Investigating the Relationship between the Causes of Corruption and Corruption Risks in the Public Construction Sector of China

Yun Le[1], Ming Shan[2], Albert P.C. Chan[3], and Yi Hu[4]

Abstract

Understanding the causes of corruption is one of the key topics in the research of corruption in construction because it addresses the fundamental issues of the widespread corruption risks in the public construction sector. Through an empirical survey, this study finds a positively correlated relationship between the causes of corruption and corruption risks in the public construction sector of China. The data were collected from industrial practitioners and academics that had public construction project experiences in China, and thereafter analyzed by factor analysis and partial least squares structural equation modeling. The results show that the causes of corruption could be categorized into two constructs, namely, the flawed regulation systems, and the lack of a positive industrial climate. The results also indicate that the most influential item on the construct of the flawed regulation systems is negative role models of leadership, followed by inadequate sanctions, the lack of rigorous supervision, and multifarious authorizations. The most influential

[1] Professor and Head of Department of Construction Management and Real Estate, Associate Director of Research Institute of Complex Engineering & Management, School of Economics and Management, Tongji University, Shanghai, China.
[2] Ph.D. Candidate (Joint Program), Research Institute of Complex Engineering & Management, School of Economics and Management, Tongji University, Shanghai (200092), and Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China. (Corresponding author) Email: ming.shan@connect.polyu.hk
[3] Professor and Interim Dean of Faculty of Construction and Environment, Professor of Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China.
[4] Ph.D. Candidate, Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China.

item on the construct of the lack of a positive industrial climate is interpersonal connections, followed by close relationships among contract parties, complexity of public construction projects, and poor standards of professional ethics. This study contributes to knowledge by examining the relationship between the causes of corruption and corruption risk using a quantitative method. Recommendations on the prevention of corruption are also suggested based on results obtained in this study.

Keywords

Corruption Risk; Cause; Public Construction Sector; China

Introduction

Public construction sector is vulnerable to corruption risks, and is thus considered as the most corrupt business sector (Harboon and Heinrich 2011). In this sector, construction projects are unique and complex, it is difficult to benchmark project performance against selected indicators (e.g. cost and time), and to make access to the hidden and inflated additional expenditure. The construction sector is also fragmented as a result of involving clients, designers, contractors, consultants, and suppliers, which imposes difficulties in the tracing of payments and the diffusion of standards of practice (Ahmad et al. 1995). In addition, public construction is a sector highly affected and regulated by the government (Chan et al. 1999). These factors have provided numerous opportunities and motives for the occurrence of corruption.

As a large developing country having a population of more than 1.3 billion, China has experienced a process of rapid urbanization and made huge investments in the public construction sector over the past two decades. The expenditure on public infrastructure and construction projects in China jumped from CNY 2 trillion (USD 0.28 trillion) in 1995 to CNY 37.4 trillion in 2012 (USD 5.34 trillion) (National Bureau of Statistics of China 2012), which has increased nearly 19 times. However, these investments have caused a high risk in corruption. According to the National Bureau of Corruption Prevention of China, between 2009 and 2011, 15,010 cases of corruption were recorded in the public construction sector, more than 1167 public officials above county level were alleged of corruption, and the corresponding amount of corrupt money reached CNY 2,990 million (USD 490 million) (Xinhuanet 2011). This fact indicates the country is facing a great corruption risk in the public construction sector.

Understanding the causes of corruption in the public construction sector is essential in preventing corruption risks. Although a growing number of researchers attempted to conduct research on this topic (Tanzi 1998; Liu et al. 2004; Sohail and Cavill 2008; Bowen et al. 2012), limited empirical studies are available on this issue. Therefore, this paper focuses on the causes of corruption in the public construction sector of China, and aims to examine the relationship between the causes of corruption and corruption risks through an empirical survey.

Theoretical Framework

Causes of Corruption in Construction

Sustained efforts have been made to investigate causes of corruption in the construction sector. For instance, corruption is regarded as the result of an unethical decision (Zarkada-Fraser and Skitmore 2000; Liu et al. 2004; Moodley et al. 2008). A defective law system is also considered to provide opportunity for corruption in the construction sector (Bologna and Del Nord 2000; Sha 2004). Ling and Tran (2012) observed that an intimate relationship among contract parties could lead to corruption. Bowen et al. (2012) stated that the negative role models of public officials and absence of deterrents and sanctions are key causes of corruption in construction. Apart from the causes mentioned above, Sohail and Cavill (2008) and Tabish and Jha (2011) added that corruption often occurs in construction as a result of the deregulation in the public construction sector, the excess competition of the construction market, and inappropriate political interference in investment decision making. Tanzi (1998) further examined causes of corruption at multiple levels and aspects, such as regulations and authorizations, discretionary decisions, wage level of public servants, penalty systems, institutional controls, transparency, as well as role models of leadership. Based on the above reviews, causes of corruption could be grouped under two categories, namely, the flawed regulation system (FRS), and the lack of a positive industrial climate (LPIC).

The flawed regulation system (FRS) can be measured by multifarious authorizations (FRS1), deficiencies in rules and laws (FRS2), the lack of rigorous supervision (FRS3), inadequate sanctions (FRS4), as well as the negative role model of leadership (FRS5).

Multifarious authorizations (FRS1) are required for those organizations and professionals engaging in the construction sector. The establishment of these authorizations provides a monopoly power to the government and affiliated officials, and thus they can authorize or inspect the projects. In this case, some officials possibly make use of this authorization power to extract bribes from those who need the authorizations (Tanzi 1998; Rose-Ackerman 2008). Bologna and Del Nord (2000) and Sha (2004) pointed out that deficiencies in rules and laws (FRS2) become a hurdle to successful regulation on corrupt practices. Furthermore, these deficiencies may motivate corrupt conducts. Tanzi (1998) opined that corruption should be discouraged or discovered by honest and effective supervisors and auditors, and the lack of rigorous supervision (FRS3) can facilitate corruption. Bowen et al. (2012) conducted an online questionnaire survey in the construction sector of South Africa, which showed that inadequate sanctions (FRS4) and the negative role models of leadership (FRS5) are two main causes of corruption in the construction sector.

The lack of a positive industrial climate (LPIC) can be measured by five items: the low wage level (LPIC1), poor standards of professional ethics (LPIC2), excessive competition in the construction market (LPIC3), close relationships among contract parties (LPIC4), and complexity of public construction projects (LPIC5).

Haque and Sahay (1996) revealed a statistically significant correlation between the serious corruption situation and the low wage level (LPIC1). Numerous studies disclosed the role of the poor standards of professional ethics (LPIC2) as a root cause of corruption in the construction sector (Zarkada-Fraser 2000; Zarkada-Fraser and Skitmore 2000; Liu et al. 2004; Moodley et al. 2008; Bowen et al. 2012). Sohail and Cavill (2008) and Tabish and Jha (2011) stated that corruption may be caused by misconducts of contractors those try to secure contracts from clients in the excessively competitive market (LPIC3). Ning and Ling (2013) reported that although the close relationships among contract parties (LPIC4) is often regarded as a critical success factor of public construction projects, the relationships may also trigger corruption instead of partnership-based collaboration (Sohail and Cavill 2008; Ling and Tran 2012). Sohail and Cavill (2008) further stated that the negative impact of the complexity of public construction projects (LPIC5), for example, the information asymmetry, may lead to corruption.

