

Empirical Study of Risk Assessment and Allocation of Public-Private Partnership Projects in China

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Abstract: Earlier research studies on public-private partnership (PPP) indicated that an objective, reliable, and practical risk assessment model for PPP projects and an equitable risk allocation mechanism among different parties are crucial to the successful implementation of these PPP projects. However, actual empirical research works in this research area are limited. This paper reports the first stage of a research study, which aims to identify and assess the principal risks for the delivery of PPP projects in China and to address their proper risk allocation between the private and public sectors. An empirical questionnaire survey was designed to examine the relative importance of different risk factors and to analyze the allocation of risk factors to different parties in PPP projects. A total of 580 questionnaires were sent out, and a total of 105 valid responses were obtained for data analysis. The Mann-Whitney U test is employed to investigate whether significant difference in perception existed first between the private and public sectors and second between industrial practitioners and academics in China. The empirical findings show that the three most important risk factors for PPP projects in China are (1) government intervention; (2) government corruption; and (3) poor public decision-making processes. These findings reveal that the Chinese government intervention and corruption may be the major obstacles to the success of PPP projects in China. A major cause for these risks may be attributed to inefficient legislative and supervisory systems for PPP projects in China. After conducting the Mann-Whitney U test on the 105 survey respondents, the empirical findings indicate that the perceptions of all 34 risk factors in China between the private and public sectors were not significantly different. Similarly, there were no significant differences between academics and industrial practitioners except that the former perceived the problem of government corruption to be more severe than did the latter. For risk allocation, the empirical results indicate that the public and private sectors were in general consensus with most of the risks identified. The major risks that the public sector preferred to accept are within the systematic risk category, especially political, legal, and social risks. The private sector preferred to retain the principal risks within the specific project risk category, especially construction, operation, and relationship risks, in addition to economic risks within systematic risk category. The remaining risk, environment risk, is preferred to be shared between the two sectors. This research study enables international construction companies to better understand how risks should be assessed and allocated for PPP projects in China. It also assists in risk response planning and control for future PPP projects in China. DOI: 10.1061/(ASCE)ME.1943-5479.0000049. © 2011 American Society of Civil Engineers.

CE Database subject headings: Private sector; Partnerships; Risk management; China.

Author keywords: Public-private partnerships (PPP); Risk assessment; Risk allocation; Risk management; China.

Introduction

China is one of the most densely populated countries in the world. The estimated urban population in China is projected to increase to approximately 827 million in 2025 (United Nations 2004). To

alleviate the negative impact of unorganized urbanization growth, mass rapid transit has been prioritized as a key transport mode in mega cities. Other public facilities are also in high demand to cope with the increasing urbanization growth. However, inadequate government funding may limit the development of these projects. Public-private partnership (PPP) financing modalities have been identified as innovative tools for financing major infrastructure projects.

PPPs or private finance initiatives (PFI) originally arose in the United Kingdom (UK) during the late 1980s and early 1990s (Tieman 2003; Li et al. 2005). Since their introduction, PFIs have become the UK government's preferred method of public infrastructure procurement (Handley-Schachler and Gao 2003). In general, PPP is regarded as a general term covering all contracted relationships between the public and private sectors to produce an asset or deliver a service. The Hong Kong Efficiency Unit (2008) suggested that PPPs are collaborations in which the public and private sectors both bring their complementary skills to a project, with different levels of involvement and responsibility, for the sake of providing public services more efficiently. The European Commission (2004) defined PPP as forms of cooperation between public authorities and the world of business aiming to ensure the funding, construction, renovation, management, and maintenance of an infrastructure project. The International Monetary

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Note. This manuscript was submitted on August 11, 2009; approved on October 28, 2010; published online on October 30, 2010. Discussion period open until December 1, 2011; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Management in Engineering*, Vol. 27, No. 3, July 1, 2011. ©ASCE, ISSN 0742-597X/2011/3-136-148/\$25.00.

Fund (2006) referred to PPPs as arrangements in which the private sector supplies infrastructure assets and services that have been traditionally provided by the government.

In practice, PPP has been commonly adopted in sectors that offer the most potential for commercial opportunities such as energy supply (Pongsiri 2004), telecommunications, road and rail transportation (Mass Transit Railway Corporation Limited 2008), public housing (Hong Kong Efficiency Unit 2003a), health care and hospitals (Hong Kong Efficiency Unit 2003b), water supply and treatment (Grimsey and Lewis 2002; Chiu and Bosher 2005), e-Government (Sharma 2007), life sciences (Chataway and Smith 2006), container terminals, (Wiegman et al. 2002), helicopter and vehicle service (Hong Kong Efficient Unit 2003c), schools (Utt 1999), correctional facilities (Hong Kong Efficiency Unit 2003d), and defense (Parker and Hartley 2003).

In recent years, with the rapid growth of economic development in China, PPP is well received and widely adopted by the Chinese government to procure the public infrastructures via private finance. Projects like the "Bird Nest" (2008 Olympiad Games Gymnasium) and Beijing Metro Line 4 (BJL4) are some renowned PPP projects in China. However, when compared with other advanced countries, PPP in China is by no means mature. A number of privately financed projects have been reported as unsuccessful (Wang 2001). Previous studies on PPP indicated that an objective, reliable, and practical risk assessment model for PPP projects and a fair risk allocation mechanism among different parties are essential for the success of PPP projects (Grant 1996; HM Treasury 2000; Li et al. 2005; Jin and Doloi 2008). However, empirical works in this research area are limited. This paper reports the first stage of a funded research study that aims to identify and assess the major risks for the delivery of PPP projects in China, and to address their proper risk allocation.

Previous Research Studies on Risk Management in PPP Projects

Delmon (2000) suggested that the impact of risks in implementing a PPP project is usually significant. These risks arise from multiple sources including capital budget, construction time, construction cost, operation cost, politics and policies, market conditions, cooperation credibility, and economic environment. In spite of the perceived advantages of PPP, various risks and uncertainties often hold the government back and make the consortium go bankrupt. Examples include political risk in two build-operate-transfer projects in Thailand (Ogunlana 1997) and project delay risk in the Euro Tunnel (Francis 1993). Therefore, it is essential for the public clients and the private bidders to evaluate and allocate properly all potential risks throughout the whole project life cycle.

Grimsey and Lewis (2002) opined that much of the risk of PPP projects comes from the complexity of the arrangement itself in terms of documentation, financing, taxation, technical details, and subagreements involved in a major infrastructure venture, while the nature of the risk changes over the duration of the projects. Systematic risk management allows early detection of risks and encourages the PPP stakeholders to identify, analyze, quantify, and respond to the risks, as well as to take measures to introduce risk mitigation policies (Broome and Perry 2002; Akbiyikli and Eaton 2004). A fundamental principle is that risks associated with the implementation and delivery of services should be allocated to the party best able to manage the risk in a cost-effective manner (Hong Kong Efficiency Unit 2003a). However, Roumboutsos and Anagnostopoulos (2008) found that there are risks that the private sector is reluctant to absorb from the public sector. Examples

include inflation rate, exchange rate, interest rate fluctuation, and delays in project approvals and permits.

