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Investigating the Underlying Factors of Corruption in the Public Construction Sector: Evidence from China

Abstract

Over recent years, the issue of corruption in the public construction sector has attracted increasing attention from both practitioners and researchers worldwide. However, limited efforts are available for investigating the underlying factors of corruption in this sector. Thus, this study attempted to bridge this knowledge gap by exploring the underlying factors of corruption in the public construction sector of China. To achieve this goal, a total of 14 structured interviews were first carried out, and a questionnaire survey was then administered to 188 professionals in China. Two iterations of multivariate analysis approaches, namely, stepwise multiple regression analysis and partial least squares structural equation modeling were successively utilized to analyze the collected data. In addition, a case study was also conducted to triangulate the findings obtained from the statistical analysis. The results generated from these three research methods achieve the same conclusion: the most influential underlying factor leading to corruption was immorality, followed by opacity, unfairness, procedural violation, and contractual violation. This study has contributed to the body of knowledge by exploring the properties of corruption in the public construction sector. The findings from this study are also valuable to the construction authorities as they can assist in developing more effective anti-corruption strategies.

Keywords

Public construction sector; underlying factor of corruption; questionnaire survey; case study.

Introduction

As a core sector, construction has played a vital role in contributing to the economic and social developments of human societies (de Jong et al. 2009). However, in the recent years, its positive social images have been increasingly diminished by corruption issues (Le et al. 2014a). Corruption has damaged the construction industry at multiple levels and resulted in the underperformances of construction projects such as cost overruns and quality defects (Kenny 2009). Corruption has also brought about considerable economic loss to the construction sector. According to Sohail and Cavill (2008), the annual loss from corruption in the global construction market reached approximately USD 340 billion, accounting for 1% of the global construction market value (roughly USD 3.2 trillion). Transparency International estimated that 10% of the global infrastructure investment was lost through corruption annually (ASCE 2015). Particularly, as an important section of the construction sector, the public construction sector has been plagued by corruption constantly, and it has also been assessed as the most corrupt sector worldwide by the Transparency International's Bribe Payers Index since 1999 (Transparency International 2011).

In 2014, Le et al. (2014a) conducted a comprehensive literature review of corruption research in the construction engineering and management field and found that its primary research efforts mainly focused on identifying the forms of construction corruption, investigating the impacts of construction corruption, and exploring the anti-corruption strategies for the construction industry. Subsequent to the study of Le et al. (2014a), several studies continued examining this topic. Gunduz and Önder (2013) scrutinized the internal fraud and the corruption problem in the Turkish construction industry. Brown and Loosemore

(2015) explored the behavioral factors influencing corruption in the Australian construction industry. Bowen et al. (2015) surveyed the experiences and opinions of construction professionals on corruption in the South African construction industry. Nag (2015) investigated corruption in the Indian public procurement sector and recommended measures to combat such corruption. Concentrating on corruption in the Chinese public construction sector, Le and Shan and their partners successively investigated the principal causes of corruption (Le et al. 2014b), evaluated the effectiveness of prevailing anti-corruption strategies (Shan et al. 2015a), and developed a model to measure corruption in public construction projects (Shan et al. 2015b). Although continuing efforts have been exerted to examine the corruption issue in the construction sector, the exploration of the underlying factors causing corruption has been minimal. Exploring the underlying factors causing corruption is extremely crucial to the control of corruption as it can help deconstruct the phenomenon and reveal the areas that are most vulnerable to corruption, thereby facilitating the development of more effective anti-corruption strategies. Hence, this study attempts to bridge the knowledge gap by exploring the underlying factors in the public construction sector. This study was conducted within the context of the Chinese public construction sector and is an extension of Le et al. (2014b), Shan et al. (2015a), and Shan et al. (2015b). This study contributes to the body of knowledge by exploring the underlying factors causing corruption in the public construction sector. This study is also beneficial to the industry as its findings can provide industrial practitioners with an in-depth understanding of construction corruption and thereby introduce more effective anti-corruption strategies.

Background

Corruption in the Construction Industry

Corruption is a type of dishonest or fraudulent practice conducted by those morally depraved individuals in power, who misuse the public power for their private benefit (Gray and Kaufman 1998). This wrongdoing distorts markets and the allocation of resources, and is therefore regarded as a major obstacle to economic and social development worldwide (Tanzi 1998; Jain 201). Corruption also prevails in the construction industry (de Jong et al. 2009). In construction projects, corruption may occur with practitioners at any level and in any project phase such as project inception, planning and design, bidding and construction, and operation and maintenance (Bowen et al. 2007a, b, 2012; Tabish and Jha 2011; Nag 2015). The common forms of corruption in the construction industry are bribery, fraud, collusion, bid rigging, embezzlement, kickbacks, conflicts of interest, extortion, negligence, front companies, and nepotism (Vee and Skitmore 2003; Bowen et al. 2007a, b, 2012; Sohail and Cavill 2008; Sichombo et al. 2009; Ameh and Odusami 2010; Tabish and Jha 2011; Le et al. 2014a; Shan et al. 2016).