Corruption Risks

Several studies have been conducted to identify corruption risks in the construction sector. Sohail and Cavill (2008) examined multiple examples of corruption vulnerabilities and related stakeholders in the construction project cycle and the infrastructure service delivery. De Jong et al. (2009) enumerated main forms of corruption in the engineering/construction industry, including kickbacks and bribery, front companies, bid rigging and collusion, fraud, and conflict of interest. Alutu (2007) and Alutu and Udhawuve (2009) listed and prioritized unethical conducts in the engineering/construction industry in Nigeria based on data gathered from two questionnaire surveys. Vee and Skitmore (2003) and Bowen et al. (2007a; 2007b) adopted the same questionnaire instrument to investigate unethical practices in the Australian and South African construction sectors, which reinforced the finding of de Jong et al. (2009) that main unethical practices in the two countries are collusion, bribery, negligence, fraud, dishonesty and unfair practices. Thereafter, Bowen et al. (2012) examined 42 corrupt acts in the South African construction industry and further categorized them into two groups, namely, appointment and tender irregularities, as well as contract administration and closeout irregularities. In addition, Tabish and Jha (2011) collected 61 irregularities to reveal corruption in the procurement of public construction projects in India, and grouped them under five categories, namely, transparency, professional standards, fairness, contract monitoring and regulation, and procedural accountability irregularities. The above reviews have revealed the increasing attention on corruption issues in construction around the world, particularly those from the developing countries, such as Nigeria, South Africa, and India.

The framework of corruption risks adopted in this study is developed according to Tabish and Jha (2011) because the irregularities summarized in their study good indicators to measure corruption risks. In addition, adopting the framework of Tabish and Jha (2011) has three advantages compared with developing a new framework. First, their framework identified 61 detailed irregularities in the public procurement of India, and such irregularities have already been recognized by the industry at large. Second, the published work of Tabish and Jha (2011) included findings derived from their framework, thereby proving the worthiness of such framework in academic study. Third, China and India are similar in terms of rapid urbanization and public construction projects. However, there are two issues in adopting the framework of Tabish and Jha (2011) directly to this study. First, Tabish and Jha (2011) mainly focuses on irregularities in the project procurement phase, whereas the scope of this study extends to the entire life circle of a project. Second, there is objective difference in construction practice between India and China due to the different societal and economic system. Therefore, a series of structured interviews were conducted afterwards to refine the irregularities of Tabish and Jha (2011) and to supplement measurement items beyond the project procurement phase. The measurement items of causes of corruption were also refined and supplemented in the interviews.

Hypothesis Development

Based on the theoretical framework indicated earlier, an initial conceptual model was hypothesized to examine the relationship between the causes of corruption and corruption risks as shown in Figure 1. In the proposed model, causes of corruption are considered to be a two dimensional and second-order construct comprising the flawed regulation systems and the lack of a positive industrial climate. Corruption risks are deemed as a five dimensional and second-order construct consisting of transparency, professional standards, fairness, contract monitoring and regulation, and procedural accountability irregularities. The second-order construct approach is recommended by Wetzels et al. (2009), as it maximizes the interpretability of both measurement and the hierarchical models. In the proposed model, the hypothesis that causes of corruption are positively correlated with corruption risks in public construction projects, is to be tested.

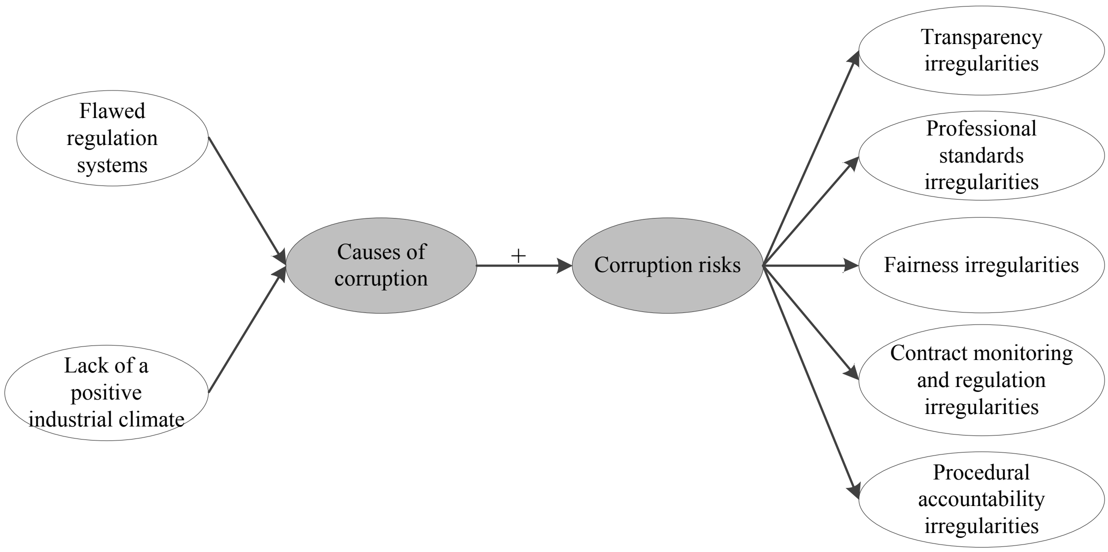

Figure 1 The initial conceptual model and research hypothesis

Research Methods

This study first established a conceptual model that defines the causes of corruption and corruption risks. Then structured interviews were used to refine the model to account for the specific conditions in China. Based on this model, a questionnaire survey was administered. On the basis of data collected from the questionnaire survey, factor analysis (FA) was conducted to validate the results from structured interviews. Partial least squares structural equation modeling (PLS-SEM) was used to test the conceptual model proposed in this study. Results obtained from the different methods can triangulate and complement each other, thus yielding stronger and more reliable findings (Hon et al. 2012).

To refine the proposed measurement items of causes of corruption and corruption risks in China, a series of structured face-to-face interviews were conducted between July and August 2013. Fourteen experienced industrial experts and academics were invited and participated in the interviews. Each interviewee was requested to provide his endorsement on the proposed measurement items, by using a five point rating system of “1-strongly disagree”, “2-disagree”, “3-neutral”, “4-agree”, and “5-strongly agree”. Interviewees were also encouraged to supplement the measurement items that were not recorded in the interviews. Only measurement items receiving the support of most interviewees were considered as key measurement items and added in the theoretical framework. As mentioned earlier, this additional procedure is necessary because the framework of Tabish and Jha (2011) mainly focuses on the measurement items in project procurement phase other than the entire life circle of a project. In addition, mean score of each measurement item was calculated and a threshold of 2.5 was established as a cut criterion as recommended by Hsueh et al. (2009). To ensure the reliability and quality of interviews, all the interviewees involved had at least ten years of experience in public construction projects in China and senior positions in their organizations. Additionally, the selection of 14 interviewees with various professional backgrounds and geographic locations increased the heterogeneity of the interviewees and thus improved the validity of interviews. Table 1 shows the backgrounds of interviewees.

(Please insert Table 1 here.)

A structured questionnaire was developed based on the measurement items consolidated in the structured interviews. The target population included industrial practitioners (e.g. clients, contractors, designers, and consultants), governmental officials, and academics involved in public construction projects in China. To maximize the number of potential survey respondents, a number of government agencies, research institutions, and companies within the construction industry were contacted. In the end, eight institutions accepted the invitations and agreed to facilitate the survey. They are all active players in the public sector in China. Each of them represents a huge number of governmental officials or industry professionals or researchers from a broad range of the entire sector. These institutions are:

1. Research Institute of Complex Engineering & Management, Tongji University;
2. Shanghai Construction Consultants Association;
3. Shanghai Xian Dai Architectural Design (Group) Co., Ltd.;
4. School of Civil Engineering and Transportation, South China University of Technology;
5. College of Civil Engineering, Shenzhen University;
6. Construction Commission of Zhengzhou Municipality;
7. Zhengzhou Metro Group Co., Ltd.;
8. China Construction Eighth Engineering Division.

The questionnaire was disseminated through three channels between September and October 2013. First, an online version of the questionnaire was developed and disseminated to professionals and academics within the above supporting institutions. Second, hard copies were also distributed in an industrial forum held in Shanghai. Selected qualified attendants of this meeting were invited to participate in this survey. Third, field surveys were conducted in three public construction projects in Shanghai, Jinan (the capital city of Shandong Province), and Zhengzhou (the capital city of Henan Province), respectively. The three survey approaches adopted in this study enhance the validity of the survey results. Lastly, one hundred and eighty eight valid replies were received. Among them, eighty seven replies were collected from the online survey, twenty replies were collected from the industrial forum, and eighty one replies were collected from the field surveys. Table 2 shows the backgrounds of respondents.