Wang et al. (2004) identified and evaluated the multifaceted risks and their effective mitigation measures associated with international construction projects, particularly in developing countries. A risk model, named Alien Eye's Risk Model, was proposed to show the hierarchical levels of the risks and the influential relationship among the risks in a risk influence matrix. In addition, a qualitative risk mitigation framework was developed to provide detailed risk management strategies and procedures.

Zhang (2005) analyzed the critical success factors for PPP projects in infrastructure development. A number of rank agreement factor (RAF), namely, (1) concession agreement, (2) loan agreement, (3) guarantees/support/comfort letters, (4) supply agreement, (5) operation agreement, (6) off-take agreement; (7) design and construct contract, (8) shareholder agreement, and (9) insurance agreement were found to be essential in ensuring PPP success.

Li et al. (2005) presented a process of negotiation for risk allocation. The process combines a systematic risk-management approach for construction projects proposed by Al-Bahar and Crandall (1990) with the principle of risk-sharing in PPP/PFI procurement supported by Grant (1996) and HM Treasury (2000). Under the proposed framework, the public sector sponsor identifies the risks attached to the project in a risk register, sets out the risks relevant to each stage of the project, the likelihood of occurrence for each risk event and an estimate of the financial consequences. The analysis helps the public client establish the type and quantum of risks that it seeks to transfer to the private sector. They found that the public sector partner should retain site availability and political risks. Relationship risks, force majeure risks, and the risks of legislation changes should be shared by both private and public sectors. The majority of the remaining project risks, especially those at the meso risk level (i.e. directly associated with the project itself), should be allocated to the private sector partner.

Sachs et al. (2007) provided insight into the opportunities and impact of political risks in China and 14 Asian countries on opportunities in infrastructure projects under PPP schemes. Sachs and Tiong (2009) proposed a method to quantify qualitative information on risks (QQIR). This method bridges the gap between qualitative and quantitative risk assessment methods. It employs fuzzy set theory and results in deriving customized probability density functions for stochastic applications in risk assessment and financial modeling. Jin and Doloi (2008) conducted an empirical study in a transaction cost economic perspective to interpret the risk allocation mechanism. Multiple linear regression was used to develop models to determine the causal relationship between explanatory and response variables of an operationalized theoretical framework for risk allocation in PPP projects. They recommended that nonprobability-based analytical techniques and consideration of the nonlinear relationship should be applied in future research. To analyze the expansion of Madrid-Barajas's subway network to the international airport, Soliño and Vassallo (2009) found that nonintegrated PPP contracts have important advantages for urban rail PPP, particularly for conventional subway networks. These advantages are notable in terms of encouraging economies of scale and density, boosting competition, and reducing the financial costs. Yuan et al. (2010) proposed 15 performance objective attributes, based on the perspectives of different stakeholders, to implement complete and effective performance management in PPP projects. Chan et al. (2010) conducted an empirical study and found that the top three obstacles rated by the Hong Kong respondents were (1) lengthy delays because of political debate, (2) lengthy delays in negotiation, and (3) very few schemes have actually reached the contract stage (aborted before contract).

After a review of the contemporary literature, it was found that numerous studies focus on risk identification and allocation for the delivery of PPP projects in western countries. However, few, if any, studies focus on identifying and assessing the risks for procuring PPP projects in China and addressing their proper allocation. For this reason, this paper aims to fill this research gap.

Research Methodology

Identification of Significant Risk Factors for PPP Projects

Although various definitions of risk reside in different people's minds, risks always exist in construction projects and often cause schedule delay or/and cost overrun. PPP projects are no exception. Risk management is a key issue in project management. The identification and management of risks is a core design of any PPP

procurement. The first step of risk management is risk identification. It includes the recognition of potential risk event conditions in a project and the clarification of risk responsibilities. A total of 34 risk factors for PPP projects were identified after conducting an extensive literature review (Table 1). Then, a questionnaire survey was conducted to identify the most significant risk factors for PPP projects in China and to investigate the perceptions of industrial practitioners and academics on risk allocation. The target survey respondents included industrial practitioners in the public and private sectors who have been involved in risk management of PPP projects in China; and academics who have been involved in the research of PPP projects in China. These respondents either have rich hands-on working experience in procuring PPP projects in China or have extensive research experience in PPP research studies. The respondents were asked to rate each risk factor using a five-point Likert scale from a consolidated conceptual framework of all 34 PPP risk factors identified from the literature.

Table 1. Risk Factors Associated with PPP Projects

Risk factors	Gallimore et al. (1997)	Salzmann and Mohamed (1999)	Kumaraswamy and Zhang (2001)	Grimsey and Lewis (2002)	Li et al. (2005)	Warburton and Baker (2005)	Shen et al. (2006)	Maslyukivska and Sohail (2007)	Ng and Loosemore (2007)	Estache et al. (2007)	Medda et al. (2007)	Zou et al. (2008)	Total number of hits of a certain risk factor
1. Government corruption			*			*		*				*	4
2. Government intervention			*			*	*		*			*	5
3. Nationalization/expropriation			*		*				*	*	*		5
4. Public credit					*				*			*	3
5. Third-party delay/violation					*								1
6. Political/public opposition		*		*	*					*		*	5
7. Imperfect law and supervision system							*	*					2
8. Legislation change	*		*	*	*		*	*	*	*			8
9. Interest rate fluctuation			*		*				*	*	*	*	6
10. Foreign exchange fluctuation		*	*	*					*	*	*	*	7
11. Inflation		*	*		*		*			*		*	6
12. Poor public decision-making process					*								1
13. Land acquisition	*				*					*			3
14. Delay in project approvals and permits	*				*		*		*				4
15. Conflicting or imperfect contract					*		*						2
16. Financing risk	*	*			*		*						4
17. Project/operation changes				*			*						2
18. Completion risk	*								*	*			3

Table 1. (Continued.)

Risk factors	Gallimore et al. (1997)	Salzmann and Mohamed (1999)	Kumaraswamy and Zhang (2001)	Grimsey and Lewis (2002)	Li et al. (2005)	Warburton and Baker (2005)	Shen et al. (2006)	Maslyukivska and Sohail (2007)	Ng and Loosemore (2007)	Estache et al. (2007)	Medda et al. (2007)	Zou et al. (2008)	Total number of hits of a certain risk factor
19. Material/labor nonavailability			*		*		*		*	*			5
20. Unproven engineering techniques							*		*	*			3
21. Unforeseen weather/geotechnical conditions					*				*				2
22. Operation cost overrun	*	*		*	*		*		*	*			7
23. Market competition (uniqueness)								*				*	2
24. Change in market demand			*	*	*					*	*	*	6
25. Price change			*	*					*				3
26. Expense payment risk							*		*				2
27. Lack of supporting infrastructure							*		*				2
28. Residual risk	*				*				*				3
29. Inadequate competition for tender								*					1
30. Inability of concessionaire									*	*			2
31. Force majeure		*	*	*	*				*	*			6
32. Organization and coordination risk					*		*		*				3
33. Change in tax regulation	*		*		*				*	*	*		6
34. Environment risk	*	*		*	*			*					5
	9	7	12	9	21	2	14	6	20	15	6	8	129

Typical risks reported from the PPP literature can be classified into two major categories: (1) systematic/country risks; and (2) specific project risks (United Nations Development Organization (UNIDO) 1996). The systematic/country risks are related to objective market environment, and they are always beyond the control of private investors. The specific project risks arise from the various nature of a project or from the events in the immediate micro-environment (Adams et al. 2006). The systematic/country risks include (1) political risks, (2) economic risks, (3) legal risks, (4) social risks, and (5) nature risks. The specific project risks encompassed (1) construction risks, (2) operation risks, (3) market risks, (4) relationship risks, and (5) other specific project risks. Further details on these risks can be seen in Table 2. A total of 34 risk factors can be grouped into these 10 key risk groups as follows, and their interpretations are illustrated in Table 3.