Some efforts have been made to explore the causes of corruption in the construction industry. In some cases, corruption was deemed to be the result of unethical decision-making (Zarkada-Fraser and Skitmore 2000; Moodley et al. 2008). For developing countries under societal transition that may lack mature law systems, corruption might be incurred by the defective institutional systems or insufficient legal punishments (Bologna and Del Nord 2000). Sohail and Cavill (2008) summarized several primary causes of corruption in construction as follows: (1) over competition in the tendering process, (2) insufficient transparency in the tenderer selection criteria, (3) political interference, (4) complicated institutional roles and functions, and (5) asymmetric information amongst project parties. Tabish and Jha (2011) emphasized that corruption in construction was attributable to the lack of standardized execution in construction projects. Bowen et al. (2012) stated that the construction industry was susceptible to corruption owing to its particular characteristics such as the complexity and uniqueness of construction projects, the considerable number of contractual links and the culture of secrecy. Le et al. (2014b) stressed that the principal causes of corruption in the Chinese public construction sector are flawed regulation systems and lack of a positive industrial climate.

The impacts of corruption in the construction industry can be tagged at three levels, namely, impacts at the project level, the organizational level, and the national level. At the project level, corruption is considered to be an extremely significant risk to construction projects in various countries, particularly those in developing countries that lack mature legislative and administrative system (Deng et al. 2003; Choudhry and Iqbal 2013; Deng et al. 2014b); while the typical consequences of corruption risk are the increase in project costs and waste of public funds (Meduri and Annamalai 2013; Hwang et al. 2016). At the organizational level, corruption affects the execution of the expansion strategies of global construction companies in the international construction market greatly (Crosthwaite 1998; Ling and Hoang 2010; Tang et al. 2012; Deng et al. 2014a). This is understandable because normally global construction companies would avoid conducting business with those host countries having a serious problem of corruption. As for the impact at national level, corruption in the construction industry has hindered the social and economic development of various countries worldwide (Snaith and Khan 2008). For instance, Jimenez (2009) and Romero et al. (2012) noted that construction corruption led to the speculative bubble in Spain and resulted in many unsuccessful urban expansion cases in this country. Skorupka (2008) and Badun (2011) stated that the slow development of infrastructure in Poland and Croatia was attributable to corrupt practices in the civil and construction sectors.

To prevent corruption in the construction industry, various strategies have been proposed. The commonly advocated strategies are developing leadership, enforcing rules, regulations and sanction systems, implementing training and education, transparency mechanism, ethical code, project governance, and using audit and information technologies (Zou 2006; Sohail and Cavill 2008; Sichombo et al. 2009; Bowen et al. 2012; Kenny 2012; Tabish and Jha 2012; Shan et al. 2015a). In addition, several construction industry associations, nongovernmental organizations, and international organizations have also devoted considerable efforts to fight against corruption in the construction industry. The American Society of Civil Engineers promoted a "zero tolerance" policy to cultivate an anticorruption culture in the U.S. construction industry (Crist 2009). In collaboration with the Global Infrastructure Anti-Corruption Centre, Transparency International developed an integrated anticorruption system: The Project Anti-Corruption System (PACS), which has promoted a group of anticorruption strategies to prevent corruption (Transparency International 2013). The World Economic Forum also established the Global Partnering Against Corruption Initiative which provided a platform for construction companies to gain anticorruption knowledge (World Economic Forum 2013).

Corruption in the Chinese Public Construction Sector

Over the past three decades, the government of China has continuously been using increasing fixed-asset investments to boost its economic development (Zeng et al. 2016), and a considerable fixed-asset investment has been devoted to the public construction sector (Wu et al. 2012). According to the National Bureau of Statistics of China (2015), the total investment in the public construction sector increased almost 100 times from 27 billion (Chinese Yuan, CNY) (approximately USD 4 billion) in 1981 to CNY 267,5 billion (approximately USD 400 billion) in 2014. However, such huge investments have also caused numerous corruption cases within the Chinese public construction sector. The National Bureau of Corruption Prevention reported 15,010 cases of corruption recorded in the public construction sector between 2009 and 2011, which resulted in an economic loss of CNY 3 billion (approximately USD 490 million) (Xinhua Net 2011a). Findings from a research project funded by the Ministry of Science and Technology showed that, among the 164 provincial officials who were prosecuted between 1986 and 2014, more than 40 percent of them were associated with corruption in the public construction sector (Wang 2014). These statistics suggests that China is facing a significant, serious and continuing challenge in preventing corruption in the public construction sector.

Methodology

This study was conducted in five steps. First, structured interviews were conducted to generate the irregularities related to corruption in the Chinese public construction sector. Second, based on the interview results, a questionnaire was developed and disseminated within the public construction sector to collect the opinion-based data of those irregularities related to corruption. Third, based on the collected data, a factor analysis was conducted to extract the underlying factors of corruption. Fourth, the stepwise multiple regression analysis and the partial least squares structural equation modeling analysis were carried out separately to analyze the collected data to explore the most influential underlying factors of corruption. Finally, a case study was conducted to triangulate the findings from the statistical analysis.

Structured Interviews

First, this study conducted a series of structured interviews to identify the irregularities related to corruption in the Chinese public construction sector. In this study, irregularities related to corruption are defined as professionals' malpractices that are caused by corruption. These corruption-related irregularities can reflect the internal attributes of corruption at large, and are helpful in exploring the underlying factors of corruption. However, in their comprehensive literature review, Le et al. (2014a) found that few studies have investigated these irregularities systematically, with the exception of Tabish and Jha (2011) that summarized a detailed list of 61 irregularities in the Indian public construction sector. This study therefore used the Tabish and Jha (2011) framework as the initial framework to derive the corruption-related irregularities in the Chinese public construction sector. This choice could be justified by two reasons: (1) the Tabish and Jha (2011) framework comprised 61 detailed irregularities gathered from the entire project life cycle, indicating that the framework was fairly comprehensive; and (2) both China and India have a booming public construction sector and are facing a similar challenge of preventing corruption in the sector (Shan et al. 2015a). Nevertheless, there should be a compatibility issue when applying the Tabish and Jha (2011) framework directly in the context of China. Thus, this study conducted structured interviews with 14 experienced experts from the Chinese public construction sector to fit the original framework in the context of China. Lastly, a total of 24 corruption-related irregularities were finalized through the interviews, as listed in Table 1. More specific details of the structured interviews could be found in Le et al. (2014b).

