and now a Special Administrative Region, was chosen for study because its construction practices are closer to those of A/E/C firms that operate in free market economies. The geographic specific findings of Beijing and Hong Kong could be applied to centrally planned economies and free market economies, respectively, in the context of the broader global community. The contrast between practices in Beijing and Hong Kong helps A/E/C firms that are currently operating in a free market economy and planning to enter a centrally planned market to better understand the differences between the RC practices in different markets. Particular attention could be paid to the key RC practices identified in this study to help them achieve better project outcomes.

In the next section, a literature review of project performance and RC practices is presented and the knowledge gaps are identified. The research design and data analysis method are then explained, followed by the presentation of the characteristics of the sample. Next, the extent to which RC practices are adopted in Beijing and Hong Kong are compared and discussed, and key RC practices that lead to better project performance are identified. The last section summarizes the findings and offers recommendations to the construction engineering and management community.

Literature Review

Operationalizing Project Performance

Project outcomes are multi-faceted. These include the traditional triple project outcomes (time, cost, and quality), safety performance, environmental performance, stakeholder satisfaction, and profitability. For this study, project outcome is viewed from the perspective of project delivery and organizational level competency. For project delivery competency, this research adopts the traditional triple project outcomes as the performance metrics, following Konchar and Sanvido (1998). For organizational level competency, service quality is operationalized as client satisfaction with the project, following Ling et al. (2004).

RC Practices Affecting Project Performance

Different aspects of RC have been covered in previous studies. These include drivers (Chan et al., 2003), obstacles (Glagola and Sheedy, 2002), success factors (Chan et al., 2004), components like trust (Wong et al., 2005), culture (Ang and Ofori, 2001),

communication (Bayliss et al., 2004), and performance index (Yeung et al., 2007). This study postulates that there are certain RC practices that significantly affect the performance of public construction projects in China. RC practices were identified from the literature review and summarized in Table 1. For brevity, these practices are coded as “a”, “b” and “c” for client, contractor, and consultant, respectively, followed by a reference number. These RC practices are divided into three categories: (1) individual organizational features and practices adopted by each contracting party (coded as a-#, b-# and c-#); (2) practices adopted in tandem by two of the contracting parties (coded as ab-#, ac-# and bc-#); and (3) practices adopted by all the major contracting parties in unison (code: abc-#). “#” represents the reference number of the RC practice.

<Insert Table 1 here.>

Knowledge Gaps

The Relational Contract Theory views contracts more as relations rather than as discrete transactions and thus, all transactions involve a wider social and economic context (Macneil, 1974). The theory states that individual transactions lie on a

spectrum ranging from “discrete” through to “relational”. The theory challenges the traditional premise that all contracts are mere transactions, and emphasizes the role of norms in determining the manner in which commercial exchanges operate in practice. These norms are further operationalized into RC approaches/practices.

The brief literature review revealed that previous studies on RC approaches did not differentiate between public and private construction projects. Whether RC principles could be applied successfully and specifically to public construction projects remains unclear.

Public projects merit an in-depth study because public clients are usually not in the position to offer future relationship incentives since most projects must be procured through the competitive bidding process, and government regulations traditionally discourage close relationships between public clients and private contracting parties (Rahman and Kumaraswamy, 2004b). Yet, public projects are highly visible and need to achieve the triple project goals because taxpayers’ money is involved.

The link between the adoption of RC practices and project outcomes is also not known. This study therefore aims to fill the gap by investigating the relevance of the

Relational Contract Theory to public contracts through exploring RC practices that may boost the performance of public projects in China significantly.

Research Method

A large study had been conducted on RC practices and the drivers of and barriers to relational contracts, as well as how these affect the performance of public construction projects in China, Australia, and Singapore. This paper reports a part of the study, focusing on RC practices and project outcomes in China.

Research Design

The questionnaire-survey is the adopted choice of research design for this study. The survey was conducted between June and November 2011 in Beijing and Hong Kong. The objectives of the survey that are relevant to this paper are twofold: (1) to evaluate the performance outcomes of completed public construction projects; and (2) to determine the extent to which RC practices were present, observed, practiced or emphasized in these projects.

The unit of analysis in this study is a completed public sector project, regardless of the extent to which RC approaches were adopted. The target population is thus completed public projects in China, and the sampling frame is hence completed public projects in Beijing and Hong Kong. In order to collect the data, multiple stakeholders comprising public sector clients and consultants, private sector consultants (e.g. architects, engineers, quantity surveyors, and project managers), and contractors, who had been involved in public construction projects in Beijing and Hong Kong, were approached. However, due to the lack of a national registry of officials/firms involved in public construction projects, the contact details of public officials were obtained from government directories. Questionnaires were then sent to all of them because the number is not large. The contact details of private consultants and contractors were derived from the respective professional and trade institutions, and randomly selected. As this group may contain those who have not handled public projects before, the questionnaire clearly stated that only those who had completed public projects should fill up the questionnaire.

Data were collected using a specially designed structured questionnaire. Section A of the questionnaire requested information on the completed public sector project and the project's performance level in four areas: cost (Y1); time (Y2); quality (Y3); and

client satisfaction (Y4). Y1 and Y2 were measured more objectively as percentage of time and cost over/under run. Y3 measured quality of output, stated as product/output quality of the facility/project. Y4 measured quality of service, stated as client satisfaction with the contracting parties' service quality. Service quality measures the transformation process (i.e. the service) from resources to the constructed facility. Y3 and Y4 were relatively subjective and thus rated on a five-point Likert scale (1 = Very dissatisfied, 3 = Neutral, 5 = Very satisfied). In Section B, respondents were asked to indicate the extent to which RC practices were adopted on a five-point Likert scale (1 = Very low, 3 = Neutral, 5 = Very high). Respondents were also given the opportunity to provide other suggestions and demographic characteristics of themselves and their companies. The questionnaire was pilot tested and then translated into Chinese.

Data Analysis Method

The data were analyzed using SPSS software. The main statistical methods used were descriptive statistics, one-way ANOVA, one-sample *t* test and Pearson's correlation analysis. The Confidence Interval (CI) was set at 0.95. One-way ANOVA was conducted to check if there is any significant difference in the extent to which RC practices were adopted in Beijing and Hong Kong. The one-sample *t* test procedure

205 was performed on the four performance metrics (Y1 to Y4) and the RC practices to
206 determine if the projects achieved significantly good performance and if the practices
207 were adopted to a significant extent, respectively. To check whether a greater
208 adoption of RC practices led to better project outcomes, Pearson's correlation
209 analysis was conducted. Each pair of variables in the Pearson's correlation analysis
210 comprised one of the four performance metrics and one of the RC practices.
211
212 **Characteristics of the sample**
213
214 Survey questionnaires were sent to 259 and 645 samples in Beijing and Hong Kong,
215 respectively. 59 and 51 valid questionnaires were returned in Beijing and Hong Kong,
216 representing response rates of 22.78% and 7.91%, respectively. Many more samples
217 were identified in Hong Kong than in Beijing because Hong Kong has more easily
218 available published information of names of public officials and private contractors
219 and consultants. However, this collection comprised a mix of private firms that had
220 and did not have experience in public projects. As the questionnaire instructed those
221 without experience in public sector projects not to reply, even though more
222 questionnaires were sent out in Hong Kong, the fact that there are fewer public sector
223 projects in Hong Kong compared to Beijing explains the lower response rate in Hong

224 Kong.

225

226 As regards sample validity, it is observed that more than 30 sets of valid project data
227 were received. The general convention is that when n>30, the central limit theorem
228 holds true. Moreover, questionnaires were sent to all the public offices that manage
229 public construction projects in Beijing and Hong Kong. No public office had been
230 deliberately left out. Cronbach's alpha values of three categories of RC practices in
231 Beijing and Hong Kong ranged from 0.832 to 0.938, suggesting that the RC practices
232 under each category have a high internal consistency (Nunnally, 1978). It is therefore
233 concluded that these data are reliable and further statistical analyses may be
234 conducted (Nunnally, 1978).

235

236 The characteristics of the respondents are given in Table 2. All the respondents have
237 extensive construction experience in various types of public construction projects.
238 The Beijing and Hong Kong respondents had an average of 11 and 22 years of
239 experience, respectively. The respondents' firms engage an average of 19,934 and
240 3,097 employees in Beijing and Hong Kong, respectively. In the light of the rich
241 experience of the respondents as shown in Table 2, these respondents should be in a
242 position to accurately assess the extent to which RC practices were present,

observed, practiced or emphasized in the project.

<Insert Table 2 here.>

Result 1: Performance of Public Projects in Beijing and Hong Kong

The first objective of this study is to evaluate project performance levels based on cost, time, quality, and client satisfaction. The *t* test results in Table 3 show that public construction projects in Beijing achieved significantly good performance in client satisfaction (3.32, p=0.000) and quality (3.19, p=0.002), but had significantly poor cost performance (10.42% cost overrun, p=0.006) and marginally failed in time performance (8.41% schedule overrun, p=0.062). Public construction projects in Hong Kong also achieved significantly good performance in client satisfaction (3.88, p=0.000) and quality (3.98, p=0.000), but their mean scores are significantly higher than those in Beijing. Similar to Beijing, the results show that public projects in Hong Kong had significantly poor cost performance (12.50%, p=0.000) and time performance (17.78%, p=0.000).

<Insert Table 3 here.>

Poor cost performance could have arose because of the prevalent practice of under bidding, hidden costs which surface only at the later stage, (Ling et al., 2006a) and inability to respond adequately to perceived change orders (Ling et al., 2008). Poor time performance may be due to Chinese clients changing the project scope and issuing too many change orders (Ling et al., 2006a). While changes were ordered on site, sometimes, the client's top management may not approve them, giving rise to abortive work and further delays (Ling et al, 2006a). Project delays may also come about because of holdups in getting approvals (Ling et al, 2008).

Result 2: RC Practices Adopted in Beijing and Hong Kong

The second objective of this study is to investigate the extent to which RC practices were adopted in Beijing and Hong Kong using *t* test of the mean. The *t* test results in Tables 4 and 5 show that there are RC practices that had been adopted to a significant extent in Beijing and Hong Kong's public projects. The finding suggests that Macneil's (1974) Relational Contract Theory is applicable to public projects although these generally comprise discrete transactions with little opportunity for future exchanges.

ANOVA results in Table 3 show that 13 practices were adopted to significantly different extents in Beijing and Hong Kong. Among these, 10 RC practices were used more frequently in Hong Kong, while only three practices were adopted more frequently in Beijing, indicating that RC concepts are generally more acceptable to contracting parties in public construction projects in Hong Kong. The implication is that A/E/C firms planning to penetrate a different type of market (e.g. centrally controlled economies versus free market economies) should pay particular attention to these 13 RC practices in order to gain an advantage over local firms.

Public clients in Beijing adopted the following RC practices to a significantly lower extent compared to Hong Kong clients – strengthening their financial capacity (a-6); acquiring knowledge of project processes (a-8); committing to other parties on a long-term basis (a-9); and adopting a positive attitude toward continuous improvement (a-16). The results echoed Sachs et al.'s (2007) finding that some local governments in mainland China lack the relevant experience and knowledge in construction, or focus too much on short-term objectives. Public organizations are usually restrained by an inertia that may stem from beliefs such as "that is not our responsibility", "there is no need to change current practices that are already good

enough (or even better than others)", or a "not invented here" syndrome (Palaneeswaran and Kumaraswamy, 2000). This inertia is more evident in Beijing than in Hong Kong, as the long-standing bureaucratic culture in mainland China has often been criticized for its lack of openness and flexibility (Piotrowski et al., 2009). In addition, unlike local governments in mainland China which suffer from a lack of funds, the Hong Kong government has adequate financial reserves and enjoys a budget surplus (Chan et al., 2009a).

Table 3 shows that compared to Hong Kong, contractors in Beijing had significantly fewer opportunities to provide specific inputs on construction methods and materials before they were formally appointed (b-13). This may be due to the Hong Kong government's more positive attitude toward promoting integration in the construction industry by encouraging contractors to give their feedback before they are formally appointed.

Contracting parties in public construction projects in Beijing have lower levels of long-term commitment to other parties (a-9, b-9 & c-9) than those in Hong Kong. The Beijing government has been investing heavily in infrastructure development and thus the market for public construction projects in Beijing is huge (BMBS, 2011). This

market situation of high construction demand causes private firms in Beijing to disregard the need to have any long-term commitments with other parties.

Compared to those in Hong Kong, contractors and consultants in Beijing are less familiar with each other (bc-1) and less likely to share information (bc-6). As Beijing's construction market is six times larger than Hong Kong's in terms of gross value of construction work (BMBS, 2011; CSD, 2011), it is therefore less likely for contractors and consultants in Beijing to have prior relationships. This lack of familiarity between contractors and consultants in Beijing may cause them to adopt a more adversarial stance with each other than those in Hong Kong, which could lead to lower enthusiasm to share project information.