Empirical Research Questionnaire

A total of 580 questionnaires were sent out, and a total of 105 valid responses were obtained for data analysis. The questionnaire was used to examine the relative importance of different risk factors and to analyze how to allocate each risk factor to different parties when PPP projects are delivered. The questionnaire was divided into three parts. The first part provides the definitions of all 34 risk factors for PPP projects in China. The second part solicits the demographic information of respondents. The main purpose of this part is to collect the background information of the respondents to conduct subsequent comparative analyses. The third part is designed to evaluate the principal risks for the delivery of PPP projects in China and to analyze how to allocate each risk factor to different parties. A five-point Likert scale is used as a measurement scale. Regarding

Table 2. Systematic and Special Project Risk Descriptions

Systematic risk category	Risk descriptions
1. Political risk group	Government corruption, government intervention, nationalization/expropriation, public credit, poor public decision-making process
2. Economic risk group	Interest rate fluctuation, foreign exchange fluctuation, inflation, financing risk
3. Legal risk group	Legislation change, imperfect law and supervision system, change in tax regulation
4. Social risk group	Political/public opposition
5. Natural risk group	Force majeure, unforeseen weather/geotechnical conditions, environment risk
Specific project risk category	
6. Construction risk group	Completion risk, material/labor nonavailability, unproven engineering techniques
7. Operation risk group	Project/operation changes, operation cost overrun, price change, expense payment risk
8. Market risk group	Market competition, change in market demand
9. Relationship risk group	Third-party delay/violation, organization and coordination risk, inability of the concessionaire
10. Other risks	Land acquisition, delay in project approvals and permits, conflicting or imperfect contract, lack of supporting infrastructure, residual risk, inadequate competition for tender

the probability of occurrence and severity, the five-point Likert scale represents 1 = very low, 2 = low, 3 = average, 4 = high, and 5 = very high. Regarding the risk allocation, the five-point scale represents 1 = wholly allocated to the Chinese government, 2 = mainly allocated to the Chinese government, 3 = equally shared by the Chinese government and the private sector, 4 = mainly allocated to the private sector, and 5 = wholly allocated to the private sector. Table 4 shows the background information of the respondents. The respondents have to meet two criteria before being invited to participate in the survey, which include (1) having extensive working experience within the construction industry of China, and (2) having been involved in the management of PPP projects in China or have gained in-depth knowledge of the PPP model through research. In fact, nearly 80% of the respondents had at least 5 years of industrial experience. All respondents held positions in either high or middle level. Many of the respondents had been involved with more than one PPP project. The hands-on working experience and relevant organizations of the identified industry practitioners uphold the validity of this study.

Research Findings and Discussions

In the survey results, the mean rating was calculated for each risk factor of PPP projects in China on the basis of the associated Risk Probability and Risk Impact (Shen et al. 2001; El-Sayegh 2008). The rating of the Risk Significance is calculated by the product of Risk Probability and Risk Impact:

$$\text{Risk Significance} = \text{Risk Probability} \times \text{Risk Impact}$$

Table 5 shows the top 10 risk factors for the PPP projects in China on the basis of the value of mean rating of Risk Significance (scales 1–25). The most significant risk factor is Government Intervention, with the value of mean rating of Risk Significance equal to 15.17. The second risk factor is Government Corruption, with the value of mean rating of Risk Significance equal to 13.10. The third risk factor is Poor Public Decision-Making Process, with the value of mean rating of Risk Significance equal to 13.03. The top two risk factors indicate that Chinese government intervention and corruption put the PPP projects in high risks. This might be caused by inadequate legislative and supervisory systems for the PPP projects in China (this risk factor is ranked fifth). The third risk factor, Poor Public Decision-Making Process, is also related to the procedures and laws controlled by the Chinese government. Public credit ranked ninth. All these risk factors are related to the Chinese government, hence suggesting that government interven-

tion and corruption may be the major obstacles to the success of PPP projects in China. Wang et al. (2000) examined the political and force majeure risks associated with China's build, operate, and transfer (BOT) projects. Their research findings show that the top three critical risks were (1) Chinese entities' reliability, (2) change in law, and (3) force majeure. Government Corruption was ranked sixth in their study. Obviously, the significance of PPP risk factors has undergone some major changes in the previous decade.

Financing Risk was ranked fourth in this research study, possibly because the financing institutions have limited knowledge or/and trust in PPP projects in general. Project risks such as Operation Cost Overrun and Completion Risk took the sixth rank and the ninth rank, respectively. Another financial risk, Interest Rate Fluctuation, was ranked seventh, which is a common concern for most PPP projects worldwide (Li et al. 2005; Ng and Loosemore 2007).

The values of Kendall's coefficient of concordance were calculated by using the Statistical Package for the Social Sciences (SPSS) to measure the internal agreement within the same group of respondents on the rankings of different risk factors of PPP projects in China. A high or significant value of W indicates that different respondents rank the risk factors consistently. The values of W for the rankings of Risk Probability, Risk Impact, and Risk Significance (Risk Probability \times Risk Impact) of 34 risk factors for PPP projects in China were 0.183, 0.084, and 0.149, respectively. The computed values of the W s were all statistically significant at 1% significance level (Table 4). It can be interpreted that there is significant agreement among the respondents on the ratings of the Risk Probability, Risk Impact, and Risk Significance of the PPP projects in China.

Another traditional method for evaluating risk factors is to consider both the probability of risk occurrence and the risk impact on project objectives if a risk event occurs. To have a clearer spectrum of Risk Probability and Risk Impact, an alternative method to illustrate the evaluation of risks is to plot Risk Probability-Impact Matrix (Fig. 1). The probability value is shown on the y -axis and the impact value on the x -axis.