(Please insert Table 2 here.)

Tools for Data Analysis

Factor Analysis

Factor Analysis (FA) is a statistical technique widely adopted to identify a small number of individual factors that represent some sets of interrelated variables (Choi et al. 2011). FA using Statistical Package for the Social Sciences 17.0, was adopted to condense and summarize the measurement items proposed in this study. Principal Component Analysis was conducted to identify the underlying grouped factors for its simplicity and distinctive capacity of data-reduction (Chan et al. 2010). To obtain grouped factors for a clearer image, factor extraction with Promax Rotation and Kaiser Normalization was conducted as recommended by Conway and Huffcutt (2003). The appropriateness of using FA technique was evaluated by using Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity. According to Norusis (2008) and Choi et al. (2011), a KMO value should be higher than the threshold of 0.5. Bartlett's Test for Sphericity was also performed to present correlations among variables (Chan et al. 2010; Xu et al. 2010).

Partial Least Squares Structural Equation Modeling

PLS-SEM was adopted to test the conceptual model. PLS-SEM is a technique using a combination of principal components analysis, path analysis, and regression to simultaneously evaluate theory and data (Aibinu and Al-Lawati 2010). PLS-SEM estimates parameters for links between measurement items and their corresponding constructs and links among different constructs (Mohamed 2002). In addition, PLS-SEM has minimum demands for sample size, but it can handle nonnormal data sets (Reinartz et al. 2009; Ringle et al. 2012). Therefore, PLS-SEM was adopted in this study.

Results of PLS-SEM include a set of measurement models and a structural model. In this study, four indicators were examined to evaluate the measurement models, namely, (1) internal consistency reliability; (2) indicator reliability; (3) convergent validity; and (4) discriminating validity (Hair et al. 2011; Ning and Ling 2013; Zhao et al. 2013). Composite Reliability (CR) was used to assess the internal consistency reliability, which should be larger than 0.7 (Hair et al. 2011). Loadings of measurement items on the corresponding construct were adopted to assess the indicator reliability, which should be at least larger than 0.4 (Hair et al. 2011; Ning and Ling 2013). Average Variance Extracted (AVE) was used to evaluate the convergent validity, which should be larger than 0.5 (Hair et al. 2011). With regard to discriminating validity, the AVE value of each construct should be larger than the construct’s highest squared correlation with any other latent construct or, a measurement item’s loading should be larger than all of its cross loadings (Cenfetelli and Bassellier 2009; Hair et al. 2011; Ning 2013; Zhao et al. 2013). Regarding the evaluation of the structural model, the significance of path coefficients was adopted with the aid of Bootstrapping (Hair et al. 2011; Ning and Ling 2013; Zhao et al. 2013).

Results

Structured Interview

Table 3 shows interview results of measurement items of causes of corruption provided by the interviewees. The measurement item low wage level (LPIC1) was dropped from the measurement list with an evaluation score below 2.5. This result indicated that interviewees refused to consider low wage level (LPIC1) as a key cause of corruption in construction, which is also in line with the statistical bulletin that the average wage in the construction sector ranks sixth in the whole 19 sectors in China (National Bureau of Statistics of China 2012). An additional measurement item, interpersonal connections (LPIC6), was suggested by interviewees to measure the construct of the lack of a positive industrial climate (LPIC) (Table 5). Interviewees stated that interpersonal connections (LPIC6), such as relatives, friends, and colleagues may push officials who could have been incorrupt to perform corrupt practices.

Table 4 shows the irregularities of Tabish and Jha (2011) receiving assessment scores above 2.5 points. The 19 measurement items of corruption risks were confirmed by interviewees in the context of China. Interviewees stated that some proposed measurement items used in the interviews were irregularities that may not be resulted by corruption, which should not be considered as measurement items for corruption risks. Therefore, a trim from 61 irregularities to 19 measurement items of corruption risks was obtained in terms of interview feedback. In addition, five additional measurement items suggested by the interviewees were added in the framework. As shown in Table 4, the five items were affiliated with three constructs of professional standards, fairness, and transparency irregularities, respectively. Particularly, two of them (IMM5 and IMM6) refer to the measurement items of corruption risks in project construction phase. Thus the supplementation improves the completeness of proposed framework. Additionally, Interviewee I, Interviewee L, Interviewee M, and Interviewee N recommended to rename transparency, professional standards, fairness, contract monitoring and regulation, and procedural accountability irregularities as opacity, immorality, unfairness, contractual violation, and procedural violation, respectively in the design of questionnaire which can provide a better expression in the Chinese context. Thus, the initial proposed conceptual model was refined as shown in Figure 2.

(Please insert Table 3 here.)

(Please insert Table 4 here.)

(Please insert Table 5 here.)

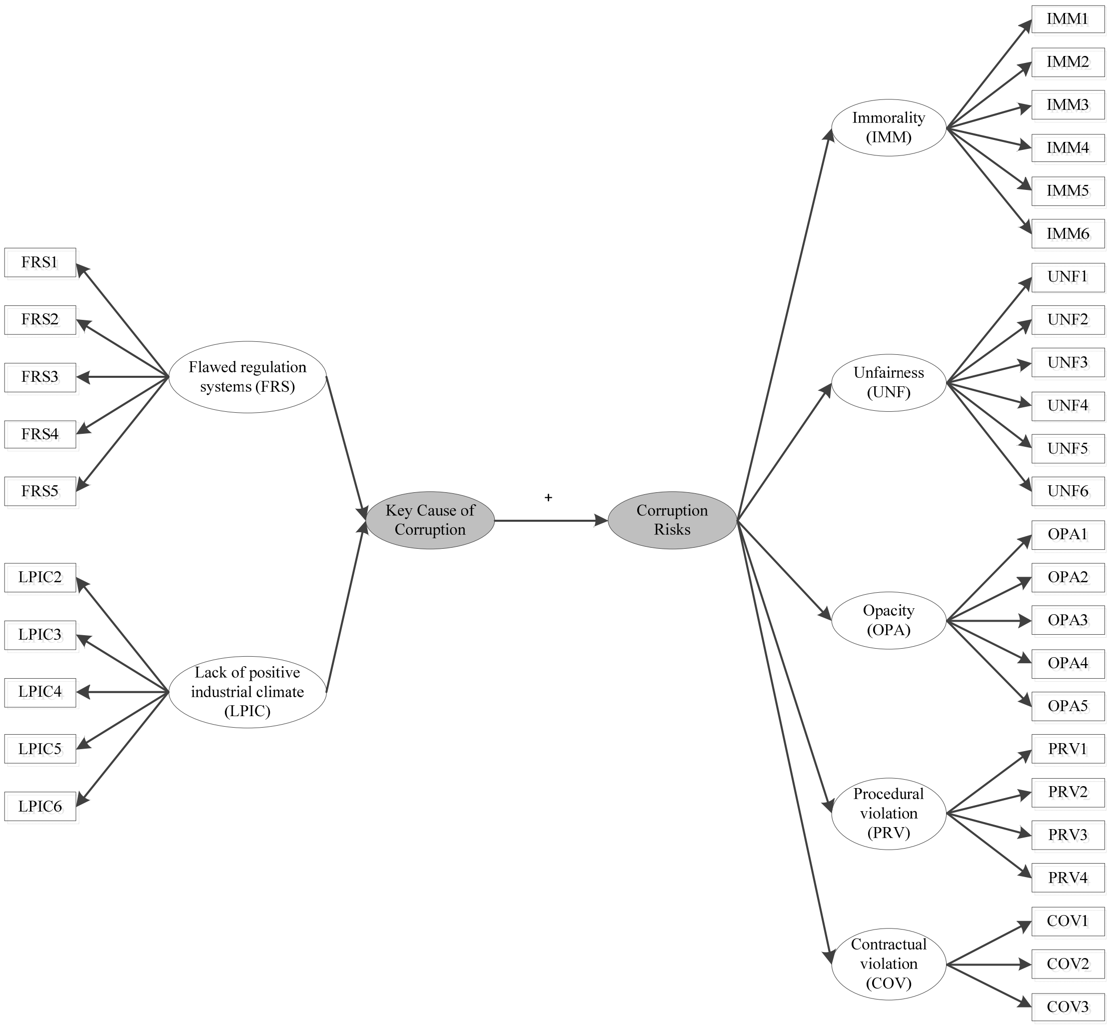

Figure 2 Refined proposed conceptual model

Factor Analysis

Table 3 shows FA results of measurement items of causes of corruption. Two constructs encapsulating eleven measurement items were generated. The KMO value is 0.789, which is considered to be acceptable to utilize FA (Norusis 2008). The total variance explained is 54.160%. The Bartlett's Test of Sphericity produced an approximate $\chi^2 = 486.044$ (d. f. = 55, p = 0.000), indicating the correlations among measurement items were high (Dziuban and Shirkey 1974). Hair et al. (2010) stated that the loading of each measurement item on its corresponding construct should not be lower than 0.5. Therefore, FRS2 and LPIC3 were dropped from the list of measurement items.