(Please insert Table 1 here.)

Questionnaire Survey

Based on the interview results, a questionnaire survey was administered to collect the opinion-based data of corruption-related irregularities from respondents. Data were collected from two perspectives, namely, probability (i.e., the possibility of occurrence of each irregularity) and severity (i.e., the impact of the consequence of each irregularity), using a five-point rating scale (i.e., 1 for very low, 2 for low, 3 for medium, 4 for high, and 5 for very high). Moreover, the questionnaire also collected the perception data of the overall corruption situation in the Chinese public construction sector from respondents with a five-point rating scale (i.e., 1 for not serious at all, 2 for not serious, 3 for medium, 4 for serious, and 5 for extremely serious).

The population of the survey targets the officials, professionals and researchers that are involved in the Chinese public construction sector. As for the sampling approach, this study used a nonprobability sampling approach instead of a probability sampling approach. This was because it would be extremely difficult to conduct probability sampling in the Chinese construction sector which had about 29,212,000 employees across the country (National Bureau of Statistics of China, 2015). In addition, among the commonly used nonprobability sampling methods such as convenience sampling, judgement sampling, quota sampling, and snowball sampling method (Jessen 1969), this study selected the convenience sampling and snowball sampling methods. Convenience sampling was selected as it was a method where subjects were selected because of their convenient accessibility and proximity to the researcher. This method was often used in exploratory research where the researcher was interested in getting an inexpensive approximation to the truth (Hultsch et al. 2002). The snowball sampling was selected as it was a method where existing study subjects recruited future subjects from among their acquaintances, and it was often used when the desired sample characteristic was rare (Noy 2008). These two non random sampling methods were particularly suitable to this study as it had a sensitive survey topic (i.e., corruption) which meant that few respondents would like to participate willingly. These two sampling methods were the most appropriate strategies to gather as many replies as possible for the survey.

The questionnaire was disseminated through three channels including an online survey, interviews with qualified attendants of an industrial summit, and field surveys at three public construction sites. A total of 188 valid replies were received, with 87 collected from the online survey, 20 from the industrial summit, and 81 from the field surveys. The profiles of the respondents are shown in Table 2. More specific details of the questionnaire survey can be found in Le et al. (2014b).

(Please insert Table 2 here.)

Factor Analysis

To obtain the underlying factors of corruption in the Chinese public construction sector, factor analysis, a commonly adopted statistical technique to identify a small number of individual factors beneath a set of interrelated variables, was used. As recommended by Zhao et al. (2013), principal component analysis was conducted to extract the underlying factors of corruption from diverse corruption-related irregularities for its simplicity and distinctive capacity of data reduction. Assuming the existence of the correlations among various underlying factors of corruption, the promax rotation was conducted as suggested by Conway and Huffcutt (2003). Appropriateness of using factor analysis was evaluated via Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity, as suggested by Dziuban and Shirkey (1974).

Stepwise Multiple Regression Analysis

Multiple regression analysis is a statistical technique used to analyze the relationship between a single dependent variable and several independent variables (Lam et al. 2008). The approach has a wide application in construction engineering and management research (Chan et al. 2001). Multiple regression analysis can help understand how a typical value of the dependent variable changes when any of the independent variables is varied, and the other independent variables are held fixed. The use of multiple regression analysis can also help disclose the various influence levels of different independent variables on the dependent variable. Thus, this study used a stepwise multiple regression analysis, a common type of multiple regression analysis, to explore the relationships between the various underlying factors of corruption and the overall corruption situation in the Chinese public construction sector, and to achieve the prioritization of the underlying factors of corruption and their influences.

Partial Least Squares-Structural Equation Modeling

The structural equation modeling method has been deemed to be one of the most suitable techniques for analyzing the possible relationships among variables (Zhao et al. 2013; Liu et al. 2016). It can model the relationships among multiple independent and dependent variables simultaneously, which differs significantly from the first-generation regression models, such as the stepwise multiple regression model, which can analyze only one layer of linkage between independent and dependent variables at a time (Gefen et al. 2000). Thus, this study also adopted structural equation modeling to explore the most influential underlying factors of corruption in the Chinese public construction sector. This study sought to use different generations of analyzing methods to generate some findings that are more reliable and convincing. Specifically, the partial least squares structural equation modeling was adopted because of its unique advantages: (1) addressing complex problems without requiring a large sample size, and (2) having no specific requirement for data distribution (Hair et al. 2011; Zhao and Singhaputtangkul 2016). The results of the underlying factors of corruption obtained from the stepwise multiple regression analysis and the partial least squares structural equation modeling analysis would be compared and discussed.

Case Study

According to Russell et al. (2014) and Fitch et al. (2015), case study refers to an in-depth investigation of a single person, group, event or community, and it is oriented to describe the objective nature of a subject qualitatively. Case study has been often used to triangulate findings generated from quantitative research methods such as statistical analysis, numerical simulation and experimental analysis. This study also used a real construction corruption case to triangulate the findings from the stepwise multiple regression analysis and the partial least squares structural equation modeling analysis.