Both scales range from 1–5, where 1 = very low to 5 = very high. The matrix shows that a total of 20 risk factors are classified as high risk (both the values of Risk Probability and Risk Impact are larger than 3), which accounts for 59% of all the 34 risk factors. They are (1) government intervention, (2) government corruption, (3) poor public decision-making process, (4) financing risk, (5) imperfect law and supervision system, (6) operation cost overrun, (7) interest rate fluctuation, (8) public credit, (9) completion

Table 3. Interpretation of Each Risk Factor Associated with PPP Projects

Risk factors	Descriptions
1. Government corruption	The behavior of the corruption of government officials will increase the cost of keeping the relationships between the government and the project company. Meanwhile, it will increase the risk of contract breaking by the government.
2. Government intervention	Government officials intervene in the project operations directly, which will affect the autonomy of private investors' decision making.
3. Nationalization/expropriation	Central or local government seizes the projects.
4. Public credit	The rejection of government to implement the responsibilities agreed in the contract, which brings direct or indirect damages.
5. Third-party delay/violation	Apart from government or private investors, other project participants do not implement the responsibilities agreed in the contract or project delay.
6. Political/public opposition	For various reasons leading to the public interest being unprotected and damaged, which, as a consequence, causes political and even public opposition to the risk of the project construction.
7. Imperfect law and supervision system	The damage arising from the current PPP legislation which is low level, low effectiveness, conflict bearing, and poor operability.
8. Legislation change	Change of law and regulations and other government macroscopic economic policies will cause the increase in project costs and decrease in revenue, etc.
9. Interest rate fluctuation	The loss of PPP projects arising from the uncertainties of the interest rate volatility.
10. Foreign exchange fluctuation	The risk of the variability of foreign currencies exchange and the foreign currencies exchangeability risk.
11. Inflation	The increase of the price level of the commodities, the decrease of purchasing power of currencies, which cause the increase of cost and other consequence.
12. Poor public decision-making process	Nonstandardized procedures, bureaucracy, lacking of PPP project experience and ability, insufficient preparation and information asymmetry, leading to poor decision making.
13. Land acquisition	The increase in project cost and extension of project duration caused by the difficulty of acquiring the rights of the land. The cost and time for land acquisition exceeds the original plans.
14. Delay in project approvals and permits	Complicated procedures are required for project approval with high cost and long time. Upon approval, it is very difficult to proceed business adjustments regarding the project scope and nature.
15. Conflicting or imperfect contract	The risk of the contract with inaccuracy, vagueness, inflexibility, inconsistency, inequitable risk-sharing, unclear division of responsibility, etc.
16. Financing risk	The risk arising from the irrational financing structure, unsound financial market, and difficulty in financing.
17. Project/operation changes	Poor constructability in design phase, design error or vagueness, standards and contracts variation, owners' variation leading to the project, or operation changes.
18. Completion risk	Project delay and cost overrun, etc., which cause insufficient cash flow and inability to pay off debts on time.
19. Material/labor nonavailability	Loss because of delay in raw materials, resources, machines and equipment, or energy supply.
20. Unproven engineering techniques	The techniques adopted are immature and cannot fulfill the standards and requirements as expected, or the techniques are of poor applicability which makes private investors to reinvest for the technology improvement.
21. Unforeseen weather/geotechnical conditions	Because of the project site's bad natural conditions, for example, climate condition, special geographical environment, and poor site conditions, etc.
22. Operation cost overrun	Government raises the standard of the products or services leading to the cost overrun by the noncommercial factors such as increase in interest rates, exchange rates or force majeure, or poor operation management.
23. Market competition (uniqueness)	An actual market competition of the existing project caused by the new project or rebuild project of government or other investors.
24. Change in market demand	Apart from the risk from arising from market competition, factors attributed to macroeconomics, social environment, change in population, adjustment of laws, and regulations leading to the change in market demand.
25. Price change	Price of PPP products or services are too high, too low, or inflexible to adjust, leading to the revenue of the project company lower than expected.
26. Expense payment risk	Infrastructure of the project or the process of the service provision is affected by other factors which prevents the timely payment of the client's (or government's) fees.
27. Lack of supporting infrastructure	The risks generated by the unavailability of the supporting facilities of the project.
28. Residual risk	Investors overuse the resources like equipment or other technical conditions, etc., which cause insufficient materials and equipment with depreciation at the end of the concession period. As a consequence, it affects the continuous operation of the projects.
29. Inadequate competition for tender	The risk includes unfair, nontransparent tendering process, incomplete tender information, insufficient number of tenders, vicious market competition, and bidding lowest price to win the tenders.
30. Inability of concessionaire	The insufficient ability of the concessionaire leading to low productivity of project construction and operation.

Table 3. (Continued.)

Risk factors	Descriptions
31. Force majeure	Before signing contract, the contract party cannot control or prevent reasonably. When the events happen, the situation cannot be escaped or conquered, such as a worker strike, or other unforeseen items that are not "natural" risks.
32. Organization and coordination risk	Because of the insufficient coordination ability of project company, the cost of communication among project participants increases and conflicts occurs.
33. Change in tax regulation	The change in tax regulation of central or local government.
34. Environment risk	Because of the increasing requirement of the government or social organization regarding the environment protection, risk generated from the project cost increase, delay in work schedule, or other loss.

Table 4. Background Information of the Respondents

(1) Role of survey respondents								
Category	Public sector		Private sector		Academic sector		Total	
Percentage	9.5		30.5		60.0		100	
(2) Type of PPP projects that the survey respondents have been involved with								
Category	Hospital	Transport	Water treatment	Electrical power	Housing	Prison	School	Other
Number	5	33	19	17	9	1	13	17
(3) Industrial experience of survey respondents								
Category	5 years or below		5–10 years		11–15 years		Above 16 years	
Percentage per freq.	16.5		16.5		23.3		43.7	
(4) PPP experience of survey respondents								
Category	None		1–2 years		3–5 years		Above 6 years	
Percentage	13.6		25.0		45.5		15.9	

risk, (10) inflation rate fluctuation, (11) change in market demand, (12) project/operation changes, (13) conflicting or imperfect contract, (14) inadequate competition for tender, (15) delay in project approvals and permits, (16) foreign exchange fluctuation, (17) price change, (18) lack of supporting infrastructure, (19) third-party delay/violation, and (20) organization and coordination risk. A total of 13 risk factors are classified as moderate risk (the values of Risk Probability are between 2 and 3, and the value of Risk Impact is larger than 3), which accounts for 38% of all the risk factors. They are (1) inability of concessionaire, (2) expense payment risk, (3) land acquisition, (4) environment risk, (5) legislation change, (6) market competition (uniqueness), (7) force majeure, (8) material/labor nonavailability, (9) change in tax regulation, (10) nationalization/expropriation, (11) unforeseen weather/geotechnical conditions, (12) unproven engineering techniques, and (13) political/public opposition. Only one risk factor is classified as low risk (residual risk) where both the values of Risk Probability and Risk Impact are lower than 3.