Table 3 shows that "Clarity of division of responsibilities among contracting parties" (abc-1) was rated significantly higher in Hong Kong than in Beijing. As public construction projects in Hong Kong adopt standard conditions of contract, the division of responsibilities is clearer than in Beijing, where in-house or bespoke contracts are preferred (Lu, 2005).

"Level of reciprocation/face-saving gestures between the client and contractor" (ab-8),

338 “Collective/combined responsibility by a pre-selected group comprising one person
339 from each major party” (abc-4) and “Effectiveness of team-building events used in the
340 project” (abc-13) were rated significantly higher in Beijing than in Hong Kong. This
341 may be attributed to the “guanxi” that exists in Chinese culture. Private participants in
342 Beijing have to spend much more time and effort to cultivate *guanxi* with public clients
343 than those in Hong Kong (Sachs et al., 2007). There are hence many entertainment
344 activities that need to be carried out in order to cultivate and maintain good
345 relationships with public clients in Beijing. In Hong Kong, this is not so pronounced
346 because the government departments are inherited from the British, and these have
347 well-defined responsibilities and codes of conduct. They are usually not allowed to
348 participate in team-building events with private firms and cannot receive nor
349 reciprocate favors.
350
351 **Result 3: RC Practices Affecting Project Outcomes**
352
353 The third objective of this study is to identify RC practices that lead to better project
354 performance. Tables 4 and 5 list the RC practices in Beijing and Hong Kong,
355 respectively, that are significantly correlated with performance metrics (Y1 to Y4) in
356 an ascending order based on mean ratings. The mean ratings measure the extent to

357 which the RC practices were adopted. Significant negative correlations with Y1 and
358 Y2 and significant positive correlations with Y3 and Y4 suggest that when the RC
359 practice is adopted to a larger extent, the project performance is also significantly
360 better. Overall, 32 and 56 out of a total of 88 practices are significantly correlated with
361 performance outcomes of public construction projects in Beijing and Hong Kong,
362 respectively. The result indicates that RC principles have greater impact on the
363 outcomes of public construction projects in Hong Kong than in Beijing.
364
365 <Insert Tables 4 and 5 here.>
366
367 Key RC practices are defined in this study as those significantly correlated with
368 project performance but not adopted to a significant extent. As shown in Tables 4 and
369 5, there were eight and 11 of these key RC practices in Beijing and Hong Kong,
370 respectively. These RC practices are further depicted in Figure 1. The discussions in
371 the following sub-sections focus on these key RC practices.
372
373 <Insert Figure 1 here.>
374
375 RC practices affecting project performance significantly are depicted in Figures 2 and

3 for Beijing and Hong Kong, respectively. It is suggested that contracting parties adopt these RC practices to a greater extent in future projects so as to achieve better project performance. In terms of generalizing the findings to the broader global community, Figure 2 is important for firms when investing in a centrally controlled economy like China, while Figure 3 is useful for adoption in a free market economy.

<Insert Figures 2 and 3 here.>

Cost Performance (Y1)

Table 4 shows that the cost performance of public construction projects in Beijing is significantly correlated with five RC practices. On the other hand, there are 16 RC practices that are significantly correlated with the cost performance of public construction projects in Hong Kong (see Table 5). Among them, clients' attitude toward continuous improvement (a-16) and consultants' top management support for RC practices (c-15) are significantly correlated with cost performance in both Beijing and Hong Kong. The findings agree with Black et al. (2000) that a positive attitude toward, and support for, RC practices, especially from senior management, is important.

Among the five RC practices in Beijing that are significantly correlated with cost performance, only one – client's knowledge level of project processes (a-8) – was not adopted to a significant extent and hence needs to be highlighted. Clients' lack of knowledge of project processes could lead to an inadequate brief and feasibility study or an inaccurate pre-tender estimate, which may eventually result in cost overrun (Ling and Leong, 2002). It is therefore recommended that public sector organizations capture the knowledge and information on project processes, products, and technology after a project is completed so that better project outcomes can be attained in future projects (Love et al., 2010). For the "one-off" type of client who develops only one project in a long while, it may not be worthwhile to acquire in-depth construction knowledge. In this instance, choosing a reputable and knowledgeable consultant is suggested.

Four RC practices in Hong Kong, i.e. "Clearly defined equitable risk-sharing arrangement among contracting parties" (abc-6), "Ongoing social relationships between clients and contractors" (ab-7), "Ongoing social relationships between clients and consultants" (ac-7), and "Consultants' previous experience in relational contracting approaches" (c-10), were not adopted to a significant extent yet had

414 significant correlation with cost performance. This indicates that the RC practices
415 need more attention.
416
417 The respondents in Hong Kong regarded the practice “Clearly defined equitable
418 risk-sharing arrangement among contracting parties” (abc-6) as a key RC practice
419 affecting cost and time performance, and this supports the view of Rahman and
420 Kumaraswamy (2002). Yet, this practice was not adopted to a significant extent
421 because the public sector’s standard conditions of contract drafted by public bodies
422 may be biased toward the public client.
423
424 Table 5 shows “Ongoing social relationships (e.g. “guanxi” and social ties outside of
425 the project)” between clients and contractors/consultants (ab-7 and ac-7) are key RC
426 practices because they were significantly correlated with cost performance, but not
427 adopted to a significant extent. These mutual ongoing social relationships outside of
428 the project between clients and other contracting parties do not commonly exist in
429 public construction projects in Hong Kong. One explanation could be that the
430 procurement procedures in public construction projects in Hong Kong are subject to
431 strict regulations, and competitive bidding is almost always required (Rahman and
432 Kumaraswamy, 2004b). However, this study found that closer ongoing social

433 relationships among contracting parties are significantly correlated with cost (Y1) and
434 time performance (Y2), and client satisfaction (Y4). This could be attributed to the
435 trust and friendship that are present in ongoing relationships, causing contracting
436 parties to be more willing to compromise should problems arise and thus achieve
437 better outcomes (Castro et al., 2009). The implication is that past and current
438 relationships may be taken into account in the selection of contractors and
439 consultants.
440
441 Table 5 shows that consultants' previous experience in RC approaches (c-10) is
442 significantly correlated with cost performance (Y1) and client satisfaction (Y4), but not
443 adopted to a significant extent in Hong Kong. As explained in the introduction, it is still
444 not known if public sector projects can enjoy the full benefits of RC. It is
445 understandable that consultants lack experience in RC approaches.
446
447 ***Time Performance (Y2)***
448
449 Significant negative correlation was observed between schedule overrun of public
450 construction projects in Beijing and eight RC practices (see Table 4), while 14 RC
451 practices are significantly and negatively correlated with time performance in Hong

452 Kong (see Table 5). There is no common practice in the two lists. In Beijing,
453 contractors were involved in five out of eight RC practices, while in Hong Kong, 13 out
454 of 14 practices relate to clients.
455
456 Table 4 shows that the eight RC practices that significantly affect time performance
457 are all significantly adopted in past public construction projects in Beijing. This may be
458 attributed to the Chinese government's strong emphasis on the timely completion of
459 public projects (Liu et al., 2010). It could also be observed in Table 3 that time overrun
460 in Beijing's public construction projects was not significant (t=1.904, p=0.062), which
461 is consistent with the findings here.
462
463 Among the 14 RC practices that are significantly correlated with time performance in
464 Hong Kong, five practices were not adopted to a significant extent in past projects.
465 These are: "Clearly defined equitable risk-sharing arrangement among contracting
466 parties" (abc-6), "Effectiveness of team-building events used in the project" (abc-13),
467 "Ongoing social relationships between clients and contractors" (ab-7), "Client has
468 organizational culture that fits relational contracting practices" (a-5), and "Previous
469 experience in RC approaches" (a-10). Practices abc-6 and ab-7 had significant
470 correlation with both time performance (Y2) and cost performance (Y1) and have

been discussed in the previous section.

"Effectiveness of team-building events used in the project" (abc-13) was not significantly observed in past public construction projects in Hong Kong. However, as shown in Table 5, significant correlations were found with time performance (Y2) and client satisfaction (Y4). In Hong Kong, officials in public departments that are modeled after the British system are not allowed to participate in team-building events at an inter-personal level. Therefore, contracting parties would rely more on contractual arrangements to guard against trouble, and this rigidity may increase the time needed to execute a project and lead to delays. As team building in the early phases of a project was found to influence participants' behavior and increase project knowledge (Kadefors, 2004), making more effort in team building is recommended (Diallo and Thuillier, 2005).

The results show that clients' "organizational culture fits RC practices" (a-5) and "previous experience in RC approaches" (a-10) were not adopted to a significant extent, yet had significant correlation with time performance (Y2). This agrees with Chan and Kumaraswamy's (1997) finding that client-initiated variation is one of the principal and common causes of delays in Hong Kong, especially when introduced

mid-stream. Clients' lack of an appropriate organizational culture that fits RC practices is the main reason for ineffective project partnering (Ng et al., 2002), and is more critical for public clients (Palaneeswaran and Kumaraswamy, 2000).

Quality Performance (Y3)

Quality performance of public construction projects in Beijing is significantly correlated with 13 RC practices. Five out of the 13 practices were not adopted to a significant extent in past public construction projects. On the other hand, 19 RC practices have significant correlation with quality performance in Hong Kong, and two of these were not adopted to a significant extent.

Contractors' top management support for RC practices (b-15) was significantly correlated with quality performance in both Beijing and Hong Kong. It is the senior management's responsibility to set policies, control resources and train staff. RC is therefore unlikely to succeed without the backing of top management (Akintoye and Main, 2007).

Five out of the 13 RC practices that are significantly correlated with quality

509 performance in Beijing were not adopted to a significant extent. These include:
510 clients' level of innovation/creativity (a-1) and investment in development of
511 collaborative working skills (a-17), consultants' investment in development of
512 collaborative working skills (c-17), contractors' level of innovation/creativity (b-1), and
513 ongoing social relationships between contractors and consultants (bc-7).
514
515 As clients are responsible for the preparation of clear and unambiguous specifications
516 (Jha and Iyer, 2006), they play an important role in helping the project to achieve the
517 desired quality level and need to be competent in defining the level of expected
518 quality. This may explain why clients' level of innovation/creativity (a-1) and
519 investment in development of collaborative working skills (a-17) had significant
520 correlation with quality performance. However, public clients in Beijing are usually
521 infrequent clients or "one-off" clients (Ke et al., 2011), who are unable to be innovative
522 and are not motivated to develop collaborative working skills because they do not
523 have a demand for construction products on a regular basis.
524
525 Consultants' investment in the development of collaborative working skills (c-17) was
526 not significantly adopted in Beijing, yet had significant impact on quality performance.
527 Zhao et al. (2011) also found that modern project management tools and techniques

528 have not been extensively adopted by consultants in China's construction industry.
529 Under such an environment, it is understandable that consultants do not invest much
530 in the development of collaborative working skills in Beijing. As consultants are
531 important links between clients and contractors, a higher level of collaborative
532 working skills of consultants would increase the interaction among project participants,
533 improve mutual understanding and information sharing, and thereafter boost quality
534 performance (Jha and Iyer, 2006).
535
536 Contractors' level of innovation/creativity (b-1) showed a significant correlation with
537 quality performance, perhaps due to its impact on the contractors' operations and
538 output (Yasamis et al., 2002). Consistent with the low contribution rate of science and
539 technology to China's construction industry (Lu et al., 2008), contractors in Beijing
540 may be unwilling to invest in innovation because of the uncertain outcome.
541
542 Ongoing social relationships between contractors and consultants (bc-7) engender
543 good communication, thereby facilitating proper monitoring and timely feedback,
544 which enhance project quality. Ongoing social relationships also enable instances of
545 poor workmanship or improper usage of resources to be reported promptly, and this
546 aids in achieving the desired quality level (Jha and Iyer, 2006).

In Hong Kong, consultants' readiness to compromise on unclear issues (c-11) and the level of reciprocation/face-saving gestures between clients and consultants (ac-8) are key RC practices that are significantly correlated with quality performance (Y3) and client satisfaction (Y4). Currently the Hong Kong government uses a two-envelope system (i.e. technical aspects of the proposal in one envelope and consulting fees in the other) for consultant selection (Baark and Wai, 2000). It is therefore difficult for the client to make a reciprocation /face-saving gesture and directly employ a consultant. Meanwhile, the readiness to compromise on unclear issues is perceived to be an important factor in implementing RC principles (Rahman and Kumaraswamy, 2004a). This is more so for consultants, as they prepare specifications and drawings that are usually far from perfect, and so, compromises on unclear issues need to be made by consultants in order to improve quality performance.

Client Satisfaction (Y4)

Table 4 shows that client satisfaction is significantly correlated with 11 RC practices in Beijing. As shown in Table 5, 39 RC practices have significant correlation with client satisfaction in Hong Kong. The large difference between the numbers of correlated

practices in these two cities may to some extent reflect the greater emphasis and expectation of collaborative behaviors in Hong Kong. Six RC practices were common to both Beijing and Hong Kong. These include three individual features and practices adopted by contractors, and three mutual practices among contracting parties. The former are: “Level of innovation/creativity” (b-1), “Knowledge level of project processes” (b-8), and “Long-term commitment level” (b-9). The latter are: “Sharing of project information between contractor and consultant” (bc-6), “Ongoing social relationships between clients and consultants” (ac-7), and “Level of inter-personal relations/cultural harmony between clients and contractors” (ab-5).