Results

Factor Analysis

Table 3 shows the factor analysis result of the irregularities related to corruption. The KMO value was 0.863, which was higher than the threshold of 0.5 (Norušis 2008); the total variance explained was 61.62%, which was higher than the common threshold of 60% in social science research (Hair et al. 2010). Bartlett's test of sphericity produced an approximate chi-squared value x^2= 1,308.051 (degrees of freedom = 276, p = 0.000), indicating the high correlations among IRCs (Dziuban and Shirkey 1974). Thus, all the statistical parameters were acceptable, proving the appropriateness of conducting factor analysis. Based on the factor analysis results, five specific irregularities related to corruption, namely, IRC6, IRC8, IRC13, IRC14, and IRC17, were excluded from the final framework due to the low factor loadings less than 0.5 (Hair et al. 2010). The other 19 irregularities were categorized into five underlying factors, namely (1) immorality, (2) unfairness, (3) opacity, (4) procedural violation, and (5) contractual violation, which was basically aligned to the findings from Tabish and Jha (2011).

(Please insert Table 3 here.)

Stepwise Multiple Regression Analysis Results

Stepwise multiple regression analysis was conducted between five underlying factors of corruption as the independent variables and the overall corruption situation in the Chinese public construction sector as the dependent variable, with the aid of SPSS 17.0. Input of the five underlying factors of corruption were the factor scores obtained from previous factor analysis on diverse irregularities related to corruption. As recommended by Chan et al. (2001), an entrance criterion was set in which an F statistic must be significant at the level of 0.01. Table 4 shows that the regression model consisting of five UFCs has a R^2 value of 0.68, and was significant at the level of 0.01. The result indicated that the five underlying factors of corruption contributed significantly to the overall corruption situation. In addition, immorality is the most influential underlying factor of corruption with a standardized coefficient of 0.38, followed by unfairness (0.31), opacity (0.27), procedural violation (0.23), and contractual violation (0.17).

(Please insert Table 4 here.)

Partial Least Squares Structural Equation Modeling Analysis Results

To conduct partial least squares structural equation modeling analysis, a hypothesized structural equation model was established, as shown in Figure 1. The hypothesized model consisted of six measurement models and a structural model. Among the six measurement models, one measured the overall corruption situation, and the other five measured various underlying factors of corruption. The structural model measured the relationships between five underlying factors of corruption and the overall corruption situation, hypothesizing that the five underlying factors of corruption were positively correlated to the overall corruption situation in the Chinese public construction sector.

(Please insert Figure 1 here.)

Data collected from the questionnaire were inserted into Smart PLS 2.0M3 to test the hypothesized model. Three indicators, namely, composite reliability (CR), loadings of observed variables on the latent variable, and average variance extracted (AVE), were examined to evaluate the reliability and validity of the measurement models. Results listed in

Table 5 showed that (1) the loadings of all the irregularities related to corruption on their corresponding underlying factors of corruption were greater than 0.4, indicating an acceptable indicator reliability (Ning and Ling 2013; Zhao et al. 2015); (2) the CR values were higher than 0.7, suggesting a satisfactory level of internal reliability of irregularities related to corruption with their corresponding underlying factors of corruption (Hair et al. 2011); and (3) the AVE values were higher than 0.5, showing a satisfactory level of convergent validity for the underlying factors of corruption (Hair et al. 2011). Moreover, results in Table 6 showed that the AVE of each underlying factor of corruption was higher than its squared correlation with any other underlying factor of corruption; results in Table 7 indicated that each irregularity had the highest loading on its corresponding underlying factor of corruption. Results in Table 6 and Table 7 suggested that these underlying factors of corruption had a high discriminant validity (Hair et al. 2011; Ning and Ling 2013).

(Please insert Table 5 here.)

(Please insert Table 6 here.)

(Please insert Table 7 here.)

Results in Table 8 showed the path coefficients and corresponding *t*-statistics of the structural model. The five paths have t-values greater than 2.58, indicating that these paths are statistically significant at the 0.01 level (Hair et al. 2011). Therefore, the hypotheses of five underlying factors of corruption positively correlated with the overall corruption situation are supported. Moreover, based on the path coefficient results, immorality is the most influential underlying factor of corruption, followed by opacity, unfairness, procedural violation, and contractual violation. These results were aligned with the stepwise multiple regression analysis results.

(Please insert Table 8.)

Case Study

In this section, a prosecuted corruption case was scrutinized to triangulate the research findings obtained from the stepwise multiple regression analysis and structural equation modeling analysis. On 15 November 2010, a residential building under energy efficiency retrofit in Jingan District, Shanghai was burnt down, resulting in the loss of 58 lives, injury to 71 people, and economic losses of CNY 158 million (approximately USD 25.5 million). On the surface, the case appeared to be a construction safety accident. However, the official investigation report revealed that the root cause of the accident was typically corruption (Xinhua Net 2010). In addition, as been widely reported by the media, numerous concrete details of this case were available to the public. Thus, this study selected this case to carry out the triangulation work. The specific details of the case are as follows.