Comparisons of Risk Rankings for the PPP Projects in China among Private, Public, and Academic Sectors

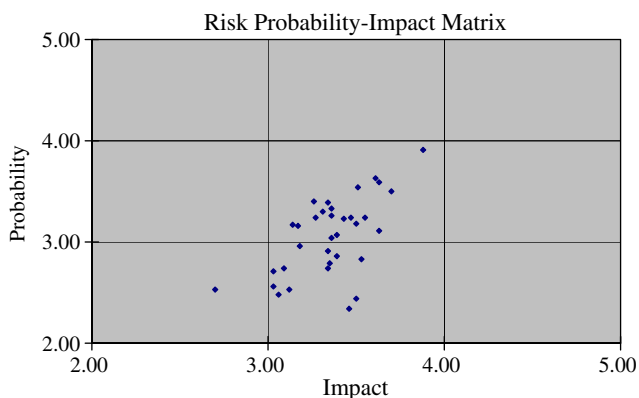
To investigate whether significant differences existed between perceptions of the private and public sectors and between industrial practitioners and academics on the risk factors for the PPP projects in China, Mann-Whitney U tests were conducted. The Mann-Whitney U test is a nonparametric test that is employed with ordinal (rank-order) data in a hypothesis testing situation involving a design with two independent samples. It tests whether two independent samples represent two populations with different median

values (Sheskin 2007). If the result of this test is significant (the significance level is lower than 0.05), it can be concluded that there is significant statistical difference between two sample medians. Two comparisons (private sector versus public sector; industrial practitioners versus academics) were conducted in this research study. A similar statistical technique has been used to compare the perceptions of Hong Kong and western respondents on construction project briefing (Yu et al. 2008); and to compare the perceptions of financial criteria between different groupings (Zhang 2005).

Table 6 shows that there is no significant statistical difference between the public and private sectors on the risk rankings of PPP projects in China. Since no significant statistical difference existed between the public and private sectors, they were grouped as industrial practitioners and their perceptions were further compared with academics. Table 7 shows the mean rank of the academics and industrial practitioners and the results of the Mann-Whitney U test. The results revealed that the views of academics and industrial practitioners on all the risk factors for PPP projects in China were not statistically significantly different at 5% significance level, except for the risk factor of government corruption. This indicates that academics perceived that the problem of government corruption is more severe than industrial practitioners believe. It is generally believed that academics take a neutral role in judgment, so their views may reinforce that corruption is a major obstacle to the success of PPP projects in China. In fact, many of the academics had at least 5 years of industrial experience and they had been involved with more than one PPP project. Therefore, their views are believed to be reliable.

Table 5. Overall Risk Ranking of PPP Projects in China

Risk factor	Risk probability	Risk impact	Risk significance	
	Mean	Mean	Mean product	Rank
1. Government corruption	3.63	3.61	13.10	2
2. Government intervention	3.91	3.88	15.17	1
3. Nationalization/expropriation	2.34	3.46	8.10	30
4. Public credit	3.11	3.63	11.29	8
5. Third-party delay/violation	3.16	3.17	10.02	19
6. Political/public opposition	2.48	3.06	7.59	33
7. Imperfect law and supervision system	3.54	3.51	12.43	5
8. Legislation change	2.79	3.35	9.35	25
9. Interest rate fluctuation	3.39	3.34	11.32	7
10. Foreign exchange fluctuation	3.24	3.27	10.59	16
11. Inflation	3.33	3.36	11.19	10
12. Poor public decision-making process	3.59	3.63	13.03	3
13. Land acquisition	2.86	3.39	9.70	23
14. Delay in project approvals and permits	3.30	3.31	10.92	15
15. Conflicting or imperfect contract	3.23	3.43	11.08	13
16. Financing risk	3.50	3.70	12.95	4
17. Project/operation changes	3.40	3.26	11.08	12
18. Completion risk	3.24	3.47	11.24	9
19. Material/labor nonavailability	2.74	3.09	8.47	28
20. Unproven engineering techniques	2.56	3.03	7.76	32
21. Unforeseen weather/geotechnical conditions	2.53	3.12	7.89	31
22. Operation cost overrun	3.24	3.55	11.50	6
23. Market competition (uniqueness)	2.74	3.34	9.15	26
24. Change in market demand	3.18	3.50	11.13	11
25. Price change	3.07	3.39	10.41	17
26. Expense payment risk	2.91	3.34	9.72	22
27. Lack of supporting infrastructure	3.04	3.36	10.21	18
28. Residual risk	2.53	2.70	6.83	34
29. Inadequate competition for tender	3.26	3.36	10.95	14
30. Inability of concessionaire	2.83	3.53	9.99	20
31. Force majeure	2.44	3.50	8.54	27
32. Organization and coordination risk	3.17	3.14	9.95	21
33. Change in tax regulation	2.71	3.03	8.21	29
34. Environment risk	2.96	3.18	9.41	24
Number of respondents (<i>n</i>)	101	102	101	
Kendall's coefficient of concordance (<i>W</i>)	0.183	0.084	0.149	
Level of significance	0.000	0.000	0.000	

**Fig. 1.** Risk probability-impact matrix

Preferred Risk Allocation of PPP Projects in China

A number of research studies have stated that in general, risks should be allocated to the party that can best handle it [Li (unpublished report, 2003); Hong Kong Efficiency Unit 2003a; Lam et al. 2007]. Grimsey and Lewis (2002) pointed out that the arrangements of PPP projects are founded on the transfer of risk from the public to the private sector under circumstances where the private sector is best placed to manage the risk. The general principles are common to all public sectors insofar as the projects seek to shift risk from the public sector to the private sector and offer a profit incentive to the private sector in return. However, the principal aim for the public sector is to achieve value for money in the services provided while ensuring that the private sector entities meet their contractual obligations properly and efficiently. Lam et al. (2007) identified seven key risk allocation criteria:

Table 6. Results of Risk Factors for Risk Ranking of PPP Projects in China between Public and Private Sectors Using Mann-Whitney U Test

Risk factor	Public sector	Private sector	Z	p-value
	Mean rank	Mean rank		
1. Government corruption	25.60	20.22	−1.222	0.222
2. Government intervention	19.80	22.03	−0.511	0.609
3. Nationalization/expropriation	22.35	21.23	−0.254	0.800
4. Public credit	15.05	23.52	−1.920	0.055
5. Third-party delay/violation	26.00	20.09	−1.414	0.157
6. Political/public opposition	19.05	22.27	−0.755	0.450
7. Imperfect law and supervision system	20.25	21.89	−0.374	0.708
8. Legislation change	18.30	22.50	−0.955	0.339
9. Interest rate fluctuation	17.90	22.63	−1.091	0.275
10. Foreign exchange fluctuation	20.72	21.08	−0.080	0.936
11. Inflation	16.33	22.31	−1.348	0.178
12. Poor public decision-making process	21.80	21.41	−0.091	0.928
13. Land acquisition	24.30	20.63	−0.838	0.402
14. Delay in project approvals and permits	18.40	22.47	−0.923	0.356
15. Conflicting or imperfect contract	23.55	20.86	−0.611	0.541
16. Financing risk	21.85	21.39	−0.107	0.915
17. Project/operation changes	25.25	20.33	−1.123	0.261
18. Completion risk	24.15	20.67	−0.795	0.427
19. Material/labor nonavailability	20.05	21.95	−0.438	0.662
20. Unproven engineering techniques	18.00	22.59	−1.051	0.293
21. Unforeseen weather/geotechnical conditions	17.25	22.83	−1.270	0.204
22. Operation cost overrun	25.60	20.22	−1.229	0.219
23. Market competition (uniqueness)	19.20	22.22	−0.684	0.494
24. Change in market demand	18.00	22.59	−1.050	0.294
25. Price change	19.50	22.13	−0.598	0.550
26. Expense payment risk	23.00	21.03	−0.469	0.639
27. Lack of supporting infrastructure	18.11	21.81	−0.831	0.406
28. Residual risk	19.35	22.17	−0.649	0.516
29. Inadequate competition for tender	26.40	19.97	−1.461	0.144
30. Inability of concessionaire	21.60	21.47	−0.030	0.976
31. Force majeure	19.50	22.13	−0.596	0.551
32. Organization and coordination risk	19.30	22.19	−0.661	0.508
33. Change in tax regulation	17.50	22.75	−1.200	0.230
34. Environment risk	16.10	23.19	−1.618	0.106