Table 4 shows FA results of measurement items of corruption risks. Five constructs encapsulating twenty-four measurement items were generated. The KMO value is 0.863, which is considered to be acceptable (Norusis 2008). The total variance explained is 61.623%. The Bartlett's Test of Sphericity produced an approximate $\chi^2 = 1308.051$ (d. f. = 276, p = 0.000), indicating that the correlations among measurement items were high (Dziuban and Shirkey 1974). The IMM2, UNF3, OPA2, PRV4, and COV3 were excluded from the list of measurement items because their factor loadings were lower than 0.5 (Hair et al. 2010).

Evaluation of Measurement Models

Tables 6, 7 and 8 show the evaluation results of measurement models. Table 6 shows that (1) all loadings are larger than 0.6 with t-values larger than 2.58, indicating the acceptable indicator reliability (Hair et al. 2011; Ling et al. 2013; Ning and Ling 2013); (2) the values of CR are over 0.7, suggesting a satisfactory level of reliability of internal indicators with each construct (Hair et al. 2011; Ning 2013); (3) the values of AVE are higher than 0.5, showing a satisfactory level of convergent validity of the constructs (Hair et al. 2011; Ning 2013). Table 7 shows that each construct's AVE is higher than its squared correlation with any other construct. Table 8 indicates that each measurement item has the highest loading on the corresponding construct. They indicate the high discriminate validity of the constructs (Hair et al. 2011; Ling et al. 2013; Ning 2013). The results of measurement model evaluation suggest that each construct has internal consistency reliability.

(Please insert Table 6 here.)

(Please insert Table 7 here.)

(Please insert Table 8 here.)

Evaluation of Hierarchical Models

Table 9 shows that all path coefficients for the hierarchical models are significant (t-value >2.56). Values of CR are also over 0.7, suggesting a satisfactory level of reliability of first-order constructs with the corresponding second-order construct (Bagozzi and Yi 1988; Ling et al. 2013).

(Please insert Table 9 here.)

Evaluation of Structural Model

The path coefficient between causes of corruption and corruption risks has a t-value higher than 2.58, indicating its statistical significance at the 0.01 level (Henseler et al. 2009). The hypothesis that causes of corruption are positively correlated with corruption risks is supported in the hypothesized sign. Figure 3 shows the testing results of the conceptual model.

(Please insert Figure 3 here.)

Discussion

According to the PLS-SEM results, all the statistical parameters were found to be acceptable, which validated the hypothesis developed in the study (Hair et al. 2011). The PLS-SEM results suggested that the causes of corruption have a positive correlation with corruption risks in public construction projects in China. The results also showed that flawed regulation systems (FRS) and the lack of a positive industrial climate (LPIC) had significant correlations with the second-order construct the causes of corruption. The flawed regulation systems (FRS) emerged as the most principal set of causes of corruption with a path coefficient of 0.605. The lack of a positive industrial climate (LPIC) emerged as the second most principal set of causes of corruption with a path coefficient of 0.560.

The Flawed Regulation Systems

The negative role model of leadership (FRS5) had the highest factor loading (0.830) on the flawed regulation systems (FRS). Leadership plays a vital role in the culture of an organization, particularly for an ethically-oriented culture (Sims 1992; 2000;

Schein 2006). A positive leadership can facilitate the achievement of a mission via fair and honest actions (Tabish and Jha 2012). However, the negative role models of leadership can lead to corruption. The leaders may engage in acts of corruption themselves or, they overlook such acts performed by their friends, relatives, or colleagues. Under such circumstance, their subordinates will not behave differently (Tanzi 1998). According to Li et al. (2013), an evident phenomenon has been found that, in most corruption cases referring to the public construction sector in China, acts of corruption are conducted by a collective consisting of some leaders and their subordinates. In a recent survey conducted in South Africa, Bowen et al. (2012) also reported that corrupt practices of organizational leaders could produce negative role models to their subordinates, which would be followed by the subordinates.

The inadequate sanctions (FRS4) had the second high factor loading (0.737) on the flawed regulation systems (FRS). Theoretically, a tough sanction on corruptors who get caught can help curb corruption (Tanzi 1998; Zarkada-Fraser 2000). However, in China, the public opine that very few people are sanctioned correspondingly for corrupt practices they have performed (He 2000). Furthermore, a wide gap exists between the identification of sanctions in the legislative and regulative systems and the sanctions that are actually imposed. In certain cases, political or administrative interference prevent the timely or full application of sanctions. This may be due to the high social cost that is reluctant to be afforded by accusers, such as losing friend. In addition, judges who impose sanctions could have been accessible to corruption themselves or may have personal biases (Tanzi 1998). The above factors limit the role of sanctions in preventing corrupt acts, which also brings toleration for small corrupt acts that may gradually evolve to bigger ones.

The lack of rigorous supervision (FRS3) received the third ranking among the measurement items on the flawed regulation systems (FRS). Generally, the most effective control against corruption in the public construction sector should be the rigorous supervision that is added by site supervisors and auditors, namely, the third party beyond clients and contractors (Tanzi 1998). In the construction sector of China, the site supervisors and auditors are paid for their services by clients (Guo and Yang 2008). In this case, the quality of supervision provided by the site supervisors and auditors may be affected by the corrupt clients. Furthermore, in most cases, the profit rates of site supervisors and auditors given by clients are low (Guo and Yang 2008). Thus the site supervisors and auditors may fail in maintaining their integrity to take bribes from corrupt contractors and loosen their supervision. Gradually, a negative climate of relaxed supervision in the site supervisors and auditors formulate and lead to more corruption in the public construction sector of China.

The multifarious authorizations (FRS1) had the fourth high factor loading (0.600) in the list of measurement items on the flawed regulation systems (FRS). Numerous authorizations must be obtained from the governmental administrative department before a company engaging in a construction project (Zou et al. 2007). For example, one hundred and eight authorizations are needed in Guangdong Province (Southern Metropolis Daily 2013). Additionally, in most cases, the approval of these authorizations is opaque or is not even available publicly, or cannot be achieved only from a specific office or department (Tanzi 1998; Neelankavil 2002). Thus, these authorizations generate the need for frequent contacts between companies and governmental officials (Park 2003). A great amount of time is spent by companies in the process of acquiring these authorizations or dealing with governmental officials. Hence, some companies choose to pay bribes to accelerate the approval process of governmental authorizations (Tanzi 1998; Argandona 2001).

Lack of Positive Industrial Climate

Interpersonal connections (LPIC6) had the highest factor loading (0.789) on the lack of a positive industrial climate (LPIC). The term of interpersonal connections is common in studies that discussed culture factors affecting doing business in China (Alston 1989). In a society which has been ruled a long time by man instead of by law, an organization can gain a distinctly competitive advantage by building good interpersonal connections with the governmental officials. Interpersonal connections may bring vital resources, personal gains, and cost savings to the individuals or organizations that employ them. However, these benefits are often obtained by exchanging favors of various parties, especially by exchanging money and power (Fan 2002). In China, to a certain extent, interpersonal connections are regarded as a synonym for corrupt acts such as bribery, nepotism and fraud (Yang 1994). Although corruption can be found in any country, interpersonal connections in China provide a more fertile soil than any other country for corruption to flourish (Fan 2002).