The renovated energy saving project was initiated by Jingan District Construction and Traffic Committee (JDCTC), the local construction administration department. Provisionally and arbitrarily proposed by the chief director of JDCTC, the project was not in JDCTC's normal work plan; thus, it received no due administrative approval and legal financial provisions. The general manager of a local contractor, Shanghai Jiayi Construction and Decoration Co. Ltd. (SJCD), has an intimate relationship with the chief director of JDCTC, who suggested that the project be awarded to SJCD even when the project was still at the conception stage. Nevertheless, SJCD did not meet the due qualification requirements for contracting the project. Under such a circumstance, the chief director of JDCTC arranged the project to be awarded first to Jingan General Construction Company (JGCC), who met the contracting qualification requirements, which would then subcontract the project to SJCD. However, even JGCC was not on the shortlist of eligible candidate companies that could contract for renovated energy saving projects in the Jingan District. Thus, the chief director of JDCTC decided arbitrarily to update the shortlist to include JGCC.

As a recommended consulting company of JDCTC, Shanghai Fuda Engineering Management Consulting Co. Ltd. (SFEMC) secured the bidding consultancy contract of the project. Based on the contract, SFEMC was responsible for administering the bidding procedures for the project on behalf of JDCTC. Considering that the project would be eventually awarded to SJCD, which was not qualified to contract the entire project, SFEMC proposed an illegal bidding mode that would help SJCD secure the project in a speciously legal manner. Under the proposed bidding model, the entire renovated energy saving project was split into three small projects, each of which SJCD was nominally qualified to undertake legally. From the three small projects, one was selected for bidding. As planned, the project was awarded to SJCD. The other two were awarded directly to SJCD with an excuse that the two other projects were highly similar to the project that was submitted for bidding. Thus, additional bids were unnecessary.

SJCD was not a qualified candidate contractor that could undertake a renovated energy saving project in the Jingan District; thus, SJCD participated in the project bidding in the name of JGCC. Based on the arrangement made by a staff member from JDCTC, two construction companies, together with JGCC, submitted bidding documents. However, all bidding documents were actually prepared by SJCD and even the representatives of the three companies attending the bidding meeting were all from SJCD. Finally, the project was awarded to JGCC and then subcontracted to SJCD, as planned. Although SJCD secured the project, it was unable to undertake it because the company only had ten employees. Subsequently, SJCD divided the project into three parts, namely, the energy saving branch, the scaffolding branch, and the aluminum window branch. SJCD then subcontracted these parts to different contractors. However, such subcontracting violates the construction law of China.

Using the Shanghai Dimu Property Management Co. Ltd. (SDPM) as a front company, two local merchants secured the scaffolding branch by bribing a deputy general manager of SJCD. Subsequently, the two merchants illegally subcontracted the scaffolding branch further to a welding foreman. The welding foreman then hired two frontline workers to implement the welding operation. One of these frontline workers had an outdated welding operation certificate, whereas the other did not possess such a certificate at all. With the help of a staff member from JDCTC, the Shanghai Zhengjie Energy Saving Engineering Co. Ltd. (SZESE) secured the energy saving branch from SJCD and supplied the supposedly flame-retardant insulation materials for the project.

On 15 November 2010, a flash spark from the illegal welding operation of the two unqualified frontline workers ignited the insulation materials that led to the disaster. The network of the related parties in this case was depicted as shown in Figure 2.

(Please insert Figure 2 here.)

After scrutinizing the case, 21 irregularities related to corruption were spotted and categorized under different underlying factors of corruption, as shown in Table 9. Results in

Table 8 showed that immorality had the highest frequency (7), followed by opacity (5), unfairness (4), procedural violation (3), and contractual violation (2). This case study triangulated the findings obtained from the statistical analysis results that immorality was the most influential underlying factor of corruption in the Chinese public construction sector, followed by opacity, unfairness, procedural violation, and contractual violation.

(Please insert Table 9 here.)

Discussions and Recommendations

Stepwise multiple regression analysis, structural equation modeling analysis, and the case study achieved the same findings: immorality was the most influential underlying factor of corruption in the Chinese public construction sector, followed by opacity, unfairness, procedural violation, and contractual violation. The five underlying factors of corruption are discussed as follows.

In this study, immorality was regarded as the most influential underlying factor of corruption. According to Letki (2006), immorality can be explained as a type of behavior that is in active opposition to a body of standards or principles that are considered good and right. Corruption means the violation of moral laws, norms, standards, virtues, and values that characterize society (Besio and Pronzini 2014). Thus, most corrupt practices have the characteristics of immorality. Specific to the construction sector, if good morals exist among practitioners, clients should refuse to collude with tenderers and secure open, just, and fair biddings; contractors should construct projects rigorously based on the original designs instead of proposing as many construction changes as they can to reap extra profit; site supervisors should be loyal to their duties to exercise strict supervision even though they are offered bribes by ill-disposed contractors or suppliers. Unfortunately, construction practitioners seem to have a poor record in this regard (Sohail and Cavill 2008; Tabish and Jha 2012). To address this issue, Frankel (1989) suggested that more input should be directed to improving morals of construction professionals and in this regard, professional codes are effective instruments. A profession's code is the most visible and explicit enunciation of its professional norms. The code embodies the collective conscience of a profession and is a testimony to the group's recognition of its moral dimension (Frankel 1989). Hence, sound and clear professional codes can definitely restrain the acts of practitioners and thus curb corruption in the construction sector.