In Beijing, three out of the six RC practices affecting client satisfaction (b-1, bc-6, ac-7) were not adopted to a significant extent. b-1 has been discussed in the previous section.

The sharing of project information between contractors and consultants (bc-6) would enable contractors to better understand the design and consultants to promptly identify potential conflicts, leading to higher client satisfaction. However, each party in mainland China tends to treat information as confidential rather than something to be shared. This is to prevent its own interests from being compromised as there is

585 conflict of interests among the participants, especially between contractors and
586 consultants (Tai et al., 2009).
587
588 The reason why “Ongoing social relationship between clients and consultants” (ac-7)
589 was not significantly adopted in Beijing may be attributed to the current procurement
590 system, which was discussed above. It is worth noting that there is a significant
591 negative correlation between Beijing’s client satisfaction and the ongoing
592 relationships between clients and consultants, which is a direct contrast to Hong Kong.
593 Zuo and Ma (2007) found that one of the major issues in China’s consultancy industry
594 is that the responsibilities of consultants are usually not clearly defined. Due to the
595 ongoing social relationships between clients and consultants, they may have signed a
596 loose contract where the responsibilities of consultants are not clearly spelt out.
597 Clients could thereafter be less satisfied.
598
599 Table 5 shows that eight RC practices that significantly affect client satisfaction were
600 not significantly adopted in Hong Kong. They comprise two individual features and
601 practices of consultants, four mutual practices, and two joint practices. The two
602 individual features and practices of consultants are: “Previous experience in RC
603 approaches” (c-10) and “Readiness to compromise on unclear issues” (c-11). The

four mutual practices are: “Ongoing social relationships” among contracting parties (ab-7, ac-7 & bc-7) and “Level of reciprocation/face-saving gestures between clients and consultants” (ac-8). The two joint practices are: “Collective/combined responsibility by a pre-selected group comprising one person from each major party” (abc-4) and “Effectiveness of team-building events used in the project” (abc-13). Among them, practices c-10, c-11, ab-7, ac-7, ac-8, and abc-13 have significant correlation with other performance indexes, which has been discussed above.

Ongoing social relationships among contracting parties (ab-7, ac-7 & bc-7) were found to be significantly correlated with client satisfaction in Hong Kong. This is consistent with Castro et al.’s (2009) finding that construction companies form coalitions principally on the basis of past or current relationships.

“Collective/combined responsibility by a pre-selected group comprising one person from each major party” (abc-4) is currently not a common behavior in Hong Kong. An independent facilitator is sometimes appointed to chair a few workshops and assist in fostering confidence among the contracting parties (Chan et al., 2009b). However, the facilitator would not be involved throughout the whole life of the project. Therefore, a joint group comprising at least one person from each party is not commonly available.

Conclusions

This study investigated RC practices that are adopted in public construction projects in China. Using a structured questionnaire, data were collected from experienced contracting parties who had been personally involved in public construction projects in Beijing and Hong Kong. The statistical analysis revealed that public construction projects in both cities had achieved significantly good quality performance and client satisfaction but not in budget and schedule performance. However, public construction projects in Hong Kong achieved significantly better performance in owner satisfaction and quality than those in Beijing.

The main findings (see Tables 4 and 5) are: 32 and 56 RC practices are significantly correlated with the performance outcomes of public construction projects in Beijing and Hong Kong, respectively; and eight and 11 of these RC practices in Beijing and Hong Kong, respectively, are key practices as they are not adopted to a significant extent but are significantly correlated with performance outcomes. The unique value of the findings to the construction engineering and management community is the identification of a list of key RC practices which could be adopted as they lead to

642 better project outcomes. Some of these key RC practices are: having collective
643 responsibility comprising one person from each major contracting party; sharing risks
644 equitably among contracting parties; organizing effective team-building events;
645 sharing project information among contracting parties; developing collaborative
646 working skills; and compromising on unclear issues.
647
648 Another main finding is that 13 practices were adopted to significantly different
649 extents in Hong Kong and Beijing. To generalize the findings to the broader global
650 community, to a limited extent, the findings from Hong Kong may be applicable to
651 countries that adopt the open market economy, while those from Beijing may be
652 implemented by countries that adopt a planned economy. Hong Kong's open market
653 is indicated by its global competitiveness rank of 11 out of 142 countries, which is
654 comparable to the US and UK's rankings of 5th and 10th respectively, and ahead of
655 Australia's 20th placing (World Economic Forum, 2011). As for Beijing, its planned
656 economy is also known as authoritarian capitalism (McGregor, 2012) where the state
657 directs and controls a large share of the country's economic output. The central
658 planning extends to allocation of workload through administrative orders (Zhang,
659 2003). The implications of the findings for the global communities that adopt project
660 management style along PMI's (2008) framework are: they should have better

division of responsibilities among contracting parties; share more project information; and have long-term commitment to the project. On the other hand, in planned economies, RC practices that are adopted to a significantly larger extent are having combined responsibility comprising one person from each major contracting party, and organizing effective team-building events.

The results show that public projects in China had adopted many RC practices among contracting parties to a significant extent, such as alignment of objectives, joint coordination and monitoring of plans, and joint problem solving. The findings contribute to the body of knowledge by showing that the Relational Contract Theory is valid for public projects even though they are procured through open bidding, and hence do not lend themselves to future relationships. The implication is that A/E/C firms should approach public projects with a relational mindset and not view them as discrete transactions just because the public sector uses open bidding. Another contribution to knowledge is that the relational approach is shown to be important as it leads to better project outcomes.

One limitation faced in this study is that correlation does not mean causation. Therefore the results should be interpreted carefully. Correlation statistics should not

be taken as conclusive evidence that those RC practices are definitely the most appropriate ones to be adopted. Secondly, the findings are not easily generalized to different regions in China, as the public projects that were used to inform this research were from Beijing and Hong Kong only. Finally, the population size could not be estimated, and hence the significance of the sample could not be determined mathematically. In future studies, data from other regions in China could be collected, with the population defined more clearly.

Acknowledgements

The research is made possible by Singapore Ministry of Education's Academic Research Fund Tier 2 funding support (Grant number: MOE2009-T2-2-067) for the project entitled 'Boosting public construction project outcomes through relational transactions'. Prof Patrick Zou and Ning Yan's contribution to the questionnaire design is acknowledged with grateful thanks. Special gratitude is extended to those industry practitioners who have kindly participated in the surveys reported in this paper

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906

Table
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Table 1: Features and Practices Identified

RC Practices		Code	Authors who investigated
Individual features & practices	Level of innovation/creativity	a-1, b-1, c-1	Chan et al., 2004; Cheng et al., 2000
	Commitment of resources to the project	a-2, b-2, c-2	Cheng et al., 2000; Chen and Chen, 2007
	Effort in implementing relational contracting practices	a-3, b-3, c-3	Black et al., 2000; Chen and Chen, 2007
	Acceptance of relational contracting practices	a-4, b-4, c-4	Black et al., 2000; Kumaraswamy et al., 2005b
	Organizational culture fit to relational contracting practices	a-5, b-5, c-5	Rahman and Kumaraswamy, 2004a, 2004b
	Financial capacity	a-6, b-6, c-6	Black et al., 2000; Chen and Chen, 2007
	Flexibility when situations change	a-7, b-7, c-7	Chen and Chen, 2007; Ling et al., 2006b
	Knowledge level of project processes	a-8, b-8, c-8	Cheng et al., 2000; Love et al., 2010
	Long-term commitment level	a-9, b-9, c-9	Cheng et al., 2000
	Previous experience in relational contracting approaches	a-10, b-10, c-10	Kumaraswamy et al., 2005a, b;
	Readiness to compromise on unclear issues	a-11, b-11, c-11	Rahman and Kumaraswamy, 2004a, b
	Reputation in the industry	a-12, b-12, c-12	Powell, 1990; Gulati and Gargiulo, 1999
	Specific inputs on construction methods, materials, etc, before they were formally appointed	a-13, b-13, c-13	Bayliss et al., 2004; Rahman and Kumaraswamy, 2004b
	Team working attitude	a-14, b-14, c-14	Black et al., 2000; Chen and Chen, 2007
	Top management support for relational contracting practices	a-15, b-15, c-15	Black et al., 2000, Akintoye and Main, 2007

	Attitude toward continuous improvement	a-16, b-16, c-16	Black et al., 2000; Chen and Chen, 2007
	Investment in development of collaborative working skills	a-17, b-17, c-17	Hastings, 1995; Dyer, 1996
Mutual practices between two members	Familiarity/previous relationships	ab-1, ac-1, bc-1	Gulati, 1999; Zaheer and Soda, 2009
	Mutual trust	ab-2, ac-2, bc-2	Xu et al., 2005; Kumaraswamy, et al., 2005b
	Mutual understanding	ab-3, ac-3, bc-3	Black, 2000; Love et al., 2010
	Open and effective communication	ab-4, ac-4, bc-4	Chen and Chen, 2007; Doloi, 2009
	Level of inter-personal relations/cultural harmony (individual level)	ab-5, ac-5, bc-5	Kumaraswamy et al., 2005a; Rahman and Kumaraswamy, 2008
	Sharing of project information	ab-6, ac-6, bc-6	Uzzi and Lancaster, 2003; Maurer and Ebers 2006
	Ongoing social relationships (e.g. “guanxi”, social ties, and kinship outside of this project)	ab-7, ac-7, bc-7	Gulati and Gargiulo, 1999; Castro et al., 2009
	Level of reciprocation/face-saving gestures	ab-8, ac-8, bc-8	Oliver, 1990; Pervan et al., 2011
Joint practices among all members	Clarity of division of responsibilities among contracting parties	abc-1	Anvuur and Kumaraswamy, 2007; Halman and Braks, 1999
	Acceptance of performance appraisal mechanism for the project	abc-2	Rahman and Kumaraswamy, 2004a, b
	Alignment of objectives of different contracting parties	abc-3	Cheng et al. 2000; Rahman and Kumaraswamy, 2008
	Collective/combined responsibility by a pre-selected group comprising one person from each major party	abc-4	Chan et al., 2004; Halman and Braks, 1999
	Joint coordination and monitoring plans among contracting parties	abc-5	Chan et al., 2004; Yeung et al., 2007
	Clearly defined equitable risk-sharing arrangement among contracting parties	abc-6	Rahman and Kumaraswamy, 2002; Ling et al., 2006b
	Flexible/adjustable contracts to address uncertainties	abc-7	Rahman and Kumaraswamy, 2005
	Commitment level of contracting parties to joint problem solving	abc-8	Chan et al., 2004; Chen and Chen, 2007

	Presence of conducive learning climate/environment	abc-9	Chan et al., 2004; Chan et al., 2006
	Acceptance of dispute resolution mechanism for the project	abc-10	Rahman and Kumaraswamy, 2004a, 2004b
	Clarity of contract conditions (e.g. scope of contract, duties & responsibilities)	abc-11	Wong and Cheung, 2005
	Real gain-share/pain-share among contracting parties	abc-12	Black et al., 2000; Ling et al., 2006b
	Effectiveness of team-building events used in the project	abc-13	Cheng and Li, 2001, 2002

Note: a, b, and c in code column refer to client, contractor, and consultant, respectively.