The close relationships among contract parties (LPIC4) had the second high factor loading (0.783) on the lack of positive industrial climate (LPIC). The close relationships among contract parties (LPIC4) have been considered to be a vital success factor of public construction project (Ning and Ling 2013). These relationships can yield a wide range of benefits, such as securing rare resources, obtaining information and privilege, and providing insurance against uncertainty in the implementation of projects. However, close relationships among contract parties can also cause collusion, a typical form of corrupt act. According to Zarkada-Fraser and Skitmore (2000), collusion in the construction sector can be defined as the corrupt acts of various parties that coordinate their behaviors surreptitiously, which brings lost to the benefits of projects. Additionally, collusion caused by the close relationships among contract parties is even more difficult to be disclosed, as the collusive behaviors may not violate the regulation systems under the collaboration of the collusive parties.

The complexity of public construction projects (LPIC5) was the third high factor loading (0.691) on the lack of positive industrial climate (LPIC). The complexity of public construction projects has created an extra burden on construction participants and trigger corruption risks (El-Sayegh 2008). Tanzi and Davoodi (1998) stated that project complexity may increase difficulties in the contractual design, engineering design, project construction, and site supervision of public construction projects. The uncertainties caused by project complexity provide good opportunities for potential corruptors to reap private gains (Tanzi and Davoodi 1998). For example, the complex, non-standard production processes of construction projects may foster asymmetric information stocks between the contract parties, thus providing opportunity for the occurrence of corruption (de la Cruz et al. 2006; Kenny 2009).

The poor standards of professional ethics (LPIC2) ranked fourth in the factor loadings of all items on the lack of a positive industrial climate (LPIC). Professionals refer to a group of well-trained people organized to serve a body of specialized knowledge in the interests of society (Appelbaum and Lawton 1990). Professional ethics can be regarded as a set of moral principles that govern the conduct for these professionals (Allen 1990). Sohail and Cavill (2008) highlighted the seven principles for ethical behaviors of professionals, namely fair reward, integrity, honesty, objectivity, accountability, reliability, and fairness. However, previous studies have revealed the common existence of unethical behaviors in the construction industry, which have received a large amount of research concern in the past (Vee and Skitmore 2003; Bowen et al. 2007a; 2007b). Obviously, poor standards of professional ethics (LPIC2) compromise the integrity of individuals or organizations, which are apt to produce a negative effect on decision making of key project parties, such as clients, the government, and others.

Conclusion and Recommendations

To examine the relationships between the causes of corruption and corruption risks in the public construction sector of China, this study conducted a questionnaire survey. PLS-SEM results of the survey strongly supported the hypothesis that the causes of corruption are positively correlated with corruption risks.

Analysis results showed that the causes of corruption could be grounded under two constructs, namely, the flawed regulation systems (FRS), and the lack of a positive industrial climate (LPIC). In addition, the flawed regulation systems (FRS) had a higher path coefficient on corruption risks in the public construction sector of China than the lack of a positive industrial climate (LPIC). This result indicates that the flawed regulation systems (FRS) have a higher influence on corruption risks than the lack of a positive industrial climate (LPIC). Thus, anti-corruption strategies referring to regulation issues deserve more attention.

According to the factor loading of each measurement item on the flawed regulation systems (FRS), the descending order of the measurement items' contribution to corruption is, the negative role models of leadership (FRS5), inadequate sanctions (FRS4), the lack of rigorous supervision (FRS3), and multifarious authorizations (FRS1). In light of the analysis results, four recommendations were provided for preventing corruption in the public construction sector of China: (1) appoint an upright and honest leader in an organization. A fixed channel for employees to report their corrupt leaders must be in place and these informers must be protected effectively, (2) make sure that each corrupt act is dealt with adequate sanction, and ensure the information of corruption cases sanctioned is available to the public, (3) a third independent party should be employed to assess the quality of supervision work at regular intervals, and (4) simplify the authorizations that need to be approved by the government and clarify the procedures and their respective time limits for the application of authorizations.

Based on the factor loading of each measurement item on the lack of a positive industrial climate (LPIC), the descending order of the measurement items' contribution to corruption is, interpersonal connections (LPIC6), close relationships among contract parties (LPIC4), complexity of public construction projects (LPIC5), and poor standards of professional ethics (LPIC2). Therefore, specific suggestions are formulated in this study: (1) consolidate, clarify, and announce the procedures of awarding public construction projects, hence reduce the adverse influence resulted by the interpersonal connections between business and government, (2) impose rigorous supervision and auditing on public projects implemented by contract parities having long-term cooperation, to remit the collusion risks these projects are confronted with, (3) publish the information of complex public construction projects in time to avoid the information isolated island that may result in corruption. In addition, a sound system that could well manage the complexity is also necessary, and (4) strengthen the training of professional standards among the practitioners in the construction sector. A mutual evaluation of professional ethics among employees could be performed at intervals.

This study has contributed to establishment of the body of knowledge in corruption in developing economies by examining the relationships between the causes of corruption and corruption risks in the Chinese context through an empirical survey. The findings are beneficial to scholars in relevant fields because it revealed the sources of corruption in the public construction sector of China. This study also provides guidelines for professionals and organizations involved in the construction industry in China on corruption prevention. Although empirical evidences of this study are from public construction projects in China, the results might also provide reference for other developing countries with a large public construction sector.

The main limitation of this study lies in the opinion-based nature of the questionnaire survey. However, this study has attempted to relieve bias of participants by qualifying the selection of participants and administering the questionnaire in an anonymous way. Additionally, there is a common view by the academics that reliable findings are still available in corruption research based on questionnaire survey as long as the items included in the questionnaire are specific and derived systematically (Jain et al. 2001; Kaufmann et al. 2006; Sampford et al. 2006).

Future research is recommended to focus on the investigation of rationale of various causes of corruption using an appropriately chosen quantitative and/or qualitative research method. In addition, as the measurement items of corruption risks has been identified in this study, future research should develop a systematic model to measure corruption risk index in public construction projects.

Acknowledgements

This study has been funded by the Joint PhD scheme between The Hong Kong Polytechnic University and Tongji University, and the National Natural Science Foundation of China (Grant No. 71172107 & 71390523). Authors gratefully acknowledge the Department of Building and Real Estate at The Hong Kong

Polytechnic University, as well as the Research Institute of Complex Engineering & Management at Tongji University for providing supports to conduct this research study. Special thanks go to Dr. K. N. Jha and Dr. S.Z.S. Tabish at Indian Institute of Technology, Delhi for permitting the use of their questionnaire instrument. Authors would also like to appreciate the contributions of all professionals involved in the survey.

References

Ahmad, I.U., Russell, J.S., and Abou-Zeid, A. (1995). "Information technology (IT) and integration in the construction industry." *Constr. Manage. Econ.*, 13(2), 163-171.

Aibinu, A. A., and Al-Lawati, A. M. (2010). "Using PLS-SEM technique to model construction organizations' willingness to participate in e-bidding." *Auto. Constr.*, 19(6), 714-724.

Allen, R.E. (1990) *The Concise Oxford Dictionary of Current English*, 8th edn, Clarendon Press, Oxford.

Alston, J. P. (1989). "Wa, guanxi, and inhwa: Managerial principles in Japan, China, and Korea." *Bus. Horizons*, 32(2), 26-31.

Alutu, O. E. (2007). "Unethical practices in Nigerian construction industry: Prospective engineers' viewpoint." *J. Prof. Issues Eng. Educ. Pract.*, 133(2), 84-88.

Alutu, O. E., and Udhawuve, M. L. (2009). "Unethical practices in Nigerian engineering industries: Complications for project management." *J. Manage. Eng.*, 25(1), 40-43.

Argandona, A. (2001). "Corruption: the corporate perspective." *Bus. Ethics Eur. Rev.*, 10(2), 163-175.