Opacity was assessed as the second most influential underlying factor of corruption. A large body of literature has proved that opacity is a fertile ground for corruption in the construction sector because it hinders the public from accessing project information and disallows the monitoring of corrupt practices (Sohail and Cavill 2008; Tabish and Jha 2011). Opacity is a crucial issue especially in awarding projects. For instance, a large public project may be clandestinely split into several small projects by corrupt government officials or client staff, and then contracted directly to the companies that they prefer. This misconduct is notorious in China, even in national-level public projects, such as the Three Gorges Dam (Xinhua Net 2014). Furthermore, opacity is also a significant concern in the bidding evaluation process, which is not usually accessible to all the tenderers in China (Jiang and Feng 2007). Thus, the corrupt members of the bid evaluation panel may provide biased evaluations in favor of those who have bribed them. The mechanism of transparency should be used to fight against opacity. This mechanism can bring project information to the thorough supervision of the public; such information includes decision making, project approval, project bidding, and progress of project implementation. Two specific measures have been suggested as follows: (1) an open hearing should be conducted before the start of a public project. The hearing must involve government officials, residents around the project, and experts with diverse professional backgrounds, such as urban planning, archeology, environmental protection, civil engineering, and construction. The hearing can ensure that the decision-making process is transparent and fair; and (2) information, including project properties, bidding, plans, and implementation, should be publicly announced. In particular, a website should be established to ensure that project information can be tracked, thereby enabling the public to monitor the project.

The third most influential underlying factor of corruption was unfairness. Inevitably, corruption causes unfairness because corruptors provide unequal treatment between corrupt and incorrupt companies. A considerable literature has also proved that corruption is consistently the source of unfairness in construction projects (Bowen et al. 2007a; b; Tabish and Jha 2011). Similar to opacity, unfairness is particularly prominent in awarding the project. For instance, a client could set some extreme requirements to exclude qualified tenderers from the bidders' list and only allow the "favored" tenderer to participate in the bidding, which runs counter to the rule of fair competition. In another case, a client may relax the conditions and requirements for the unqualified companies who pay them bribes. A client may also intentionally disclose some underlying confidential information to its preferred tenderer to ensure that it would win the contract. Given that unfairness could be most easily perceived by industry practitioners, a safe reporting channel should be a useful tool to curb unfairness in construction projects.

This study revealed that procedural violation was an essential part of the vulnerabilities to corruption in the Chinese public construction sector, which was consistent with the findings of previous studies of corruption in other countries, such as Nigeria (Alutu and Udhawuve 2009), South Africa (Bowen et al. 2012), India (Tabish and Jha 2011; 2012), and Turkey (Gunduz and Önder 2013). Procedural violation mainly refers to misconduct that are non-compliant with the routine principles and procedures of project procurement and construction (Tabish and Jha 2011). For instance, a project proceeding without administrative approval from a local construction administration department (Xinhua Net 2011); project funds being embezzled by corrupt governmental officials (Deng et al. 2003); and a project originally designed and sanctioned as a public utility ultimately being constructed as a commercial utility (Hebei News 2013). To curb procedural violation, an independent third party should be introduced to supervise the implementation of diverse procedures in the public construction sector. This institution should have no conflict of interest with any of the contracting parties, not even with the local authorities. Only then can the independence of the institution be assured, which forms the basis for objective and strict supervision.

Contractual violation mainly refers to the non-compliance with or the misuse of contract provisions. For instance, contractors may not deploy sufficient technical staff and equipment in construction sites as stipulated in the contract, which is quite common in China. However, only a few contractors were reported to have been blamed or fined for this violation, which could be attributed to the corrupt relationship between contractors and clients. In addition, the escalation clause has been widely misused by corrupt client staff and contractors to gain improper profits (Lan 1999; Ye et al. 2013). For example, client staff may actively approve the material inflation claim proposed at an unreasonably high price by a contractor for the promised kickbacks. As for the strategy to curb contractual violation, a standardized, clear, and concise tender document should be helpful, as would a combination of regulatory and provisional auditing. However, similar to the recommendation for curbing procedural violation, the institution providing the auditing service must also be an independent third party.

Conclusions

Recently, researchers have started to pay close attention to the corruption issues in the public construction sector, a sector that has been continuously regarded as the most corrupt sector around the world (Transparency International 2008, 2011). Existing research interests on corruption in the public construction sector mainly focus on identifying the irregularities related to corruption (Tabish and Jha 2011), investigating the principal causes of corruption (Le et al. 2014b), evaluating the effectiveness of anti-corruption strategies (Tabish and Jha 2012; Shan et al. 2015a), and measuring corruption in public construction projects (Shan et al. 2015b). However, few research efforts have been devoted to explore the properties of corruption in the public construction sector. Thus, facilitated by a series of qualitative and quantitative research methods such as a structured interview, a questionnaire survey and a case study, this study explored the underlying factors of corruption in the Chinese public construction sector. Results showed that immorality was the most influential underlying factor of corruption in this sector, followed by opacity, unfairness, procedural violation, and contractual violation.

Although the research aims have been achieved, some limitations are still present. First, due to the limited research of irregularities related to corruption in the current literature, this study can only rely on the Tabish and Jha (2011) framework to develop its theoretical framework, which made the theoretical foundation of this study less convincing. Second, the non random sampling methods adopted in this study reduced the likelihood that the sample could have represented a good cross section from the whole population. Thus, caution should be warranted when analysis results are interpreted and generalized. Third, this study merely used one simple perception-based question to measure the overall corruption situation in the Chinese public construction sector, and the assessments derived from this measuring strategy might be subjective, vague and cannot reflect the real corruption situation in the sector. Fourth, the findings from this study mainly applied to the context of public construction sector in China, which might vary in other countries.