- Whether the party is *able to foresee* the risk;
- Whether the party is *able to assess* the possible magnitude of consequences of the risk;
- Whether the party is *able to control* the chance of the risk occurring;
- Whether the party is *able to manage* the risk in case of occurring;
- Whether the party is *able to sustain* the consequences if the risk occurs;
- Whether the party will *benefit from bearing* the risk; and
- Whether the *premium charged* by the risk receiving party is considered *reasonable and acceptable* for the owner.

The preferred risk allocation of PPP projects in China between the public and private sectors is analyzed based on the calculated mean ratings, as shown in Table 7. The following formula, which is based on the distribution of the normal distribution curve, is used to calculate the ranges within which PPP risks in China should be allocated to the contracting parties, i.e., 1 = mainly to the public sector, 2 = equally shared between the public and private sectors, and 3 = mainly to the private sector (Selvanathan et al. 2004; Berenson et al. 2009; Bowerman et al. 2009):

$$X_{10\%} = U \pm Z^* \sigma$$

where $X_{10\%}$ = the values of upper and lower limits within which the risk should be allocated to a specified party; U = the mean value of the population, Z = corresponding Z value as computed from the normal curve table; σ = population standard deviation.

After calculations, the following ranges can be defined:

$$X_{10\%} = U \pm Z^* \sigma = 3 \pm 0.125 \cdot 1$$

Because the value of 3 is the score for equally shared risk allocation, taking 0.125 as the corresponding Z value and standard deviation of 1 for this calculation, the upper and lower limits for the range are 2.875 scores and 3.125 scores, respectively.

Hence, if the mean value is lower than 2.875 scores, the risk should be mainly borne by the public sector. If the mean value is between 2.875 scores and 3.125 scores, the risk should be equally shared between the public and private sectors. If the mean value is greater than 3.125 scores, the risk should be mainly borne by the private sector. The proposed method for determining risk allocation preference is considered more reliable and accurate than those

Table 7. Results of Risk Factors for Risk Ranking of PPP Projects in China between Academics and Industrial Practitioners Using Mann-Whitney U Test

Risk factor	Academics	Industrial practitioners	Z	p-value
	Mean rank	Mean rank		
1. Government corruption	59.23	44.36	-2.498	0.013
2. Government intervention	54.63	49.60	-0.864	0.387
3. Nationalization/expropriation	53.07	51.73	-0.226	0.821
4. Public credit	54.25	51.27	-0.499	0.618
5. Third-party delay/violation	53.26	52.64	-0.109	0.913
6. Political/public opposition	55.15	50.02	-0.863	0.388
7. Imperfect law and supervision system	57.20	47.18	-1.706	0.088
8. Legislation change	51.43	55.17	-0.628	0.530
9. Interest rate fluctuation	51.78	54.69	-0.496	0.620
10. Foreign exchange fluctuation	52.34	52.72	-0.064	0.949
11. Inflation	53.79	50.67	-0.536	0.592
12. Poor public decision-making process	53.51	52.30	-0.207	0.836
13. Land acquisition	52.43	52.60	-0.030	0.976
14. Delay in project approvals and permits	54.25	51.27	-0.500	0.617
15. Conflicting or imperfect contract	56.70	47.86	-1.493	0.135
16. Financing risk	53.27	52.63	-0.110	0.912
17. Project/operation changes	54.66	50.70	-0.670	0.503
18. Completion risk	55.62	49.36	-1.058	0.290
19. Material/labor nonavailability	54.77	50.55	-0.718	0.473
20. Unproven engineering techniques	56.98	47.48	-1.616	0.106
21. Unforeseen weather/geotechnical conditions	54.65	50.72	-0.664	0.507
22. Operation cost overrun	55.20	49.95	-0.886	0.375
23. Market competition (uniqueness)	55.39	49.68	-0.960	0.337
24. Change in market demand	55.22	49.92	-0.898	0.369
25. Price change	53.89	51.77	-0.356	0.722
26. Expense payment risk	53.45	52.38	-0.184	0.854
27. Lack of supporting infrastructure	50.64	55.14	-0.768	0.443
28. Residual risk	55.75	49.19	-1.129	0.259
29. Inadequate competition for tender	57.19	47.19	-1.683	0.092
30. Inability of concessionaire	53.48	52.34	-0.190	0.849
31. Force majeure	57.43	46.85	-1.772	0.076
32. Organization and coordination risk	53.77	51.93	-0.311	0.756
33. Change in tax regulation	55.32	49.78	-0.941	0.347
34. Environment risk	57.68	46.51	-1.899	0.058

applied by previous researchers (Li et al. 2005; Andi 2006; El-Sayegh 2008). Their practice to determine risk allocation preference is dependent on whether the risk factors receive more than 50% agreement from the respondents. If a risk does not receive more than 50% agreement, it will be labeled as “undecided.” Such a classification (undecided) is purely hypothetical and does not reflect the industry practice.

Table 8 shows that a total of 15 risk factors are preferred to be allocated to the public sector. These include (1) government corruption, (2) government intervention, (3) nationalization/expropriation, (4) public credit, (5) political/public opposition, (6) imperfect law and supervision system, (7) legislation change, (8) poor public decision-making process, (9) land acquisition, (10) delay in project approvals and permits, (11) market competition (uniqueness), (12) lack of supporting infrastructure, (13) inadequate competition for tender, (14) force majeure, and (15) change in tax regulation. Most of these risks fall within the systematic risk category, including political, legal, and social risks.

The views between the public and private sectors are largely consistent for all these 15 risk factors and indicate that they should be allocated mainly to the public sector. The only three differences

are (1) market competition (uniqueness), (2) inadequate competition for tender, and (3) change in tax regulation. The private sector opined that the government controls both the price and quantity sold; hence the associated risks should be borne primarily by the government. However, the government perceived that the private sector should also be responsible for this risk; and hence, it should be shared by both parties. Similarly, the private sector opined that both the central and local governments control the tax regulation; hence, the risk should be borne primarily by the government. Nevertheless, the local government did not share this view and believed that the risk should be shared with the private sector. Interestingly, the public sector was prepared to take up the risk for “inadequate competition for tender,” but the private sector was happy to bear a share of this risk.