Table 2: Characteristics of Respondents

Characteristic		Beijing		Hong Kong	
		No.	**%**	**No.**	**%**
Experience in construction industry	< 5 years	8	14	3	6
	5-9 years	14	24	4	8
	10-14 years	22	38	6	12
	≥ 15 years	14	24	37	74
	Average	11		22	
	Min	2		3	
	Max	30		56	
Organization type	Government	10	18	15	29
	Engineering firm	1	2	3	6
	Architectural firm	10	18	0	0
	Quantity surveying firm	5	9	3	6
	Contractor	32	57	27	53
	Others	4	7	3	6
Ownership of organization	Public	30	52	23	45
	Private	13	22	27	53
	Joint Venture	15	26	1	2
	Average of public percentage	45		50	
Size of total workforce	< 100	12	21	2	4
	100-999	23	40	17	35
	≥ 1000	22	39	30	61
	Average	19934		3097	
	Min	25		10	
	Max	160000		50000	

Table 3: Extent of Differences between Beijing and Hong Kong

Code	Beijing			Hong Kong			ANOVA	
	Mean	**T**	**Sig.**	**Mean**	**T**	**Sig.**	**F**	**Sig.**
Cost (Y1)	10.42%	2.866	0.006	12.50%	4.535	0.000	0.198	0.657
Time (Y2)	8.41%	1.904	0.062	17.78%	5.213	0.000	2.721	0.102
Quality (Y3)	3.19	3.296	0.002	3.98	11.364	0.000	62.222	0.000
Client Satisfaction (Y4)	3.32	3.777	0.000	3.88	9.656	0.000	20.087	0.000
a-6	3.56	3.795	0.000	4.28	9.456	0.000	12.839	0.001
a-8	3.16	1.219	0.228	3.87	7.258	0.000	15.415	0.000
a-9	3.07	0.482	0.632	3.77	5.468	0.000	11.303	0.001
a-16	3.32	2.746	0.008	3.87	6.317	0.000	9.387	0.003
b-9	3.45	4.259	0.000	3.90	7.019	0.000	7.587	0.007
b-13	3.44	3.605	0.001	3.88	5.831	0.000	5.315	0.023
c-9	3.26	2.668	0.010	3.63	4.555	0.000	4.838	0.030
ab-8	3.69	5.680	0.000	3.24	1.900	0.063	6.232	0.014
bc-1	3.04	0.256	0.799	3.56	4.288	0.000	7.113	0.009
bc-6	3.13	1.044	0.301	3.53	3.400	0.001	4.334	0.040
abc-1	3.29	2.664	0.010	3.92	8.267	0.000	15.995	0.000
abc-4	3.66	7.519	0.000	3.14	1.188	0.241	12.777	0.001
abc-13	3.43	4.236	0.000	3.06	0.375	0.709	4.145	0.044

Table 4: Correlation of RC Practices to Project Performance in Beijing

RC Practices	Mean	Cost (Y1)		Time (Y2)		Quality (Y3)		Satisfaction (Y4)	
		Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
bc-7	2.93					0.316	0.019		
a-1	2.96					0.267	0.047		
a-17	3.05					0.299	0.026		
bc-6	3.13							0.295	0.029
c-17	3.16					0.275	0.041		
a-8	3.16	-0.290	0.035						
b-1	3.18					0.386	0.003	0.358	0.007
ac-7	3.25							-0.271	0.043
abc-10	3.27*			-0.280	0.040				
abc-1	3.29*							0.358	0.006
a-16	3.32*	-0.273	0.048						
bc-5	3.33*			0.371	0.007			0.299	0.026
c-2	3.33*			-0.290	0.037				
bc-3	3.36*							0.305	0.022
a-5	3.36*					0.290	0.030		
bc-8	3.41*							0.310	0.023
a-14	3.43*			-0.382	0.005				
b-13	3.44*					0.267	0.048		
b-9	3.45*					0.325	0.015	0.280	0.037
abc-11	3.47*	-0.309	0.022						
ab-5	3.48*							0.348	0.009
ac-5	3.50*					0.306	0.022		
b-5	3.61*			-0.287	0.039				
c-15	3.63*	-0.277	0.045						
a-12	3.68*	-0.341	0.015						
b-6	3.72*					0.274	0.045		
b-4	3.73*							0.294	0.028
b-8	3.75*							0.270	0.044
b-2	3.77*					0.416	0.001		
b-15	3.82*			-0.422	0.002	0.331	0.013		
c-12	3.82*			-0.386	0.005	0.307	0.020		
b-12	3.98*			-0.308	0.026				
Total		5		8		13		11	

Note: * significant at p<0.050 based on *t* test of the mean results

Table 5: Correlation of RC Practices to Project Performance in Hong Kong

RC Practices	Mean	Cost (Y1)		Time (Y2)		Quality (Y3)		Satisfaction (Y4)	
		Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
abc-6	2.82	-0.300	0.038	-0.349	0.015				
ab-7	3.00	-0.398	0.006	-0.318	0.031			0.386	0.006
abc-13	3.06			-0.347	0.016			0.351	0.011
ac-7	3.12	-0.435	0.005					0.372	0.014
a-10	3.13			-0.374	0.012				
bc-7	3.14							0.316	0.039
abc-4	3.14							0.375	0.007
c-11	3.20					0.385	0.014	0.329	0.038
ac-8	3.20					0.332	0.028	0.323	0.032
a-5	3.21			-0.376	0.012				
c-10	3.25	-0.431	0.007					0.348	0.028
c-5	3.30*	-0.367	0.023	-0.415	0.010				
abc-10	3.31*	-0.312	0.031						
a-4	3.32*							0.295	0.044
bc-2	3.37*							0.305	0.047
a-17	3.40*							0.311	0.033
ab-2	3.43*							0.305	0.033
ab-6	3.43*							0.295	0.039
abc-2	3.44*					0.317	0.025		
b-11	3.45*					0.359	0.011	0.324	0.023
ab-3	3.45*							0.342	0.016
ab-5	3.47*			-0.317	0.032			0.352	0.013
c-4	3.50*	-0.323	0.048			0.331	0.037	0.349	0.027
abc-3	3.50*	-0.421	0.003	-0.409	0.004			0.311	0.028
b-1	3.51*							0.417	0.003
c-1	3.51*					0.345	0.027		
a-14	3.52*					0.367	0.012		
b-17	3.53*					0.300	0.036	0.292	0.042
c-2	3.53*							0.325	0.040
c-16	3.53*	-0.443	0.005			0.456	0.003	0.507	0.001
ab-1	3.53*			-0.328	0.026				
bc-6	3.53*					0.355	0.019	0.437	0.003
b-10	3.55*							0.309	0.031
c-13	3.60*							0.326	0.040
ab-4	3.61*					0.291	0.042		
c-9	3.63*	-0.322	0.048			0.315	0.048	0.392	0.012
c-14	3.65*	-0.499	0.001			0.418	0.007	0.403	0.010
bc-4	3.65*							0.358	0.018
b-5	3.67*							0.318	0.026
a-15	3.68*							0.347	0.017

RC Practices	Mean	Cost (Y1)		Time (Y2)		Quality (Y3)		Satisfaction (Y4)	
		Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
c-15	3.70*	-0.354	0.029			0.333	0.036	0.371	0.018
ac-1	3.73*			-0.387	0.012				
abc-11	3.76*			-0.320	0.027				
a-9	3.77*	-0.339	0.025						
b-16	3.80*							0.412	0.003
a-8	3.87*			-0.320	0.034				
a-16	3.87*	-0.362	0.016	-0.343	0.023	0.383	0.008	0.383	0.008
b-9	3.90*							0.316	0.027
abc-1	3.92*					0.332	0.017		
b-12	3.96*					0.360	0.011	0.406	0.004
c-12	3.97*	-0.414	0.010						
a-12	4.02*			-0.382	0.010				
b-8	4.02*							0.444	0.001
b-14	4.02*	-0.310	0.036			0.490	0.000	0.452	0.001
b-15	4.02*					0.333	0.019	0.377	0.008
b-2	4.06*							0.294	0.041
Total		16		14		19		39	

Note: * significant at p<0.050 based on *t* test of the mean results

Figure 1
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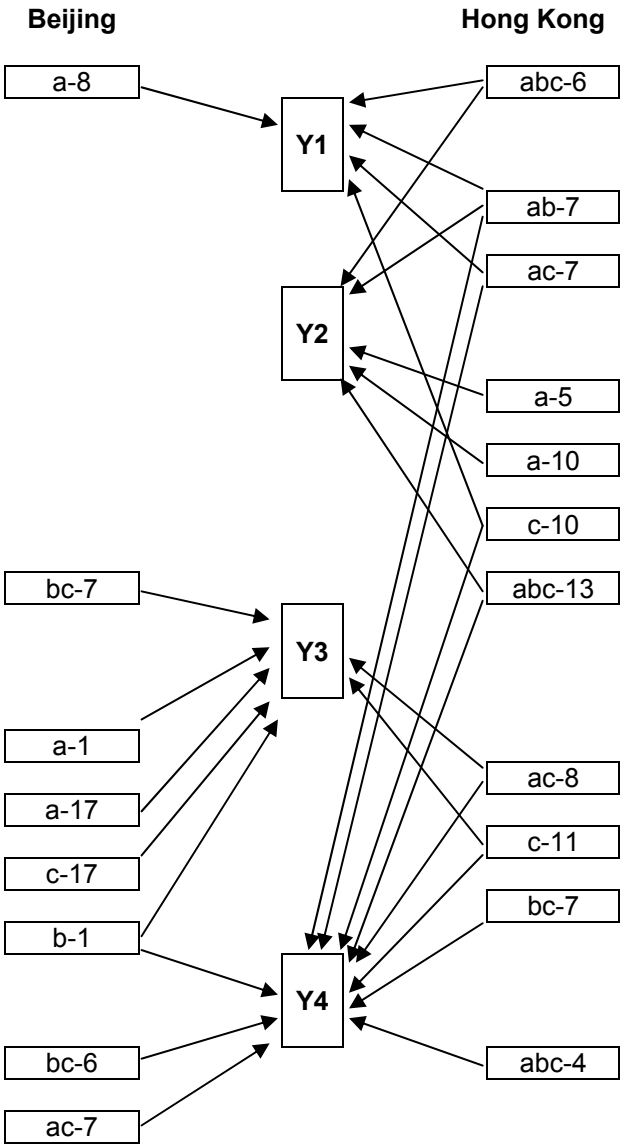

Figure 1: RC practices that need more emphasis
Note: Refer to Table 1 for descriptions of the codes

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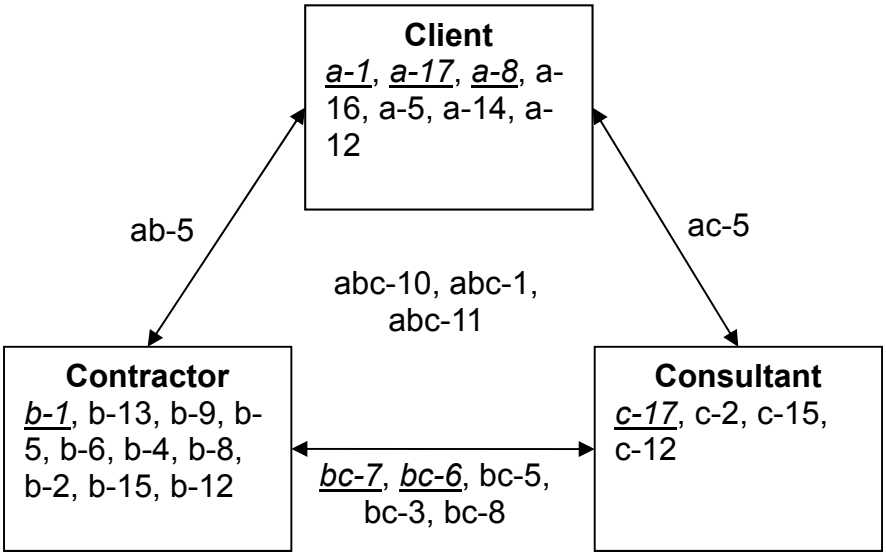

Figure 2: Framework to Better Manage Public Projects in Beijing

Notes: 1) Refer to Table 1 for descriptions of the codes;

2) Italicized and underlined items are key RC practices identified in Table 4

Figure 3
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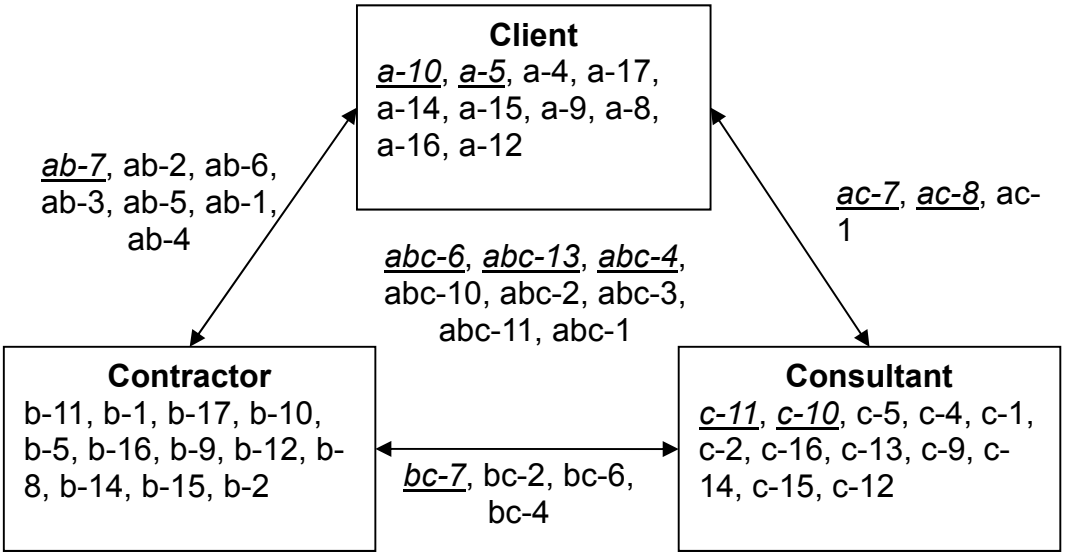

Figure 3: Framework to Better Manage Public Projects in Hong Kong

Notes: 1) Refer to Table 1 for descriptions of the codes;

2) Italicized and underlined items are key RC practices identified in Table 5

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Publication Title: Journal of Construction Engineering and Management

Manuscript/Chapter Title: Key Relational Contracting Practices Affecting Performance of Public Construction Projects in China

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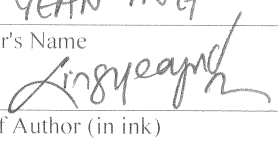
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up to 34 lines = 315 word equiv.	up to 34 lines = 630 word equiv.
up to 51 lines = 473 word equiv.	up to 51 lines = 945 word equiv.
up to 68 text lines = 630 word equiv.	up to 68 text lines = 1260 word equiv.