Appelbaum, D. and Lawton, S. (1990). *Ethics and the Professions*, Prentice-Hall, Englewood Cliffs, NJ

Bagozzi, R. P. and Yi, Y. (1988). "On the evaluation of structural equation models." *J. Acad. Marketing Sci.*, 16 (1), 74-94.

Bologna, R., and Del Nord, R. (2000). "Effects of the law reforming public works contracts on the Italian building process." *Build. Res. Info.*, 28(2), 109-118.

Bowen, P., Akintoye, A., Pearl, R., and Edwards, P. J. (2007a). "Ethical behaviour in the South African construction industry." *Constr. Manage. Econ.*, 25(6), 631-648.

Bowen, P., Pearl, R., and Akintoye, A. (2007b). Professional ethics in the South African construction industry. *Build. Res. Inf.*, 35(2), 189-205.

Bowen, P.A., Edwards, P.J., and Cattell, K. (2012). "Corruption in the South African construction industry: a thematic analysis of verbatim comments from survey participants." *Constr. Manage. Econ.*, 30(10), 885-901.

Cenfetelli, R. T., and Bassellier, G. (2009). "Interpretation of formative measurement in information systems research." MIS Quarterly, 33(4), 689–707.

Chan, A. P., Lam, P. T., Chan, D. W., Cheung, E., and Ke, Y. (2010). "Critical success factors for PPPs in infrastructure developments: Chinese perspective." *J. Constr. Eng. Manage.*, 136(5), 484-494.

Chan, W.K., Wong, F.K., and Scott, D. (1999). "Managing construction projects in China-the transitional period in the millennium." *Int. J. Project Manage.,* 17(4), 257-263.

Choi, T. N., Chan, D. W., and Chan, A. P. (2011). "Perceived benefits of applying Pay for Safety Scheme (PFSS) in construction–A factor analysis approach." *Safety Sci.*, 49(6), 813-823.

Conway, J. M., and Huffcutt, A. I. (2003). "A review and evaluation of exploratory factor analysis practices in organizational research." *Organ. Res. Meth.*, 6(2), 147-168.

de Jong, M., Henry, W. P., and Stansbury, N. (2009). "Eliminating corruption in our engineering/construction industry." *Leadership Manage. Eng.*, 9(3), 105-111.

de la Cruz, M. P., del Caño, A., and de la Cruz, E. (2006). "Downside risks in construction projects developed by the civil service: the case of Spain." *J. Constr. Eng. Manage.*, 132(8), 844-852.

Dziuban, C. D., and Shirkey, E. C. (1974). "When is a correlation matrix appropriate for factor analysis? Some decision rules." *Psychol. Bull.*, 81(6), 358-361.

El-Sayegh, S. M. (2008). "Risk assessment and allocation in the UAE construction industry." *Int. J. Project Manage.*, 26(4), 431-438.

Fan, Y. (2002). "Guanxi's consequences: Personal gains at social cost." *J. Bus. Ethics*, 38(4): 371-380.

Guo, Z., and Yang, M. (2008). "New standards of payment for the site superviros and the corresponding strategies." *Project Manage.*, (4), 46-47, 59. (In Chinese)

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., and Tatham, R. L. (2010). *Multivariate data analysis*, Prentice Hall Upper Saddle River, NJ.

Hair, J. F., Ringle, C. M., and Sarstedt, M. (2011). "PLS-SEM: Indeed a silver bullet." *J. Marketing Theo. Pract.*, 19(2), 139–151.

Harboon, D., and Heinrich, F. (2011). *Bribe payers index 2011*. Transparency International. Berlin, Germany.

Haque, N. U., and Sahay, R. (1996). "Do government wage cuts close budget deficits? Costs of corruption." *Staff Papers-International Monetary Fund*, 754-778.

He, Z. (2000). "Corruption and anti-corruption in reform China." *Communis. Post-Commun.*, 33(2), 243-270.

Henseler, J., Ringle, C., and Sinkovics, R. (2009). "The use of partial least squares path modeling in international marketing." *Adv. Int. Marketing*, 20, 277-320.

Hon, C.K.H., Chan, A.P.C., and Yam, M.C.H. (2012). "Empirical study to investigate the difficulties of implementing safety practices in the repair and maintenance sector in Hong Kong." *J. Constr. Eng. Manage.*, 138(7), 877-884.

Hsueh P.R., Graybill J.R., Playford E.G., Watcharananan S.P., Oh M.D., Já alam K., Huang S., Nangia V., Kurup A., Padiglione A.A. (2009). "Consensus statement on the management of invasive candidiasis in intensive care units in the Asia-Pacific Region." *Int. J. Antimicrob. Agents*, 34(3), 205-209.

Jain, A. K. (2001). Corruption: a review. *J. Econ. Surv.*, 15(1), 71-121.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2006). "Measuring corruption: Myths and realities." *Dev. Outreach*, 8(2), 124-37.

Kenny, C. (2009). “Transport construction, corruption and developing countries.” *Transport Rev.*, 29(1), 21-41.

Li, Y., Le, Y., Zhang B., and Shan, M. (2013). “The correlations among corruption severity, power and behavior features in construction industry: An empirical study based on 148 typical cases.” *Manage. Rev.*, 25(8), 21-31. (In Chinese)

Ling, F. Y., Ning, Y., Ke, Y., and Kumaraswamy, M. M. (2013). “Modeling relational transaction and relationship quality among team members in public projects in Hong Kong.” *Auto. Constr.*, 36, 16-24.

Ling, F. Y. Y., and Tran, P. Q. (2012). “Effects of interpersonal relations on public sector construction contracts in Vietnam.” *Constr. Manage. Econ.*, 30(12), 1087-1101.

Liu, A.M., Fellows, R., and Ng, J. (2004). “Surveyors' perspectives on ethics in organisational culture.” *Eng. Constr. Archit. Manage.*, 11(6), 438-449.

Mohamed, S. (2002). “Safety climate in construction site environments.” *J. Constr. Eng. Manage.*, 128(5), 375-384.

Moodley, K., Smith, N., and Preece, C. N. (2008). “Stakeholder matrix for ethical relationships in the construction industry.” *Constr. Manage. Econ.*, 26(6), 625-632.

National Bureau of Statistics of China. (2012). *China Statistical Yearbook*, 2012., http://www.stats.gov.cn/tjsj/ndsj/2012/indexch.htm

Ning, Y. (2013). “Quantitative effects of drivers and barriers on networking strategies in public construction projects.” *Int. J. Project Manage.*, 32(2), 286-297.

Ning, Y. and Ling, F. (2013). "Reducing Hindrances to Adoption of Relational Behaviors in Public Construction Projects." *J. Constr. Eng. Manage.*, 139(11), 04013017.

Norusis, M.J. (2008). *SPSS 16.0 advanced statistical procedures companion*, Prentice-Hall, Upper Saddle River, N.J.

Park, H. (2003). "Determinants of corruption: A cross-national analysis." *Multinatl. Bus. Rev.*, 11(2), 29-48.

Reinartz, W., Haenlein, M., and Henseler, J. (2009). "An empirical comparison of the efficacy of covariance-based and variance-based SEM." *Int. J. Res. Marketing*, 26(4), 332–344.

Ringle, C., Sarstedt, M., and Straub, D. (2012). "A critical look at the use of PLS-SEM in MIS Quarterly." MIS Quarterly, 36(1), iii–xiv.

Rose-Ackerman, S. (2008). "Briefing: Risks of corruption in government infrastructure projects." P. I. Civil Eng-Munic, Institution of Civil Engineers, 149-150.

Sampford, C., Shacklock, A., and Connors, C. (2006). *Measuring corruption*. Ashgate Publishing Limited, Hampshire, England.

Schein, E.H. (2006). *Organizational culture and leadership*, third edition, Jossey-Bass, San Francisco, C.A., U.S.A.

Sha, K. (2004). "Construction business system in China: An institutional transformation perspective." *Build. Res. Inf.*, 32(6), 529-537.

Sims, R. R. (1992). "The challenge of ethical behavior in organizations." *J. Bus.*

Ethics, 11(7), 505-513.