Table 8 also indicates that a total of 18 risk factors are preferred to be allocated to the private sector. These include (1) third-party delay/violation, (2) interest rate fluctuation, (3) foreign exchange fluctuation, (4) inflation, (5) conflicting or imperfect contract, (6) financing risk, (7) project/operation changes, (8) completion risk, (9) material/labor nonavailability, (10) unproven engineering techniques, (11) unforeseen weather/geotechnical conditions,

Table 8. Preferred Risk Allocation of PPP Projects in China between the Public and Private Sectors

No.	Risk factors	All respondents				Public sector				Private sector			
		N	Mean	SD	Allocated to	N	Mean	SD	Allocated to	N	Mean	SD	Allocated to
1	Government corruption	105	2.21	1.15	Public	10	2.20	0.92	Public	32	2.28	1.14	Public
2	Government intervention	104	2.14	1.15	Public	10	1.80	0.92	Public	32	2.13	1.26	Public
3	Nationalization/expropriation	105	1.93	1.42	Public	10	1.80	0.92	Public	32	1.66	1.07	Public
4	Public credit	105	2.03	1.18	Public	10	1.60	0.70	Public	32	1.88	1.24	Public
5	Third-party delay/violation	105	3.41	0.74	Private	10	3.00	1.05	Equally shared	32	3.34	0.60	Private
6	Political/public opposition	105	2.47	0.80	Public	10	2.30	0.82	Public	32	2.50	0.62	Public
7	Imperfect law and supervision system	105	2.53	1.04	Public	10	2.30	1.06	Public	32	2.28	0.92	Public
8	Legislation change	105	2.43	1.04	Public	10	2.40	0.97	Public	32	2.16	0.95	Public
9	Interest rate fluctuation	104	3.59	0.93	Private	9	3.11	0.60	Equally shared	32	3.41	1.07	Private
10	Foreign exchange fluctuation	104	3.46	1.00	Private	10	2.70	1.06	Public	32	3.44	1.01	Private
11	Inflation	105	3.50	0.87	Private	10	3.00	0.67	Equally shared	32	3.28	0.85	Private
12	Poor public decision-making process	105	2.11	1.10	Public	10	2.20	0.92	Public	32	2.16	1.11	Public
13	Land acquisition	104	2.41	1.06	Public	10	2.60	0.97	Public	32	2.28	1.05	Public
14	Delay in project approvals and permits	105	2.45	1.24	Public	10	2.60	0.84	Public	32	2.50	1.27	Public
15	Conflicting or imperfect contract	105	3.29	0.69	Private	10	3.10	1.00	Equally shared	32	3.41	0.67	Private
16	Financing risk	105	3.92	0.95	Private	10	3.30	0.82	Private	32	4.00	0.88	Private
17	Project/operation changes	105	3.66	0.89	Private	10	3.00	0.47	Equally shared	32	3.69	0.82	Private
18	Completion risk	105	3.98	0.88	Private	10	3.40	0.84	Private	32	3.88	0.79	Private
19	Material/labor nonavailability	105	3.95	0.91	Private	10	3.20	0.92	Private	323	3.91	0.86	Private
20	Unproven engineering techniques	105	4.22	0.86	Private	10	3.50	0.97	Private	32	4.19	0.78	Private
21	Unforeseen weather/geotechnical conditions	105	3.45	0.90	Private	10	3.10	0.74	Equally shared	32	3.31	0.69	Private
22	Operation cost overrun	105	3.94	0.98	Private	10	2.50	0.85	Public	32	4.06	0.80	Private
23	Market competition (uniqueness)	105	2.68	1.19	Public	10	3.00	0.82	Equally shared	32	2.47	1.32	Public
24	Change in market demand	105	3.38	0.97	Private	10	3.10	1.10	Equally shared	32	3.31	1.06	Private
25	Price change	105	3.24	1.01	Private	10	3.20	1.14	Private	32	3.03	0.93	Equally shared
26	Expense payment risk	105	3.25	0.97	Private	10	3.00	0.94	Equally shared	32	3.25	0.98	Private
27	Lack of supporting infrastructure	105	2.63	1.06	Public	10	2.80	0.63	Public	32	2.59	1.16	Public
28	Residual risk	105	3.50	1.01	Private	10	3.50	0.97	Private	32	3.53	0.95	Private
29	Inadequate competition for tender	105	2.59	1.13	Public	10	2.50	0.97	Public	32	2.91	1.12	Equally shared
30	Inability of concessionaire	105	3.66	1.18	Private	10	3.10	1.29	Equally shared	32	3.53	1.14	Private
31	Force majeure	105	2.80	0.55	Public	10	2.80	0.42	Public	32	2.84	0.45	Public
32	Organization and coordination risk	105	3.50	0.85	Private	10	3.40	0.84	Private	32	3.53	0.84	Private
33	Change in tax regulation	105	2.64	1.02	Public	10	3.00	0.94	Equally shared	32	2.50	0.98	Public
34	Environment risk	105	3.06	1.01	Equally shared	10	3.10	0.57	Equally shared	32	3.09	1.00	Equally shared

(12) operation cost overrun, (13) change in market demand, (14) price change, (15) expense payment risk, (16) residual risk, (17) inability of concessionaire, and (18) organization and coordination risk. Most of these risks are within the specific project risk category.

The views between the public and private sectors for some risk factors are slightly different. The public sector viewed that nine of the 18 risk factors should be equally shared while the private sector believed that they should take primary responsibility in managing these risk factors. These risk factors are (1) third-party delay/

violation, (2) interest rate fluctuation, (3) inflation, (4) conflicting or imperfect contract, (5) project/operation changes, (6) unforeseen weather/geotechnical conditions, (7) change in market demand, (8) expense payment risk, and (9) inability of concessionaire. The findings show that the public sector was willing to bear a share of these risks, but the private sector was prepared to take up these risks. This reflects that both the public and private sectors are more willing to be responsible for these risks. Two more interesting results are “foreign exchange fluctuation” and “operation cost overrun.” Both the public and private sectors believed that they should

be taking primary responsibility in managing these risks. The results appear to be not logical because it is commonly accepted that the risk of foreign exchange fluctuation should be wholly borne by the government, not by the private sector. On the other hand, the risk “operation cost overrun” is commonly regarded to be absorbed by the private sector, not by the government. As shown in Table 7, one risk factor, environment risk, is preferred to be shared between the public and private sectors, and both sectors concurred with this arrangement.