In spite of these limitations, the findings from this study are still valuable because they have provided the industry and academia with an in-depth understanding of the properties of corruption in the public construction sector. In particular, the construction authorities could develop more effective anti-corruption strategies based on the implications of this study. For further research actions, a social network analysis could be conducted among the diverse corrupt parties to investigate their interactions. Also, it would be interesting to examine the ethical decision-making of those practitioners working on public construction projects.

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Appendix

Table 1 IRCs identified from structured interviews

Code [a]	Irregularity related to corruption
IRC1	Administrative approval and financial sanction not taken even before the work starts.
IRC2	The provisions are not as per the laid down yardstick.
IRC3	Work is not executed for the same purpose for which the provisions were sanctioned.
IRC4	The consultant is not appointed after proper publicity and open competition.
IRC5	The criteria adopted in prequalification of consultant are restrictive and benefit only few consultants.
IRC6	The selection of consultant is not done by the appropriate authority.
IRC7	Adequate & wide publicity is not given to tender.
IRC8	Adequate time for submission of tender/offer not given.
IRC9	Prequalification criteria for selection of contractor are stringent.
IRC10	The evaluation of tenders is not done exactly as per the notified criteria.
IRC11	The negotiation on the tender not done as per the laid down guidelines.
IRC12	The conditions/specifications are relaxed in favor of the contractor to whom the work is being awarded.
IRC13	The work order/supply order is not placed within justified rates.
IRC14	Work is executed without the availability of funds for the said purpose.
IRC15	The work is not executed as per the original design.
IRC16	Compliance with conditions regarding obtaining licenses, insurance policies and deployment of technical staff not being followed by contractor.
IRC17	The proper record of hindrances is not being maintained from the beginning.
IRC18	The deviations, especially in abnormally high rated and high value items are not properly monitored and verified.
IRC19	The escalation clause is not applied correctly for admissible payment.
IRC20	A large project that should have called for bids is split into several small projects and contracted without bidding.
IRC21	Contractors provide false certificates in bidding.
IRC22	Confidential information of bidding is disclosed to a specific bidder.
IRC23	Substitution of unqualified materials in construction.
IRC24	Site supervisor neglects his duties by taking bribes from contractor.

[a] IRC = irregularity related to corruption

Table 2 Profile of the respondents

Personal attributes	Categories	Number of respondents	Percentage
Organization	Government	20	10.6
	Client	43	22.9
	Contractor	43	22.9
	Consultant	46	24.5
	Designer	26	13.8
	Academic	10	5.3
Position	Top managerial level (e.g. director, general manager, professor)	49	26.1
	Middle managerial level (e.g. project manager)	88	46.8
	Professional (e.g. engineer, quantity surveyor)	51	27.1
Years of experience	>20	24	12.8
	11-20	40	21.3
	6-10	76	40.4
	<5	48	25.5
Working place*	Eastern China	63	33.5
	Central China	55	29.2
	Western China	37	19.7
	Northeastern China	33	17.6

Table 3 Factor analysis result of IRCs

IRC	UFC[b]					New code
	UFC1: Immorality (IMM)	UFC2: Unfairness (UNF)	UFC3: Opacity (OPA)	UFC4: Procedural violation (PRV)	UFC5: Contractual violation (COV)	
IRC1				0.74		PRV1
IRC2				0.71		PRV2
IRC3				0.64		PRV3
IRC4		0.80				UNF1
IRC5		0.85				UNF2
IRC6		0.45[a]				-
IRC7			0.72			OPA1
IRC8			0.48[a]			-
IRC9		0.71				UNF3
IRC10			0.75			OPA2
IRC11			0.76			OPA3
IRC12		0.64				UNF4
IRC13					0.44[a]	-
IRC14	0.47[a]					-
IRC15	0.73					IMM1
IRC16					0.57	COV1
IRC17				0.44[a]		-
IRC18	0.70					IMM2
IRC19					0.75	COV2
IRC20			0.62			OPA4
IRC21	0.67					IMM3
IRC22		0.65				UNF5
IRC23	0.74					IMM4
IRC24	0.75					IMM5
Variance explained (%)	33.68	9.72	6.64	6.30	5.28	
Cumulative variance explained (%)	33.68	43.40	50.04	56.34	61.62	

[a] IRC was excluded due to a factor loading less than 0.5.

[b] UFC = underlying factor of corruption

Table 4 Stepwise multiple regression analysis results

Underlying factors of IRCs	Unstandardized coefficients (β)	Standard error	Standardized coefficients (β)	*t*	Significance
UFC1: Immorality	0.16	0.01	0.38	25.36	0.00
UFC3: Opacity	0.13	0.01	0.31	20.84	0.00
UFC2: Unfairness	0.11	0.01	0.27	20.44	0.00
UFC4: Procedural violation	0.10	0.01	0.23	17.15	0.00
UFC5: Contractual violation	0.07	0.01	0.17	13.67	0.00
Constant	3.17	0.01		670.01	0.00
R^2	0.68				