C. Total Characters wide by Total Text lines = word equiv. as shown in the table above. **Add word equivalents** for each table in the column labeled "**Word Equivalents.**"

Estimating Length of Tables &

Tables	Word Equivalents	**Figures**
Table 1	945	Figure 1
2	315	2
3	315	3
4	315	4
5	473	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	10
11	0	11
12	0	12
13	0	13
14	0	14
15	0	15
		16
Please double-up tables/figures if additional space is needed (ex. 20+21).		17
		18
		19
		20 and 21

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up to 7 in.(177.8mm) high = 473 word equiv.	up to 7 in.(177.8mm) high = 945 word equiv.
up to 9 in.(228.6mm) high = 630 word equiv.	up to 9 in.(228.6mm) high = 1260 word equiv.

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Total Tables/Figures:	2837	(word equivalents)
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Total words and word equivalents:	**10010**	
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Key Relational Contracting Practices Affecting the Performance of Public Construction Projects in China

Note: When referencing line numbers, please refer to the “tracked change” version of the revised manuscript.

No.	Comments	Responses
1	In their revision, the authors should review all comments and information that encompass statistical significance and concisely reorganize them in a short statement to be included in the "characteristics of the sample" section. The authors have addressed the majority of the reviewer's comments, except for the one about the statistical significance. More discussion on the statistical significance and validity of the sample is required. Is the sample statistically significant or not? The reviewer acknowledges the authors' response; however, the population size could be estimated to address this point.	We agree with the handling editor and Reviewer #6 that it is desirable to know if the sample is statistical significant or not. This could have been done through estimating the confidence interval for the proportion of public projects was calculated using the equation below. $z_{\alpha/2} = \frac{L\sqrt{n}}{0.5}$ Where: $z_{\alpha/2}$ is the number for which $P(Z > z_{\alpha/2}) = \alpha/2$. L is the distance of extension on each side of the sample proportion n is the sample size. Unfortunately, we could not estimate L because the population size could not be estimated. This is because the population is defined as “completed public projects in China” (see lines xx – xx), without defining the start and end dates, and the minimum project values. The questionnaire also did not ask respondents to state the start and end dates of their projects. Notwithstanding this, we suggest that the samples are valid for these reasons. The first is the general convention that when n>30, the central limit theorem holds true. The second reason is that questionnaires were sent to all the public offices in Beijing and Hong Kong that manage public construction projects. No public office had been deliberately left out. Thirdly, high Cronbach’s alpha values of 0.832 to 0.938 were obtained, suggesting high internal consistency. See lines xx – xx. We have now also added another limitation of study: The population size could not be estimated, and hence the significance of the sample could not be determined mathematically. See lines xx – xx.

No.	Comments	Responses
2	Also, some discussion should be provided to explain the significantly different response rates among the Beijing and the Hong Kong samples.	A statement was added in the "characteristics of the sample" section in lines 222-229: Many more samples were identified in Hong Kong than in Beijing because Hong Kong has more easily available published information of names of public officials and private contractors and consultants. However, this collection comprised a mix of private firms that had and did not have experience in public projects. As the questionnaire instructed those without experience in public sector projects not to reply, even though more questionnaires were sent out in Hong Kong, the fact that there are fewer public sector projects in Hong Kong compared to Beijing explains the lower response rate in Hong Kong.
3	In addition, the reviewer strongly recommends revisiting the whole manuscript to enhance the conciseness of the writing. The paper could be significantly shortened without compromising its message.	We have gone through the whole manuscript and deleted some paragraphs without compromising its message. These include the following: lines ***-***.

Key Relational Contracting Practices Affecting the Performance of Public Construction Projects in China

Florence Y.Y. Ling[1], Yongjian Ke[2], Mohan M. Kumaraswamy, M.ASCE[3], and ShouQing Wang[4]

Abstract

Relational contracting (RC) is based on the recognition of mutual benefits and win-win scenarios that are achieved through more cooperative relationships among the contracting parties in a project. While RC principles are less difficult to apply in private sector projects, it has not been established if public sector projects can enjoy the full benefits of RC. This study aims to investigate the effective RC practices that are found in China's public construction projects. The specific objectives are to: (1) evaluate project performance levels in terms of cost, time, quality and client

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satisfaction; (2) investigate the extent to which RC practices were adopted; and (3) identify the RC practices that lead to better performance. Due to the large geographical area of China, the surveys conducted were confined to Beijing and Hong Kong. A structured questionnaire was designed to collect qualitative data. The results show that: (1) public construction projects achieved significant success in quality performance and client satisfaction but not in budget and schedule performance; and (2) RC practices were adopted to varying extents in public projects. The findings contribute to knowledge by identifying the specific RC practices that could boost project performance significantly. Another contribution to knowledge is the discovery that the Relational Contract Theory is applicable to public projects notwithstanding the need to keep relations at arm's length. A framework to manage public projects using the RC approach is recommended for adoption in Hong Kong and other countries that adopt project management style along PMI's framework. A different framework is recommended for adoption in Beijing and places that have a centrally planned and controlled economic system so as to help public projects achieve better project performance.

Subject headings: Relational Contracting, Public Construction Projects, Strategy, Beijing, Hong Kong

Introduction

Relationships among contracting parties include formal transactions and relational links. Formal contracts spell out the rights, responsibilities, and liabilities of the parties concerned. In a formal contract, parties act in an atomized manner, looking out for their own personal interests (Williamson, 1975). Relational contracting (RC) is based on the recognition of mutual benefits and win-win scenarios that are achieved through more cooperative approaches, such as partnering, alliancing, joint venturing, long-term contracting, joint risk-sharing mechanisms, integrated project delivery, and other collaborative working arrangements (Rahman and Kumaraswamy, 2004a; AIA, 2007). While RC principles are less difficult to apply in projects initiated by the private sector (Kumaraswamy, 2010), the gap in knowledge is that it is not known if public sector projects can also enjoy the full benefits of RC, such as risk and cost reduction, and better project performance (Akintoye and Main, 2007).

The term “RC practices” in this paper refers to “relational practices” or practices based on good relationship management, which are RC-type or RC-based, even though the actual contracts may not have incorporated any formal RC approaches.

China is a legitimate geographical region to investigate, as seen in many previous studies (examples are: Lu et al., 2008; Tai et al, 2009; Chan et al., 2009a; Zhao et al., 2011). Due to its strong economic growth and need for national development, there are many opportunities for architectural, engineering and construction (A/E/C) firms to operate in China's construction industry. However, the Chinese market is full of pitfalls as well. It is fragmented, heterogeneous, risky and highly competitive (Chen and Messner, 2009). To perform well in the Chinese market, knowledge of the types of RC practices that lead to project success may be important. Hence, the aim of this study is to investigate effective RC practices in China's public construction projects. The specific objectives are to: (1) evaluate public project performance levels in terms of cost, time, quality, and client satisfaction; (2) investigate the extent to which RC practices are adopted; and (3) identify the RC practices that lead to better performance of public projects in China.

Due to China's large geographical area, the scope of this study is confined to public construction projects in Beijing and Hong Kong. The capital city of Beijing was chosen for study as it has a significant number of completed public projects for the 2008 Olympics and also because it is representative of how a centrally planned

economy operates. Hong Kong, a former British colony and now a Special Administrative Region, was chosen for study because its construction practices are closer to those of A/E/C firms that operate in free market economies. The geographic specific findings of Beijing and Hong Kong could be applied to centrally planned economies and free market economies, respectively, in the context of the broader global community. The contrast between practices in Beijing and Hong Kong helps A/E/C firms that are currently operating in a free market economy and planning to enter a centrally planned market to better understand the differences between the RC practices in different markets. Particular attention could be paid to the key RC practices identified in this study to help them achieve better project outcomes.

In the next section, a literature review of project performance and RC practices is presented and the knowledge gaps are identified. The research design and data analysis method are then explained, followed by the presentation of the characteristics of the sample. Next, the extent to which RC practices are adopted in Beijing and Hong Kong are compared and discussed, and key RC practices that lead to better project performance are identified. The last section summarizes the findings and offers recommendations to the construction engineering and management community.

Literature Review

Operationalizing Project Performance

Project outcomes are multi-faceted. These include the traditional triple project outcomes (time, cost, and quality), safety performance, environmental performance, stakeholder satisfaction, and profitability. For this study, project outcome is viewed from the perspective of project delivery and organizational level competency. For project delivery competency, this research adopts the traditional triple project outcomes as the performance metrics, following Konchar and Sanvido (1998). For organizational level competency, service quality is operationalized as client satisfaction with the project, following Ling et al. (2004).

RC Practices Affecting Project Performance

Different aspects of RC have been covered in previous studies. These include drivers (Chan et al., 2003), obstacles (Glagola and Sheedy, 2002), success factors (Chan et al., 2004), components like trust (Wong et al., 2005), culture (Ang and Ofori,

2001), communication (Bayliss et al., 2004), and performance index (Yeung et al., 2007). This study postulates that there are certain RC practices that significantly affect the performance of public construction projects in China. RC practices were identified from the literature review and summarized in Table 1. For brevity, these practices are coded as “a”, “b” and “c” for client, contractor, and consultant, respectively, followed by a reference number. These RC practices are divided into three categories: (1) individual organizational features and practices adopted by each contracting party (coded as a-#, b-# and c-#); (2) practices adopted in tandem by two of the contracting parties (coded as ab-#, ac-# and bc-#); and (3) practices adopted by all the major contracting parties in unison (code: abc-#). “#” represents the reference number of the RC practice.

<Insert Table 1 here.>

Knowledge Gaps

The Relational Contract Theory views contracts more as relations rather than as discrete transactions and thus, all transactions involve a wider social and economic context (Macneil, 1974). The theory states that individual transactions lie on a

spectrum ranging from “discrete” through to “relational”. The theory challenges the traditional premise that all contracts are mere transactions, and emphasizes the role of norms in determining the manner in which commercial exchanges operate in practice. These norms are further operationalized into RC approaches/practices.

The brief literature review revealed that previous studies on RC approaches did not differentiate between public and private construction projects. Whether RC principles could be applied successfully and specifically to public construction projects remains unclear.

Public projects merit an in-depth study because public clients are usually not in the position to offer future relationship incentives since most projects must be procured through the competitive bidding process, and government regulations traditionally discourage close relationships between public clients and private contracting parties (Rahman and Kumaraswamy, 2004b). Yet, public projects are highly visible and need to achieve the triple project goals because taxpayers’ money is involved.

The link between the adoption of RC practices and project outcomes is also not known. This study therefore aims to fill the gap by investigating the relevance of the

Relational Contract Theory to public contracts through exploring RC practices that may boost the performance of public projects in China significantly.

Research Method

A large study had been conducted on RC practices and the drivers of and barriers to relational contracts, as well as how these affect the performance of public construction projects in China, Australia, and Singapore. This paper reports a part of the study, focusing on RC practices and project outcomes in China.

Research Design

The questionnaire-survey is the adopted choice of research design for this study. The survey was conducted between June and November 2011 in Beijing and Hong Kong. The objectives of the survey that are relevant to this paper are twofold: (1) to evaluate the performance outcomes of completed public construction projects; and (2) to determine the extent to which RC practices were present, observed, practiced or emphasized in these projects.

The unit of analysis in this study is a completed public sector project, regardless of the extent to which RC approaches were adopted. The target population is thus completed public projects in China, and the sampling frame is hence completed public projects in Beijing and Hong Kong. In order to collect the data, multiple stakeholders comprising public sector clients and consultants, private sector consultants (e.g. architects, engineers, quantity surveyors, and project managers), and contractors, who had been involved in public construction projects in Beijing and Hong Kong, were approached. However, due to the lack of a national registry of officials/firms involved in public construction projects, the contact details of public officials were obtained from government directories. Questionnaires were then sent to all of them because the number is not large. The contact details of private consultants and contractors were derived from the respective professional and trade institutions, and randomly selected. As this group may contain those who have not handled public projects before, the questionnaire clearly stated that only those who had completed public projects should fill up the questionnaire.