Sims, R. R. (2000). "Changing an organization's culture under new leadership." *J. Bus. Ethics*, 25(1), 65-78.

Sohail, M., and Cavill, S. (2008). "Accountability to prevent corruption in construction projects." *J. Constr. Eng. Manage.*, 134(9), 729-738.

Southern Metropolis Daily. (2013). "The administrative authorizations in Guangdong may continue to be reduced in next month." Available at http://epaper.oeeee.com/A/html/2013-11/26/content_1978414.htm

Tabish, S., and Jha, K. N. (2011). "Analyses and evaluation of irregularities in public procurement in India." *Constr. Manage. Econ.*, 29(3), 261-274.

Tabish, S., and Jha, K. N. (2012). "The impact of anti-corruption strategies on corruption free performance in public construction projects." *Constr. Manage. Econ.,* 30(1), 21-35.

Tanzi, V. (1998). "Corruption around the world: Causes, consequences, scope, and cures." *Staff Papers-International Monetary Fund*, 559-594.

Vee, C., and Skitmore, C. (2003). "Professional ethics in the construction industry." *Eng. Constr. Archit. Manage.*, 10(2), 117-127.

Wetzels, M., Odekerken-Schroder, G. and van Oppen, C. (2009). "Using PLS path modeling for assessing hierarchical construct models: guidelines and empirical illustration." MIS Quarterly, 33 (1), 177-195.

Xinhuanet. (2011). "More efforts will be imposed on the investigation of corruption in public construction sector in China." Available at http://news.xinhuanet.com/legal/2011-05/17/c_121426891.htm.

Xu, Y., Yeung, J.F.Y., Chan, A.P.C., Chan, D.W.M., Wang, S.Q., and Ke, Y. (2010). "Developing a risk assessment model for PPP projects in China-A fuzzy synthetic evaluation approach." *Auto. Constr.*, 19(7), 929-943.

Yang, M. M. (1994). *Gifts, favors, and banquets: The art of social relationships in China.* Cornell University Press. Ithaca, N.Y., U.S.A.

Zarkada-Fraser, A. (2000). "A classification of factors influencing participating in collusive tendering agreements." *J. Bus. Ethics*, 23(3), 269-282.

Zarkada-Fraser, A., and Skitmore, M. (2000). "Decisions with moral content: collusion." *Constr. Manage. Econ.*, 18(1), 101-111.

Zhao, X., Hwang, B. G., and Low, S. P. (2013). "Critical success factors for enterprise risk management in Chinese construction companies." *Constr. Manage. Econ.*, 31(12), 1199-1214.

Zou, P. X., Fang, D., Wang, S. Q., and Loosemore, M. (2007). "An overview of the Chinese construction market and construction management practice." *J. Technol. Manage. China*, 2(2), 163-176.

Tables in "Investigating the Relationship between the Causes of Corruption and Corruption Risks in the Public Construction Sector of China"

Table 1 Backgrounds of interviewees

No.	Employer	Position	Years of experience	Largest project ever managed/consulted	Working place*
A	Government	Director	20	USD 363 million	Eastern developed areas
B	Government	Deputy Director	16	USD 308 million	Central and western developing areas
C	Client	Project Manager	19	USD 363 million	Eastern developed areas
D	Client	Project Manager	17	USD 308 million	Eastern developed areas
E	Client	Director	13	USD 167 million	Central and western developing areas
F	Contractor	General Manager	25	USD 363 million	Eastern developed areas
G	Contractor	Project Manager	20	USD 122 million	Central and western developing areas
H	Contractor	Director	15	USD 85 million	Central and western developing areas
I	Consultant	General Manager	20	USD 363 million	Eastern developed areas
J	Consultant	Project Manager	16	USD 122 million	Central and western developing areas
K	Consultant	Project Manager	15	USD 85 million	Central and western developing areas
L	Academic	Professor	22	USD 197 million	Eastern developed areas
M	Academic	Professor	17	USD 73 million	Central and western developing areas
N	Academic	Associate Professor	13	USD 363 million	Eastern developed areas

Note: *Working places are divided into eastern areas with GDP per capita above USD 8,000, and central and western areas with GDP per capita below USD 5,000, according to the National Bureau of Statistics of China (2012).

Table 2 Backgrounds of respondents

Personal attributes	Categories	Number of respondents	Percentage	Cumulative percentage
Organization	Government	20	10.6	10.6
	Client	43	22.9	33.5
	Contractor	43	22.9	56.4
	Consultant	46	24.5	80.9
	Designer	26	13.8	94.7
	Academic	10	5.3	100
Position	Top managerial level (e.g., director, general manager, and professor)	49	26.1	26.1
	Middle managerial level (e.g., project manager)	88	46.8	72.9
	Professional (e.g., engineer, and quantity surveyor)	51	27.1	100
Years of experience	>20	24	12.8	12.8
	11-20	40	21.3	34.1
	6-10	76	40.4	74.5
	<5	48	25.5	100
Working place*	Eastern developed areas	96	51.1	51.1
	Central and western developing areas	92	48.9	100

Note: *Working places are divided into eastern areas with GDP per capita above USD 8,000, and central and western areas with GDP per capita below USD 5,000, according to the National Bureau of Statistics of China (2012).

Table 3 Measurement items of causes of corruption

Construct	Code	Measurement item	Source [I]											Evaluation	Factor loading	Variance explained
			A	B	C	D	E	F	G	H	I	J	K			
Flawed regulation systems (FRS)	FRS1	Multifarious authorizations			√	√								4.50	0.631	38.668%
	FRS2	Deficiencies in rules and laws			√						√	√		3.93	0.474[III]	
	FRS3	Lack of rigorous supervision			√	√								4.14	0.630	
	FRS4	Inadequate sanctions	√		√							√		3.50	0.707	
	FRS5	Negative role model of leadership	√		√									3.57	0.840	
Lack of a positive industrial climate (LPIC)	LPIC1	Low wage level			√	√								2.21[II]	-	
	LPIC2	Poor standards of professional ethics	√			√		√	√	√		√		3.07	0.568	15.492%
	LPIC3	Excessive competition in the construction market		√										3.79	0.452[III]	
	LPIC4	Close relationships among contract parties		√			√							3.36	0.792	
	LPIC5	Complexity of public construction projects		√										3.21	0.777	
	LPIC6[II]	Interpersonal connections											√	3.96	0.764	

Note: Ⅰ: A= Bowen et al. 2012; B= Sohail and Cavill 2008; C = Tanzi 1998; D = Neelankavil 2002; E = Ling and Tran 2012; F = Liu et al. 2004; G= Moodley et al. 2008; H= Zarkada-Fraser and Skitmore 2000; I= Bologna and Del Nord 2000; J= Zarkada-Fraser 2000; K= Supplementation from interviewees;

Ⅱ: LPIC1 was dropped with an evaluation score lower than 2.5 points in the interviews; LPIC6 was added by the interviewees;

Ⅲ: FRS2 and LPIC3 were dropped with factor loadings lower than 0.5.