Table 5 Evaluation results of the hypothesized model

Construct	Code	Loading	T-value	AVE	CR
IMM	IMM1	0.67	12.31	0.55	0.72
	IMM2	0.50	8.77		
	IMM3	0.50	8.84		
	IMM4	0.62	11.11		
	IMM5	0.64	10.53		
UNF	UNF1	0.62	10.72	0.57	0.74
	UNF2	0.54	11.38		
	UNF3	0.56	11.08		
	UNF4	0.49	8.73		
	UNF5	0.44	4.89		
OPA	OPA1	0.62	8.84	0.59	0.71
	OPA2	0.57	10.64		
	OPA3	0.61	11.64		
	OPA4	0.41	4.50		
PRV	PRV1	0.59	11.65	0.57	0.73
	PRV2	0.48	7.93		
	PRV3	0.50	8.48		
COV	COV1	0.73	16.92	0.57	0.79
	COV2	0.56	8.28		
OCS	OCS	0.82	17.26	0.69	0.77

Table 6 Correlation matrix and the square root of each UFC's AVE

	COV	**OCS**	**IMM**	**OPA**	**PRV**	**UNF**
COV	**0.76**[a]					
OCS	0.72	**0.83**[a]				
IMM	0.64	0.70	**0.74**[a]			
OPA	0.39	0.74	0.43	**0.77**[a]		
PRV	0.42	0.68	0.42	0.43	**0.76**[a]	
UNF	0.54	0.71	0.52	0.51	0.51	**0.75**[a]

[a] square root of each UFC's AVE

Table 7 Cross loadings for IRCs

	COV	OCS	IMM	OPA	PRV	UNF
COV1	**0.73**	0.54	0.46	0.32	0.33	0.42
COV2	**0.56**	0.38	0.37	0.17	0.20	0.26
OCS	0.30	**0.82**	0.33	0.31	0.28	0.33
IMM1	0.48	0.56	**0.67**	0.31	0.26	0.42
IMM2	0.30	0.41	**0.49**	0.20	0.22	0.22
IMM3	0.28	0.39	**0.50**	0.20	0.17	0.25
IMM4	0.38	0.48	**0.62**	0.30	0.26	0.27
IMM5	0.40	0.51	**0.64**	0.23	0.31	0.34
OPA1	0.17	0.39	0.12	**0.62**	0.23	0.25
OPA2	0.29	0.45	0.25	**0.57**	0.23	0.36
OPA3	0.20	0.46	0.28	**0.61**	0.31	0.32
OPA4	0.19	0.28	0.28	**0.41**	0.13	0.12
PRV1	0.20	0.38	0.21	0.28	**0.59**	0.30
PRV2	0.21	0.31	0.15	0.20	**0.48**	0.25
PRV3	0.25	0.37	0.29	0.19	**0.50**	0.25
UNF1	0.33	0.45	0.28	0.24	0.32	**0.62**
UNF2	0.29	0.39	0.23	0.19	0.25	**0.54**
UNF3	0.31	0.49	0.29	0.38	0.34	**0.56**
UNF4	0.20	0.39	0.28	0.29	0.13	**0.49**
UNF5	0.24	0.33	0.25	0.16	0.24	**0.44**

Table8 Evaluation results of the Structural Model

Paths	**Hypothesized sign**	**Path coefficient**	***t*-value**	**Inference**
IMM→OCS	+	0.34	15.53	Supported
UNF→OCS	+	0.30	15.19	Supported
OPA→OCS	+	0.31	15.09	Supported
PRV→OCS	+	0.19	11.39	Supported
COV→OCS	+	0.15	8.08	Supported

Table 9 Irregularities related to corruption involved in the case

UFC	Irregularities related to corruption	Frequency
Immorality	Being organized by the staff of JDCTC, a fake bidding was conducted and the project was awarded to JGCC as planned.	7
	JGCC, the company serving as the front contractor of the project, was affiliated with JDCTC, namely the client of the project.	
	The Chief Director of JDCTC actively recommended the project to be awarded to SJCD even though it has poor records in construction safety.	
	An official of JDCTC helped SZESE secure the subcontract of insulation materials branch illegally.	
	The insulation materials provided by SZESE were not specified as the flame retarded as they should be.	
	The two local merchants secured the subcontract of scaffolding branch by utilizing SDPM as a front company.	
	The chief site supervisor neglects his duties in that he did not halt construction work even as he had found the project was ongoing without due administrative approval as well as a detailed construction scheme.	
Opacity	The chief director of JDCTC designated SJCD to undertake the project even before the project was started.	5
	When he was told that SJCD could not undertake the project subject to the fact that it did not satisfy the due qualification requirement, the chief director of JDCTC proposed to award the project to JGCC first and then subcontract it to SJCD.	
	SFEMC proposed to split the entire project into three small projects to make sure SJCD would undertake the project as a nominally legitimate.	
	To award the project to JGCC, the chief director of JDCTC made JGCC an eligible candidate company who could undertake a renovated energy saving project in the Jingan District by updating the candidate shortlist optionally.	
	The supplier of insulation materials was determined in advance under the influence from the JDCTC officials.	
Unfairness	SFEMC, the bidding consultancy for the project, was not appointed after an open competition.	4
	The site supervisor was not appointed after proper publicity and open competition. In reality the appointed site supervisor has a direct conflict of interest with the project client.	
	An invited bidding was conducted to determine the suppliers of insulation materials, which should have been an open bidding based on the regulations.	
	The bid evaluation panel provided a biased evaluation to the favored supplier of insulation materials.	
Procedural violation	Being proposed provisionally the project was out of JDCTC's normal work plan.	3
	The chief director of JDCTC, sanctioned the project illegally.	
	The project lacked financial provisions.	
Contractual violation	Being incapable to implement the project, SJCD subcontracted the project to different subcontractors illegally.	2
	The majority contracts were signed in the name of JGCC but using the stamp of SJCD.	

11