Data were collected using a specially designed structured questionnaire. Section A of the questionnaire requested information on the completed public sector project and the project's performance level in four areas: cost (Y1); time (Y2); quality (Y3); and

client satisfaction (Y4). Y1 and Y2 were measured more objectively as percentage of time and cost over/under run. Y3 measured quality of output, stated as product/output quality of the facility/project. Y4 measured quality of service, stated as client satisfaction with the contracting parties' service quality. Service quality measures the transformation process (i.e. the service) from resources to the constructed facility. Y3 and Y4 were relatively subjective and thus rated on a five-point Likert scale (1 = Very dissatisfied, 3 = Neutral, 5 = Very satisfied). In Section B, respondents were asked to indicate the extent to which RC practices were adopted on a five-point Likert scale (1 = Very low, 3 = Neutral, 5 = Very high). Respondents were also given the opportunity to provide other suggestions and demographic characteristics of themselves and their companies. The questionnaire was pilot tested and then translated into Chinese.

Data Analysis Method

The data were analyzed using SPSS software. The main statistical methods used were descriptive statistics, one-way ANOVA, one-sample *t* test and Pearson's correlation analysis. The Confidence Interval (CI) was set at 0.95. One-way ANOVA was conducted to check if there is any significant difference in the extent to which

RC practices were adopted in Beijing and Hong Kong. The one-sample *t* test procedure was performed on the four performance metrics (Y1 to Y4) and the RC practices to determine if the projects achieved significantly good performance and if the practices were adopted to a significant extent, respectively. To check whether a greater adoption of RC practices led to better project outcomes, Pearson's correlation analysis was conducted. Each pair of variables in the Pearson's correlation analysis comprised one of the four performance metrics and one of the RC practices.

Characteristics of the sample

Survey questionnaires were sent to 259 and 645 samples in Beijing and Hong Kong, respectively. 59 and 51 valid questionnaires were returned in Beijing and Hong Kong, representing response rates of 22.78% and 7.91%, respectively. Many more samples were identified in Hong Kong than in Beijing because Hong Kong has more easily available published information of names of public officials and private contractors and consultants. However, this collection comprised a mix of private firms that had and did not have experience in public projects. As the questionnaire instructed those without experience in public sector projects not to reply, even though

more questionnaires were sent out in Hong Kong, the fact that there are fewer public sector projects in Hong Kong compared to Beijing explains the lower response rate in Hong Kong.

As regards sample validity, it is observed that more than 30 sets of valid project data were received. The general convention is that when n>30, the central limit theorem holds true. Moreover, questionnaires were sent to all the public offices that manage public construction projects in Beijing and Hong Kong. No public office had been deliberately left out. Cronbach's alpha values of three categories of RC practices in Beijing and Hong Kong ranged from 0.832 to 0.938, suggesting that the RC practices under each category have a high internal consistency (Nunnally, 1978). It is therefore concluded that these data are reliable and further statistical analyses may be conducted (Nunnally, 1978).

The characteristics of the respondents are given in Table 2. All the respondents have extensive construction experience in various types of public construction projects. The Beijing and Hong Kong respondents had an average of 11 and 22 years of experience, respectively. The respondents' firms engage an average of 19,934 and 3,097 employees in Beijing and Hong Kong, respectively. In the light of the rich

experience of the respondents as shown in Table 2, these respondents should be in a position to accurately assess the extent to which RC practices were present, observed, practiced or emphasized in the project.

<Insert Table 2 here.>

Result 1: Performance of Public Projects in Beijing and Hong Kong

The first objective of this study is to evaluate project performance levels based on cost, time, quality, and client satisfaction. The *t* test results in Table 3 show that public construction projects in Beijing achieved significantly good performance in client satisfaction (3.32, p=0.000) and quality (3.19, p=0.002), but had significantly poor cost performance (10.42% cost overrun, p=0.006) and marginally failed in time performance (8.41% schedule overrun, p=0.062). Public construction projects in Hong Kong also achieved significantly good performance in client satisfaction (3.88, p=0.000) and quality (3.98, p=0.000), but their mean scores are significantly higher than those in Beijing. Similar to Beijing, the results show that public projects in Hong Kong had significantly poor cost performance (12.50%, p=0.000) and time performance (17.78%, p=0.000).

<Insert Table 3 here.>

Poor cost performance could have arose because of the prevalent practice of under bidding, hidden costs which surface only at the later stage, (Ling et al., 2006a) and inability to respond adequately to perceived change orders (Ling et al., 2008). Poor time performance may be due to Chinese clients changing the project scope and issuing too many change orders (Ling et al., 2006a). While changes were ordered on site, sometimes, the client's top management may not approve them, giving rise to abortive work and further delays (Ling et al, 2006a). Project delays may also come about because of holdups in getting approvals (Ling et al, 2008).

Result 2: RC Practices Adopted in Beijing and Hong Kong

The second objective of this study is to investigate the extent to which RC practices were adopted in Beijing and Hong Kong using *t* test of the mean. The *t* test results in Tables 4 and 5 show that there are RC practices that had been adopted to a significant extent in Beijing and Hong Kong's public projects. The finding suggests that Macneil's (1974) Relational Contract Theory is applicable to public projects

although these generally comprise discrete transactions with little opportunity for future exchanges.

ANOVA results in Table 3 show that 13 practices were adopted to significantly different extents in Beijing and Hong Kong. Among these, 10 RC practices were used more frequently in Hong Kong, while only three practices were adopted more frequently in Beijing, indicating that RC concepts are generally more acceptable to contracting parties in public construction projects in Hong Kong. The implication is that A/E/C firms planning to penetrate a different type of market (e.g. centrally controlled economies versus free market economies) should pay particular attention to these 13 RC practices in order to gain an advantage over local firms.

Public clients in Beijing adopted the following RC practices to a significantly lower extent compared to Hong Kong clients – strengthening their financial capacity (a-6); acquiring knowledge of project processes (a-8); committing to other parties on a long-term basis (a-9); and adopting a positive attitude toward continuous improvement (a-16). The results echoed Sachs et al.'s (2007) finding that some local governments in mainland China lack the relevant experience and knowledge in construction, or focus too much on short-term objectives. Public organizations are

usually restrained by an inertia that may stem from beliefs such as “that is not our responsibility”, “there is no need to change current practices that are already good enough (or even better than others)”, or a “not invented here” syndrome (Palaneeswaran and Kumaraswamy, 2000). This inertia is more evident in Beijing than in Hong Kong, as the long-standing bureaucratic culture in mainland China has often been criticized for its lack of openness and flexibility (Piotrowski et al., 2009). In addition, unlike local governments in mainland China which suffer from a lack of funds, the Hong Kong government has adequate financial reserves and enjoys a budget surplus (Chan et al., 2009a).

Table 3 shows that compared to Hong Kong, contractors in Beijing had significantly fewer opportunities to provide specific inputs on construction methods and materials before they were formally appointed (b-13). This may be due to the Hong Kong government’s more positive attitude toward promoting integration in the construction industry by encouraging contractors to give their feedback before they are formally appointed.

Contracting parties in public construction projects in Beijing have lower levels of long-term commitment to other parties (a-9, b-9 & c-9) than those in Hong Kong. The

Beijing government has been investing heavily in infrastructure development and thus the market for public construction projects in Beijing is huge (BMBS, 2011). This market situation of high construction demand causes private firms in Beijing to disregard the need to have any long-term commitments with other parties.

Compared to those in Hong Kong, contractors and consultants in Beijing are less familiar with each other (bc-1) and less likely to share information (bc-6). As Beijing's construction market is six times larger than Hong Kong's in terms of gross value of construction work (BMBS, 2011; CSD, 2011), it is therefore less likely for contractors and consultants in Beijing to have prior relationships. This lack of familiarity between contractors and consultants in Beijing may cause them to adopt a more adversarial stance with each other than those in Hong Kong, which could lead to lower enthusiasm to share project information.

Table 3 shows that "Clarity of division of responsibilities among contracting parties" (abc-1) was rated significantly higher in Hong Kong than in Beijing. As public construction projects in Hong Kong adopt standard conditions of contract, the division of responsibilities is clearer than in Beijing, where in-house or bespoke contracts are preferred (Lu, 2005).

"Level of reciprocation/face-saving gestures between the client and contractor" (abc-8), "Collective/combined responsibility by a pre-selected group comprising one person from each major party" (abc-4) and "Effectiveness of team-building events used in the project" (abc-13) were rated significantly higher in Beijing than in Hong Kong. This may be attributed to the "guanxi" that exists in Chinese culture. Private participants in Beijing have to spend much more time and effort to cultivate *guanxi* with public clients than those in Hong Kong (Sachs et al., 2007). There are hence many entertainment activities that need to be carried out in order to cultivate and maintain good relationships with public clients in Beijing. In Hong Kong, this is not so pronounced because the government departments are inherited from the British, and these have well-defined responsibilities and codes of conduct. They are usually not allowed to participate in team-building events with private firms and cannot receive nor reciprocate favors.

Result 3: RC Practices Affecting Project Outcomes

The third objective of this study is to identify RC practices that lead to better project performance. Tables 4 and 5 list the RC practices in Beijing and Hong Kong,

respectively, that are significantly correlated with performance metrics (Y1 to Y4) in an ascending order based on mean ratings. The mean ratings measure the extent to which the RC practices were adopted. Significant negative correlations with Y1 and Y2 and significant positive correlations with Y3 and Y4 suggest that when the RC practice is adopted to a larger extent, the project performance is also significantly better. Overall, 32 and 56 out of a total of 88 practices are significantly correlated with performance outcomes of public construction projects in Beijing and Hong Kong, respectively. The result indicates that RC principles have greater impact on the outcomes of public construction projects in Hong Kong than in Beijing.

<Insert Tables 4 and 5 here.>

Key RC practices are defined in this study as those significantly correlated with project performance but not adopted to a significant extent. As shown in Tables 4 and 5, there were eight and 11 of these key RC practices in Beijing and Hong Kong, respectively. These RC practices are further depicted in Figure 1. The discussions in the following sub-sections focus on these key RC practices.

<Insert Figure 1 here.>

RC practices affecting project performance significantly are depicted in Figures 2 and 3 for Beijing and Hong Kong, respectively. It is suggested that contracting parties adopt these RC practices to a greater extent in future projects so as to achieve better project performance. In terms of generalizing the findings to the broader global community, Figure 2 is important for firms when investing in a centrally controlled economy like China, while Figure 3 is useful for adoption in a free market economy.

<Insert Figures 2 and 3 here.>

Cost Performance (Y1)

Table 4 shows that the cost performance of public construction projects in Beijing is significantly correlated with five RC practices. On the other hand, there are 16 RC practices that are significantly correlated with the cost performance of public construction projects in Hong Kong (see Table 5). Among them, clients' attitude toward continuous improvement (a-16) and consultants' top management support for RC practices (c-15) are significantly correlated with cost performance in both Beijing and Hong Kong. The findings agree with Black et al. (2000) that a positive attitude

toward, and support for, RC practices, especially from senior management, is important.

Among the five RC practices in Beijing that are significantly correlated with cost performance, only one – client's knowledge level of project processes (a-8) – was not adopted to a significant extent and hence needs to be highlighted. Clients' lack of knowledge of project processes could lead to an inadequate brief and feasibility study or an inaccurate pre-tender estimate, which may eventually result in cost overrun (Ling and Leong, 2002). It is therefore recommended that public sector organizations capture the knowledge and information on project processes, products, and technology after a project is completed so that better project outcomes can be attained in future projects (Love et al., 2010). For the "one-off" type of client who develops only one project in a long while, it may not be worthwhile to acquire in-depth construction knowledge. In this instance, choosing a reputable and knowledgeable consultant is suggested.

Four RC practices in Hong Kong, i.e. "Clearly defined equitable risk-sharing arrangement among contracting parties" (abc-6), "Ongoing social relationships between clients and contractors" (ab-7), "Ongoing social relationships between

clients and consultants" (ac-7), and "Consultants' previous experience in relational contracting approaches" (c-10), were not adopted to a significant extent yet had significant correlation with cost performance. This indicates that the RC practices need more attention.

The respondents in Hong Kong regarded the practice "Clearly defined equitable risk-sharing arrangement among contracting parties" (abc-6) as a key RC practice affecting cost and time performance, and this supports the view of Rahman and Kumaraswamy (2002). Yet, this practice was not adopted to a significant extent because the public sector's standard conditions of contract drafted by public bodies may be biased toward the public client.

Table 5 shows "Ongoing social relationships (e.g. "guanxi" and social ties outside of the project)" between clients and contractors/consultants (ab-7 and ac-7) are key RC practices because they were significantly correlated with cost performance, but not adopted to a significant extent. These mutual ongoing social relationships outside of the project between clients and other contracting parties do not commonly exist in public construction projects in Hong Kong. One explanation could be that the procurement procedures in public construction projects in Hong Kong are subject to

strict regulations, and competitive bidding is almost always required (Rahman and Kumaraswamy, 2004b). However, this study found that closer ongoing social relationships among contracting parties are significantly correlated with cost (Y1) and time performance (Y2), and client satisfaction (Y4). This could be attributed to the trust and friendship that are present in ongoing relationships, causing contracting parties to be more willing to compromise should problems arise and thus achieve better outcomes (Castro et al., 2009). The implication is that past and current relationships may be taken into account in the selection of contractors and consultants.