Table 4 Measurement items of corruption risks

Construct	Code	Measurement item	Evaluation	Factor loading	Variance explained
Immorality (Professional standards irregularities)	IMM1	The work is not executed as per original design accorded	3.93	0.727	33.679%
	IMM2	Work is executed without the availability of funds for the said purpose	3.93	0.474 [II]	
	IMM3	The changes, especially in abnormally high rated and high value items are not properly monitored and verified	3.29	0.696	
	IMM4 [I]	Contractors provide false certificates in bidding	3.96	0.673	
	IMM5 [I]	Substitution of unqualified materials in construction	3.54	0.735	
	IMM6 [I]	Site supervisor neglects his duties for taking bribe from contractor	3.91	0.750	
Unfairness (Fairness irregularities)	UNF1	The consultant is not appointed after proper publicity and open competition	3.64	0.797	9.718%
	UNF2	The criteria adopted in prequalification of consultant are restrictive and benefit only few consultants	3.43	0.849	
	UNF3	The selection of consultant not done by appropriate authority	3.57	0.451 [II]	
	UNF4	The criteria for selection of contractor are restrictive and benefit only few contractors	3.00	0.708	
	UNF5	The conditions/specifications are relaxed in favor of contractor to whom the work is being awarded	3.50	0.636	
	UNF6 [I]	Confidential information of bidding is disclosed to a specific bidder	3.76	0.654	
Opacity (Transparency irregularities)	OPA1	Adequate & wide publicity is not given to tender	2.71	0.720	6.644%
	OPA2	Adequate time for submission of tender/offer not given	2.64	0.482 [II]	
	OPA3	The evaluation of tenders is not done exactly as per the notified Criteria	2.57	0.752	
	OPA4	The negotiation on tender not done as per laid down guidelines	3.00	0.759	
	OPA5 [I]	A large project should have called for bids is split into several small projects and contracted without bidding	3.40	0.616	
Procedural violation (Procedural	PRV1	Administrative approval and financial sanction not taken to execute the work	2.79	0.742	6.300%
	PRV2	Lack of the sanctioned financial provisions from the government	3.86	0.707	
	PRV3	Work is not executed for the same purpose for which the sanction was accorded	2.93	0.640	

Construct	Code	Measurement item	Evaluation	Factor loading	Variance explained
accountability irregularities)	PRV4	The proper record of hindrances is not being maintained from the beginning	2.93	0.440 [Ⅱ]	
Contractual violation (Contract monitoring and regulation irregularities)	COV1	Escalation clause is not applied correctly for admissible payment	3.57	0.746	5.281%
	COV2	Compliance with conditions regarding deployment of technical staff not being followed by contractor	3.71	0.573	
	COV3	The work order/supply order is not placed within justified rates	2.71	0.443 [Ⅱ]	

Note: Ⅰ: IMM4, IMM5, IMM6, UNF6, and OPA5 were added by the interviewees;

Ⅱ: IMM2, UNF3, OPA2, PRV4, and COV3 were excluded with factor loadings lower than 0.5.

Table 5 Added measurement items and evaluations

Code	Measurement item	Interviewee														Evaluation
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	
LPIC6	Interpersonal connections				√	√	√		√		√	√	√		√	3.96
IMM4	Contractors provide false certificates in bidding	√	√	√				√	√		√		√	√		3.96
IMM5	Substitution of unqualified materials in construction	√	√		√	√				√	√	√	√	√	√	3.54
IMM6	Site supervisor neglects his duties for taking bribe from contractor		√	√	√	√				√	√		√	√	√	3.91
UNF6	Confidential information of bidding is disclosed to a specific bidder	√			√			√		√		√	√		√	3.76
OPA5	A large project should have called for bids is split into several small projects and contracted without bidding				√	√	√		√		√	√	√		√	3.40

Table 6 Measurement model evaluation

Construct	Code	Loading	T-value	AVE	CR
FRS	FRS1	0.600	8.3170	0.5143	0.8069
	FRS3	0.683	10.1444		
	FRS4	0.737	10.9578		
	FRS5	0.830	14.0376		
LPIC	LPIC2	0.669	9.9917	0.5403	0.8238
	LPIC4	0.783	13.0040		
	LPIC5	0.691	7.7230		
	LPIC6	0.789	13.4034		
IMM	IMM1	0.687	11.9562	0.5485	0.8584
	IMM3	0.732	11.4736		
	IMM4	0.719	11.3353		
	IMM5	0.772	14.248		
	IMM6	0.789	14.1749		
UNF	UNF1	0.767	15.3066	0.5600	0.8638
	UNF2	0.801	14.1633		
	UNF4	0.767	13.2561		
	UNF5	0.689	11.5474		
	UNF6	0.712	15.58		
OPA	OPA1	0.615	5.8088	0.5523	0.8301
	OPA3	0.801	12.6199		
	OPA4	0.789	12.174		
	OPA5	0.752	11.4131		
PRV	PRV1	0.794	11.2432	0.5461	0.7820
	PRV2	0.658	8.9278		
	PRV3	0.758	10.791		
COV	COV1	0.799	9.4346	0.6686	0.8013
	COV2	0.836	10.4413		

Table 7 Correlation matrix and square root of Average Variance Extracted of constructs

	COV	FRS	IMM	LPIC	OPA	PRV	UNF
COV	**0.8177**						
FRS	0.4069	**0.7171**					
IMM	0.5599	0.4882	**0.7406**				
LPIC	0.1854	0.4726	0.3092	**0.7351**			
OPA	0.2316	0.2465	0.4492	0.1674	**0.7432**		
PRV	0.3990	0.3329	0.4210	0.1167	0.4601	**0.7390**	
UNF	0.4615	0.3836	0.5508	0.2310	0.5941	0.5012	**0.7483**

Table 8 Cross loadings for individual measurement items

	COV	FRS	IMM	LPIC	OPA	PRV	UNF
COV1	**0.7989**	0.3114	0.3944	0.1566	0.2110	0.3704	0.3396
COV2	**0.8361**	0.3527	0.5164	0.1472	0.1699	0.2864	0.4125
FRS1	0.3553	**0.5999**	0.3808	0.2287	0.2085	0.2156	0.2624
FRS3	0.2882	**0.6826**	0.3130	0.3633	0.1534	0.2878	0.3102
FRS4	0.1967	**0.7369**	0.2412	0.3204	0.1419	0.2351	0.1974
FRS5	0.3403	**0.8298**	0.4621	0.4186	0.2093	0.2235	0.3277
IMM1	0.4503	0.3510	**0.6870**	0.1693	0.3286	0.2989	0.2964
IMM3	0.4893	0.3108	**0.7319**	0.2437	0.2742	0.2383	0.3226
IMM4	0.3435	0.3348	**0.7194**	0.1615	0.4024	0.2999	0.5502
IMM5	0.3764	0.3796	**0.7716**	0.2522	0.3459	0.3250	0.3899
IMM6	0.4301	0.4254	**0.7888**	0.314	0.3051	0.3867	0.4508
LPIC2	0.1199	0.4166	0.1964	**0.6691**	0.0905	0.0095	0.1492
LPIC4	0.1280	0.3210	0.2865	**0.7833**	0.1571	0.1131	0.1869
LPIC5	0.0285	0.1986	0.1138	**0.6908**	0.0878	0.0241	0.0753
LPIC6	0.2371	0.4200	0.2846	**0.7891**	0.1477	0.1742	0.2420
OPA1	0.1268	-0.0063	0.1417	0.0982	**0.6153**	0.2725	0.3146
OPA3	0.2881	0.2573	0.3402	0.1277	**0.8010**	0.3038	0.5066
OPA4	0.1791	0.1216	0.3517	0.0750	**0.7894**	0.3891	0.4164
OPA5	0.0864	0.2944	0.4454	0.1887	**0.7523**	0.3926	0.4977
PRV1	0.3164	0.2091	0.2806	0.0146	0.3927	**0.7941**	0.3743
PRV2	0.2344	0.2282	0.1999	0.1595	0.3021	**0.6582**	0.3585
PRV3	0.3247	0.2974	0.4298	0.0979	0.3236	**0.7580**	0.3801
UNF1	0.2632	0.2484	0.3445	0.1671	0.4047	0.4006	**0.7673**
UNF2	0.3276	0.1954	0.3227	0.0974	0.3448	0.3751	**0.8014**
UNF4	0.3383	0.2326	0.3891	0.1850	0.5197	0.4684	**0.7667**
UNF5	0.2793	0.2171	0.4125	0.1707	0.4829	0.1846	**0.6888**
UNF6	0.4877	0.5031	0.5629	0.2299	0.4561	0.4174	**0.7118**

Table 9 Evaluation of hierarchical models

Paths	**Path coefficient**	**T-value**	**CR**
FRS→CC	0.605	15.330	0.8320
LPIC→CC	0.560	14.306	
CR→IMM	0.820	22.166	0.9045
CR→UNF	0.861	51.096	
CR→OPA	0.738	17.325	
CR→PRV	0.685	16.841	
CR→COV	0.640	12.106	

Note: CC represents for causes of corruption

CR represents for corruption risks