Table 5 shows that consultants' previous experience in RC approaches (c-10) is significantly correlated with cost performance (Y1) and client satisfaction (Y4), but not adopted to a significant extent in Hong Kong. As explained in the introduction, it is still not known if public sector projects can enjoy the full benefits of RC. It is understandable that consultants lack experience in RC approaches.

Time Performance (Y2)

Significant negative correlation was observed between schedule overrun of public

construction projects in Beijing and eight RC practices (see Table 4), while 14 RC practices are significantly and negatively correlated with time performance in Hong Kong (see Table 5). There is no common practice in the two lists. In Beijing, contractors were involved in five out of eight RC practices, while in Hong Kong, 13 out of 14 practices relate to clients.

Table 4 shows that the eight RC practices that significantly affect time performance are all significantly adopted in past public construction projects in Beijing. This may be attributed to the Chinese government's strong emphasis on the timely completion of public projects (Liu et al., 2010). It could also be observed in Table 3 that time overrun in Beijing's public construction projects was not significant (t=1.904, p=0.062), which is consistent with the findings here.

Among the 14 RC practices that are significantly correlated with time performance in Hong Kong, five practices were not adopted to a significant extent in past projects. These are: "Clearly defined equitable risk-sharing arrangement among contracting parties" (abc-6), "Effectiveness of team-building events used in the project" (abc-13), "Ongoing social relationships between clients and contractors" (ab-7), "Client has organizational culture that fits relational contracting practices" (a-5), and "Previous

experience in RC approaches" (a-10). Practices abc-6 and ab-7 had significant correlation with both time performance (Y2) and cost performance (Y1) and have been discussed in the previous section.

"Effectiveness of team-building events used in the project" (abc-13) was not significantly observed in past public construction projects in Hong Kong. However, as shown in Table 5, significant correlations were found with time performance (Y2) and client satisfaction (Y4). In Hong Kong, officials in public departments that are modeled after the British system are not allowed to participate in team-building events at an inter-personal level. Therefore, contracting parties would rely more on contractual arrangements to guard against trouble, and this rigidity may increase the time needed to execute a project and lead to delays. As team building in the early phases of a project was found to influence participants' behavior and increase project knowledge (Kadefors, 2004), making more effort in team building is recommended (Diallo and Thuillier, 2005).

The results show that clients' "organizational culture fits RC practices" (a-5) and "previous experience in RC approaches" (a-10) were not adopted to a significant extent, yet had significant correlation with time performance (Y2). This agrees with

Chan and Kumaraswamy's (1997) finding that client-initiated variation is one of the principal and common causes of delays in Hong Kong, especially when introduced mid-stream. Clients' lack of an appropriate organizational culture that fits RC practices is the main reason for ineffective project partnering (Ng et al., 2002), and is more critical for public clients (Palaneeswaran and Kumaraswamy, 2000).

Quality Performance (Y3)

Quality performance of public construction projects in Beijing is significantly correlated with 13 RC practices. Five out of the 13 practices were not adopted to a significant extent in past public construction projects. On the other hand, 19 RC practices have significant correlation with quality performance in Hong Kong, and two of these were not adopted to a significant extent.

Contractors' top management support for RC practices (b-15) was significantly correlated with quality performance in both Beijing and Hong Kong. It is the senior management's responsibility to set policies, control resources and train staff. RC is therefore unlikely to succeed without the backing of top management (Akintoye and Main, 2007).

Five out of the 13 RC practices that are significantly correlated with quality performance in Beijing were not adopted to a significant extent. These include: clients' level of innovation/creativity (a-1) and investment in development of collaborative working skills (a-17), consultants' investment in development of collaborative working skills (c-17), contractors' level of innovation/creativity (b-1), and ongoing social relationships between contractors and consultants (bc-7).

As clients are responsible for the preparation of clear and unambiguous specifications (Jha and Iyer, 2006), they play an important role in helping the project to achieve the desired quality level and need to be competent in defining the level of expected quality. This may explain why clients' level of innovation/creativity (a-1) and investment in development of collaborative working skills (a-17) had significant correlation with quality performance. However, public clients in Beijing are usually infrequent clients or "one-off" clients (Ke et al., 2011), who are unable to be innovative and are not motivated to develop collaborative working skills because they do not have a demand for construction products on a regular basis.

Consultants' investment in the development of collaborative working skills (c-17) was

not significantly adopted in Beijing, yet had significant impact on quality performance. Zhao et al. (2011) also found that modern project management tools and techniques have not been extensively adopted by consultants in China's construction industry. Under such an environment, it is understandable that consultants do not invest much in the development of collaborative working skills in Beijing. As consultants are important links between clients and contractors, a higher level of collaborative working skills of consultants would increase the interaction among project participants, improve mutual understanding and information sharing, and thereafter boost quality performance (Jha and Iyer, 2006).

Contractors' level of innovation/creativity (b-1) showed a significant correlation with quality performance, perhaps due to its impact on the contractors' operations and output (Yasamis et al., 2002). Consistent with the low contribution rate of science and technology to China's construction industry (Lu et al., 2008), contractors in Beijing may be unwilling to invest in innovation because of the uncertain outcome.

Ongoing social relationships between contractors and consultants (bc-7) engender good communication, thereby facilitating proper monitoring and timely feedback, which enhance project quality. Ongoing social relationships also enable instances of

poor workmanship or improper usage of resources to be reported promptly, and this aids in achieving the desired quality level (Jha and Iyer, 2006).

In Hong Kong, consultants' readiness to compromise on unclear issues (c-11) and the level of reciprocation/face-saving gestures between clients and consultants (ac-8) are key RC practices that are significantly correlated with quality performance (Y3) and client satisfaction (Y4). Currently the Hong Kong government uses a two-envelope system (i.e. technical aspects of the proposal in one envelope and consulting fees in the other) for consultant selection (Baark and Wai, 2000). It is therefore difficult for the client to make a reciprocation /face-saving gesture and directly employ a consultant. Meanwhile, the readiness to compromise on unclear issues is perceived to be an important factor in implementing RC principles (Rahman and Kumaraswamy, 2004a). This is more so for consultants, as they prepare specifications and drawings that are usually far from perfect, and so, compromises on unclear issues need to be made by consultants in order to improve quality performance.

Client Satisfaction (Y4)

Table 4 shows that client satisfaction is significantly correlated with 11 RC practices in Beijing. As shown in Table 5, 39 RC practices have significant correlation with client satisfaction in Hong Kong. The large difference between the numbers of correlated practices in these two cities may to some extent reflect the greater emphasis and expectation of collaborative behaviors in Hong Kong. Six RC practices were common to both Beijing and Hong Kong. These include three individual features and practices adopted by contractors, and three mutual practices among contracting parties. The former are: “Level of innovation/creativity” (b-1), “Knowledge level of project processes” (b-8), and “Long-term commitment level” (b-9). The latter are: “Sharing of project information between contractor and consultant” (bc-6), “Ongoing social relationships between clients and consultants” (ac-7), and “Level of inter-personal relations/cultural harmony between clients and contractors” (ab-5).

In Beijing, three out of the six RC practices affecting client satisfaction (b-1, bc-6, ac-7) were not adopted to a significant extent. b-1 has been discussed in the previous section.

The sharing of project information between contractors and consultants (bc-6) would enable contractors to better understand the design and consultants to promptly

identify potential conflicts, leading to higher client satisfaction. However, each party in mainland China tends to treat information as confidential rather than something to be shared. This is to prevent its own interests from being compromised as there is conflict of interests among the participants, especially between contractors and consultants (Tai et al., 2009).

The reason why “Ongoing social relationship between clients and consultants” (ac-7) was not significantly adopted in Beijing may be attributed to the current procurement system, which was discussed above. It is worth noting that there is a significant negative correlation between Beijing’s client satisfaction and the ongoing relationships between clients and consultants, which is a direct contrast to Hong Kong. Zuo and Ma (2007) found that one of the major issues in China’s consultancy industry is that the responsibilities of consultants are usually not clearly defined. Due to the ongoing social relationships between clients and consultants, they may have signed a loose contract where the responsibilities of consultants are not clearly spelt out. Clients could thereafter be less satisfied.

Table 5 shows that eight RC practices that significantly affect client satisfaction were not significantly adopted in Hong Kong. They comprise two individual features and

practices of consultants, four mutual practices, and two joint practices. The two individual features and practices of consultants are: “Previous experience in RC approaches” (c-10) and “Readiness to compromise on unclear issues” (c-11). The four mutual practices are: “Ongoing social relationships” among contracting parties (ab-7, ac-7 & bc-7) and “Level of reciprocation/face-saving gestures between clients and consultants” (ac-8). The two joint practices are: “Collective/combined responsibility by a pre-selected group comprising one person from each major party” (abc-4) and “Effectiveness of team-building events used in the project” (abc-13). Among them, practices c-10, c-11, ab-7, ac-7, ac-8, and abc-13 have significant correlation with other performance indexes, which has been discussed above.

Ongoing social relationships among contracting parties (ab-7, ac-7 & bc-7) were found to be significantly correlated with client satisfaction in Hong Kong. This is consistent with Castro et al.’s (2009) finding that construction companies form coalitions principally on the basis of past or current relationships.

“Collective/combined responsibility by a pre-selected group comprising one person from each major party” (abc-4) is currently not a common behavior in Hong Kong. An independent facilitator is sometimes appointed to chair a few workshops and assist

in fostering confidence among the contracting parties (Chan et al., 2009b). However, the facilitator would not be involved throughout the whole life of the project. Therefore, a joint group comprising at least one person from each party is not commonly available.

Conclusions

This study investigated RC practices that are adopted in public construction projects in China. Using a structured questionnaire, data were collected from experienced contracting parties who had been personally involved in public construction projects in Beijing and Hong Kong. The statistical analysis revealed that public construction projects in both cities had achieved significantly good quality performance and client satisfaction but not in budget and schedule performance. However, public construction projects in Hong Kong achieved significantly better performance in owner satisfaction and quality than those in Beijing.

The main findings (see Tables 4 and 5) are: 32 and 56 RC practices are significantly correlated with the performance outcomes of public construction projects in Beijing and Hong Kong, respectively; and eight and 11 of these RC practices in Beijing and

Hong Kong, respectively, are key practices as they are not adopted to a significant extent but are significantly correlated with performance outcomes. The unique value of the findings to the construction engineering and management community is the identification of a list of key RC practices which could be adopted as they lead to better project outcomes. Some of these key RC practices are: having collective responsibility comprising one person from each major contracting party; sharing risks equitably among contracting parties; organizing effective team-building events; sharing project information among contracting parties; developing collaborative working skills; and compromising on unclear issues.

Another main finding is that 13 practices were adopted to significantly different extents in Hong Kong and Beijing. To generalize the findings to the broader global community, to a limited extent, the findings from Hong Kong may be applicable to countries that adopt the open market economy, while those from Beijing may be implemented by countries that adopt a planned economy. Hong Kong's open market is indicated by its global competitiveness rank of 11 out of 142 countries, which is comparable to the US and UK's rankings of 5th and 10th respectively, and ahead of Australia's 20th placing (World Economic Forum, 2011). As for Beijing, its planned economy is also known as authoritarian capitalism (McGregor, 2012) where the state

directs and controls a large share of the country's economic output. The central planning extends to allocation of workload through administrative orders (Zhang, 2003). The implications of the findings for the global communities that adopt project management style along PMI's (2008) framework are: they should have better division of responsibilities among contracting parties; share more project information; and have long-term commitment to the project. On the other hand, in planned economies, RC practices that are adopted to a significantly larger extent are having combined responsibility comprising one person from each major contracting party, and organizing effective team-building events.

The results show that public projects in China had adopted many RC practices among contracting parties to a significant extent, such as alignment of objectives, joint coordination and monitoring of plans, and joint problem solving. The findings contribute to the body of knowledge by showing that the Relational Contract Theory is valid for public projects even though they are procured through open bidding, and hence do not lend themselves to future relationships. The implication is that A/E/C firms should approach public projects with a relational mindset and not view them as discrete transactions just because the public sector uses open bidding. Another contribution to knowledge is that the relational approach is shown to be important as

it leads to better project outcomes.

One limitation faced in this study is that correlation does not mean causation. Therefore the results should be interpreted carefully. Correlation statistics should not be taken as conclusive evidence that those RC practices are definitely the most appropriate ones to be adopted. Secondly, the findings are not easily generalized to different regions in China, as the public projects that were used to inform this research were from Beijing and Hong Kong only. Finally, the population size could not be estimated, and hence the significance of the sample could not be determined mathematically. In future studies, data from other regions in China could be collected, with the population defined more clearly.

Acknowledgements

The research is made possible by Singapore Ministry of Education's Academic Research Fund Tier 2 funding support (Grant number: MOE2009-T2-2-067) for the project entitled 'Boosting public construction project outcomes through relational transactions'. Prof Patrick Zou and Ning Yan's contribution to the questionnaire design is acknowledged with grateful thanks. Special gratitude is extended to those

industry practitioners who have kindly participated in the surveys reported in this paper

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Table 1: Features and Practices Identified

RC Practices		Code	Authors who investigated
Individual features & practices	Level of innovation/creativity	a-1, b-1, c-1	Chan et al., 2004; Cheng et al., 2000
	Commitment of resources to the project	a-2, b-2, c-2	Cheng et al., 2000; Chen and Chen, 2007
	Effort in implementing relational contracting practices	a-3, b-3, c-3	Black et al., 2000; Chen and Chen, 2007
	Acceptance of relational contracting practices	a-4, b-4, c-4	Black et al., 2000; Kumaraswamy et al., 2005b
	Organizational culture fit to relational contracting practices	a-5, b-5, c-5	Rahman and Kumaraswamy, 2004a, 2004b
	Financial capacity	a-6, b-6, c-6	Black et al., 2000; Chen and Chen, 2007
	Flexibility when situations change	a-7, b-7, c-7	Chen and Chen, 2007; Ling et al., 2006b
	Knowledge level of project processes	a-8, b-8, c-8	Cheng et al., 2000; Love et al., 2010
	Long-term commitment level	a-9, b-9, c-9	Cheng et al., 2000
	Previous experience in relational contracting approaches	a-10, b-10, c-10	Kumaraswamy et al., 2005a, b;
	Readiness to compromise on unclear issues	a-11, b-11, c-11	Rahman and Kumaraswamy, 2004a, b
	Reputation in the industry	a-12, b-12, c-12	Powell, 1990; Gulati and Gargiulo, 1999
	Specific inputs on construction methods, materials, etc, before they were formally appointed	a-13, b-13, c-13	Bayliss et al., 2004; Rahman and Kumaraswamy, 2004b
	Team working attitude	a-14, b-14, c-14	Black et al., 2000; Chen and Chen, 2007
	Top management support for relational contracting practices	a-15, b-15, c-15	Black et al., 2000, Akintoye and Main, 2007

	Attitude toward continuous improvement	a-16, b-16, c-16	Black et al., 2000; Chen and Chen, 2007
	Investment in development of collaborative working skills	a-17, b-17, c-17	Hastings, 1995; Dyer, 1996
Mutual practices between two members	Familiarity/previous relationships	ab-1, ac-1, bc-1	Gulati, 1999; Zaheer and Soda, 2009
	Mutual trust	ab-2, ac-2, bc-2	Xu et al., 2005; Kumaraswamy, et al., 2005b
	Mutual understanding	ab-3, ac-3, bc-3	Black, 2000; Love et al., 2010
	Open and effective communication	ab-4, ac-4, bc-4	Chen and Chen, 2007; Doloi, 2009
	Level of inter-personal relations/cultural harmony (individual level)	ab-5, ac-5, bc-5	Kumaraswamy et al., 2005a; Rahman and Kumaraswamy, 2008
	Sharing of project information	ab-6, ac-6, bc-6	Uzzi and Lancaster, 2003; Maurer and Ebers 2006
	Ongoing social relationships (e.g. “guanxi”, social ties, and kinship outside of this project)	ab-7, ac-7, bc-7	Gulati and Gargiulo, 1999; Castro et al., 2009
	Level of reciprocation/face-saving gestures	ab-8, ac-8, bc-8	Oliver, 1990; Pervan et al., 2011
Joint practices among all members	Clarity of division of responsibilities among contracting parties	abc-1	Anvuur and Kumaraswamy, 2007; Halman and Braks, 1999
	Acceptance of performance appraisal mechanism for the project	abc-2	Rahman and Kumaraswamy, 2004a, b
	Alignment of objectives of different contracting parties	abc-3	Cheng et al. 2000; Rahman and Kumaraswamy, 2008
	Collective/combined responsibility by a pre-selected group comprising one person from each major party	abc-4	Chan et al., 2004; Halman and Braks, 1999
	Joint coordination and monitoring plans among contracting parties	abc-5	Chan et al., 2004; Yeung et al., 2007
	Clearly defined equitable risk-sharing arrangement among contracting parties	abc-6	Rahman and Kumaraswamy, 2002; Ling et al., 2006b
	Flexible/adjustable contracts to address uncertainties	abc-7	Rahman and Kumaraswamy, 2005
	Commitment level of contracting parties to joint problem solving	abc-8	Chan et al., 2004; Chen and Chen, 2007

	Presence of conducive learning climate/environment	abc-9	Chan et al., 2004; Chan et al., 2006
	Acceptance of dispute resolution mechanism for the project	abc-10	Rahman and Kumaraswamy, 2004a, 2004b
	Clarity of contract conditions (e.g. scope of contract, duties & responsibilities)	abc-11	Wong and Cheung, 2005
	Real gain-share/pain-share among contracting parties	abc-12	Black et al., 2000; Ling et al., 2006b
	Effectiveness of team-building events used in the project	abc-13	Cheng and Li, 2001, 2002

Note: a, b, and c in code column refer to client, contractor, and consultant, respectively.

Table 2: Characteristics of Respondents

Characteristic		Beijing		Hong Kong	
		No.	%	No.	%
Experience in construction industry	< 5 years	8	14	3	6
	5-9 years	14	24	4	8
	10-14 years	22	38	6	12
	≥ 15 years	14	24	37	74
	Average	11		22	
	Min	2		3	
	Max	30		56	
Organization type	Government	10	18	15	29
	Engineering firm	1	2	3	6
	Architectural firm	10	18	0	0
	Quantity surveying firm	5	9	3	6
	Contractor	32	57	27	53
	Others	4	7	3	6
Ownership of organization	Public	30	52	23	45
	Private	13	22	27	53
	Joint Venture	15	26	1	2
	Average of public percentage	45		50	
Size of total workforce	< 100	12	21	2	4
	100-999	23	40	17	35
	≥ 1000	22	39	30	61
	Average	19934		3097	
	Min	25		10	
	Max	160000		50000	

Table 3: Extent of Differences between Beijing and Hong Kong

Code	Beijing			Hong Kong			ANOVA	
	Mean	T	Sig.	Mean	T	Sig.	F	Sig.
Cost (Y1)	10.42%	2.866	0.006	12.50%	4.535	0.000	0.198	0.657
Time (Y2)	8.41%	1.904	0.062	17.78%	5.213	0.000	2.721	0.102
Quality (Y3)	3.19	3.296	0.002	3.98	11.364	0.000	62.222	0.000
Client Satisfaction (Y4)	3.32	3.777	0.000	3.88	9.656	0.000	20.087	0.000
a-6	3.56	3.795	0.000	4.28	9.456	0.000	12.839	0.001
a-8	3.16	1.219	0.228	3.87	7.258	0.000	15.415	0.000
a-9	3.07	0.482	0.632	3.77	5.468	0.000	11.303	0.001
a-16	3.32	2.746	0.008	3.87	6.317	0.000	9.387	0.003
b-9	3.45	4.259	0.000	3.90	7.019	0.000	7.587	0.007
b-13	3.44	3.605	0.001	3.88	5.831	0.000	5.315	0.023
c-9	3.26	2.668	0.010	3.63	4.555	0.000	4.838	0.030
ab-8	3.69	5.680	0.000	3.24	1.900	0.063	6.232	0.014
bc-1	3.04	0.256	0.799	3.56	4.288	0.000	7.113	0.009
bc-6	3.13	1.044	0.301	3.53	3.400	0.001	4.334	0.040
abc-1	3.29	2.664	0.010	3.92	8.267	0.000	15.995	0.000
abc-4	3.66	7.519	0.000	3.14	1.188	0.241	12.777	0.001
abc-13	3.43	4.236	0.000	3.06	0.375	0.709	4.145	0.044

Table 4: Correlation of RC Practices to Project Performance in Beijing

RC Practices	Mean	Cost (Y1)		Time (Y2)		Quality (Y3)		Satisfaction (Y4)	
		Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
bc-7	2.93					0.316	0.019		
a-1	2.96					0.267	0.047		
a-17	3.05					0.299	0.026		
bc-6	3.13							0.295	0.029
c-17	3.16					0.275	0.041		
a-8	3.16	-0.290	0.035						
b-1	3.18					0.386	0.003	0.358	0.007
ac-7	3.25							-0.271	0.043
abc-10	3.27*			-0.280	0.040				
abc-1	3.29*							0.358	0.006
a-16	3.32*	-0.273	0.048						
bc-5	3.33*			0.371	0.007			0.299	0.026
c-2	3.33*			-0.290	0.037				
bc-3	3.36*							0.305	0.022
a-5	3.36*					0.290	0.030		
bc-8	3.41*							0.310	0.023
a-14	3.43*			-0.382	0.005				
b-13	3.44*					0.267	0.048		
b-9	3.45*					0.325	0.015	0.280	0.037
abc-11	3.47*	-0.309	0.022						
ab-5	3.48*							0.348	0.009
ac-5	3.50*					0.306	0.022		
b-5	3.61*			-0.287	0.039				
c-15	3.63*	-0.277	0.045						
a-12	3.68*	-0.341	0.015						
b-6	3.72*					0.274	0.045		
b-4	3.73*							0.294	0.028
b-8	3.75*							0.270	0.044
b-2	3.77*					0.416	0.001		
b-15	3.82*			-0.422	0.002	0.331	0.013		
c-12	3.82*			-0.386	0.005	0.307	0.020		
b-12	3.98*			-0.308	0.026				
Total		5		8		13		11	

Note: * significant at p<0.050 based on *t* test of the mean results

Table 5: Correlation of RC Practices to Project Performance in Hong Kong

RC Practices	Mean	Cost (Y1)		Time (Y2)		Quality (Y3)		Satisfaction (Y4)	
		Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
abc-6	2.82	-0.300	0.038	-0.349	0.015				
ab-7	3.00	-0.398	0.006	-0.318	0.031			0.386	0.006
abc-13	3.06			-0.347	0.016			0.351	0.011
ac-7	3.12	-0.435	0.005					0.372	0.014
a-10	3.13			-0.374	0.012				
bc-7	3.14							0.316	0.039
abc-4	3.14							0.375	0.007
c-11	3.20					0.385	0.014	0.329	0.038
ac-8	3.20					0.332	0.028	0.323	0.032
a-5	3.21			-0.376	0.012				
c-10	3.25	-0.431	0.007					0.348	0.028
c-5	3.30*	-0.367	0.023	-0.415	0.010				
abc-10	3.31*	-0.312	0.031						
a-4	3.32*							0.295	0.044
bc-2	3.37*							0.305	0.047
a-17	3.40*							0.311	0.033
ab-2	3.43*							0.305	0.033
ab-6	3.43*							0.295	0.039
abc-2	3.44*					0.317	0.025		
b-11	3.45*					0.359	0.011	0.324	0.023
ab-3	3.45*							0.342	0.016
ab-5	3.47*			-0.317	0.032			0.352	0.013
c-4	3.50*	-0.323	0.048			0.331	0.037	0.349	0.027
abc-3	3.50*	-0.421	0.003	-0.409	0.004			0.311	0.028
b-1	3.51*							0.417	0.003
c-1	3.51*					0.345	0.027		
a-14	3.52*					0.367	0.012		
b-17	3.53*					0.300	0.036	0.292	0.042
c-2	3.53*							0.325	0.040
c-16	3.53*	-0.443	0.005			0.456	0.003	0.507	0.001
ab-1	3.53*			-0.328	0.026				
bc-6	3.53*					0.355	0.019	0.437	0.003
b-10	3.55*							0.309	0.031
c-13	3.60*							0.326	0.040
ab-4	3.61*					0.291	0.042		
c-9	3.63*	-0.322	0.048			0.315	0.048	0.392	0.012
c-14	3.65*	-0.499	0.001			0.418	0.007	0.403	0.010
bc-4	3.65*							0.358	0.018
b-5	3.67*							0.318	0.026

RC Practices	Mean	Cost (Y1)		Time (Y2)		Quality (Y3)		Satisfaction (Y4)	
		Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
a-15	3.68*							0.347	0.017
c-15	3.70*	-0.354	0.029			0.333	0.036	0.371	0.018
ac-1	3.73*			-0.387	0.012				
abc-11	3.76*			-0.320	0.027				
a-9	3.77*	-0.339	0.025						
b-16	3.80*							0.412	0.003
a-8	3.87*			-0.320	0.034				
a-16	3.87*	-0.362	0.016	-0.343	0.023	0.383	0.008	0.383	0.008
b-9	3.90*							0.316	0.027
abc-1	3.92*					0.332	0.017		
b-12	3.96*					0.360	0.011	0.406	0.004
c-12	3.97*	-0.414	0.010						
a-12	4.02*			-0.382	0.010				
b-8	4.02*							0.444	0.001
b-14	4.02*	-0.310	0.036			0.490	0.000	0.452	0.001
b-15	4.02*					0.333	0.019	0.377	0.008
b-2	4.06*							0.294	0.041
Total		16		14		19		39	

Note: * significant at p<0.050 based on *t* test of the mean results