Conclusions

It is a challenging task to successfully implement PPP projects in China. One of the major reasons is a lack of an effective risk-assessment model and an equitable risk-sharing mechanism tailor-made for the situation in China. The research findings indicated that the top three risk factors are government intervention, government corruption, and poor public decision-making process. These findings revealed that political risk is the most significant risk that places critical barriers for PPP projects to succeed in China. This may be caused by inefficient legislative and supervisory systems for PPP projects in China. The empirical results also showed that by using Mann-Whitney U tests, there were no statistically significant differences between private and public sectors for the perceptions of all 34 risk factors for risk rankings of PPP projects in China. Similar results were also found between academics and industrial practitioners except government corruption. This revealed that academics perceived the problem of government corruption to be more severe than that of the industrial practitioners. Regarding risk allocation, the research findings showed that both the public and private sectors are in general agreement with a majority of the risks identified as preferred risk allocation. The principal risks that the private sector is prepared to bear are within the specific project risk category, i.e., construction, operation, and relationship risks, as well as economic risks within systematic risk category. The public sector is prepared to accept the risks within the systematic risk category, i.e., political, legal and social risks. The remaining risk, environment risk, is preferred to be shared between the two sectors.

Acknowledgments

The work described in this paper was fully supported by a joint grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. N_PolyU 514/07) and the National Science Foundation Council Research Grant of China (Project No. 70731160634). This paper forms part of the research project entitled Developing an Equitable Risk-Sharing Mechanism for Public-Private Partnership Projects in the People's Republic of China, from which other deliverables have been produced with different objectives/scopes but sharing common background and methodology. The authors also wish to acknowledge the contributions of other team members including Dr. Patrick T. I. Lam, Dr. Daniel W. M. Chan, Prof. Y. J. Lu, Dr. X. D. Li, Dr. Edmond W. M. Lam, Dr. Esther Cheung, Mr. Yelin Xu, Ms. Wendy Wen, Mr. Tony Peng, and Mr. Y. W. Liu. Special gratitude is devoted to those construction academics and industrial practitioners who have responded to and contributed their valuable input in completing the survey questionnaires in China.

References

- Adams, J., Alistair, Y., and Wu, Z. H. (2006). “Public private partnerships in China-system, constraints and future prospects.” *Int. J. Public Sector Manage.*, 19(4), 384–396.
- Akbiyikli, R., and Eaton, D. (2004). “Risk management in PFI procurement: A holistic approach.” *Proc., 20th Annual Association of Researchers in Construction Management (ARCOM) Conf.*, Heriot-Watt Univ., Edinburgh, UK, 1269–1279.
- Al-Bahar, J., and Crandall, K. (1990). “Systematic risk management approach for construction projects.” *J. Constr. Eng. Manage.*, 116(3), 533–546.
- Andi, P. (2006). “The importance and allocation of risks in Indonesian construction projects.” *Constr. Manage. Econ.*, 24(1), 69–80.
- Berenson, M. L., Levine, D. M., and Krehbiel, T. C. (2009). *Basic business statistics: Concepts and applications*, 11th Ed., Pearson Prentice Hall, New York.
- Bowerman, B. L., O’Connell, R. T., and Murphree, E. S. (2009). *Business statistics in practice*, 5th Ed., McGraw-Hill, New York.
- Broome, J., and Perry, J. (2002). “How practitioners set share fractions in target cost contracts.” *Int. J. Proj. Manage.*, 20(1), 59–66.
- Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E., and Ke, Y. (2010). “Potential obstacles to successful implementation of public-private partnerships in Beijing and the Hong Kong Special Administrative Region.” *J. Manage. Eng.*, 26(1), 30–40.
- Chataway, J., and Smith, J. (2006). “The International AIDS Vaccine Initiative (IAVI): Is it getting new science and technology to world’s neglected majority?” *World development*, 34(1), 16–30.
- Chiu, T., and Bosher, C. (2005). “Risk sharing in various public private partnerships arrangements for the provision of water and wastewater services.” *Proc., Conf. on Public Private Partnerships—Opportunities and Challenges*, Hong Kong, 11–21.
- Delmon, J. (2000). *BOO/BOT projects: A commercial and contractual guide*, Sweet & Maxwell Limited, London, 40–62.
- El-Sayegh, S. M. (2008). “Risk assessment and allocation in the UAE construction industry.” *Int. J. Proj. Manage.*, 26(4), 431–438.
- Estache, A., Juan, E., and Trujillo, L. (2007). “Public-private partnerships in transport.” *Policy Research Working Paper 4436*, The World Bank.
- European Commission. (2004). “Green paper on public-private partnerships and community law on public contracts and concessions.” *COM (2004) 327 Final*, European Commission, Brussels, Belgium.
- Francis, W. A. (1993). “The channel tunnel: A case study.” *Executive Research Project, CS8*, National Defense Univ., Washington, DC.
- Gallimore, P., Williams, W., and Woodward, D. (1997). “Perceptions of risk in the private finance initiative.” *J. Prop. Finance*, 8(2), 164–176.
- Grant, T. (1996). “Keys to successful public-private partnerships.” *Can. Bus. Rev.*, 23(3), 27–28.
- Grimsey, D., and Lewis, M. (2002). “Evaluating the risks of public private partnerships for infrastructure projects.” *Int. J. Proj. Manage.*, 20(2), 107–118.
- Handley-Schachler, M., and Gao, S. S. (2003). “Can the private finance initiative be used in emerging economies?—Lessons from the UK’s successes and failures.” *Managerial Finance*, 29(5–6), 36–51.
- HM Treasury. (2000). *Public-private partnerships: The government’s approach*, The Stationery Office, London.
- Hong Kong Efficiency Unit. (2003a). “Transfer of government PRIME estate to the private sector.” Hong Kong Special Administrative Region Government, (http://www.eu.gov.hk/english/psi/psi_case/files/ppp_case_estate.pdf).
- Hong Kong Efficiency Unit. (2003b). “Case summary: University College London Hospital (UCLH) redevelopment—Improving the standard of healthcare by public private partnership.” Hong Kong Special Administrative Region Government, (http://www.eu.gov.hk/english/psi/psi_ppp/psi_ppp_cases/files/uclh_redevelopment.pdf).
- Hong Kong Efficiency Unit. (2003c). “Case summary: Provision of helicopter services by public private partnerships Victoria, Austria.” Hong Kong Special Administrative Region Government, (http://www.eu.gov.hk/english/psi/psi_ppp/psi_ppp_cases/files/ppp_case_helicopters.pdf).
- Hong Kong Efficiency Unit. (2003d). “Case summary: Prisons operated by public private partnerships Victoria, Austria.” Hong Kong Special

- Administrative Region Government, (http://www.eu.gov.hk/english/psi/psi_ppp/psi_ppp_cases/files/victoria_prisons.pdf).
- Hong Kong Efficiency Unit. (2008). "Serving the community by using the private sector: An introductory guide to public private partnerships (PPP)." Hong Kong Special Administrative Region Government.
- International Monetary Fund. (2006). *Public private partnerships, government guarantees, and fiscal risk*, Fiscal Affairs Dept., International Monetary Fund, Washington, DC.
- Jin, X., and Doloi, H. (2008). "Interpreting risk allocation mechanism in public-private partnership projects: An empirical study in a transaction cost economic perspective." *Constr. Manage. Econ.*, 26(7), 707–721.
- Kumaraswamy, M. M., and Zhang, X. Q. (2001). "Governmental role in BOT-led infrastructure development." *Int. J. Proj. Manage.*, 19(4), 195–205.
- Lam, K. C., Wang, D., Lee, T. K., and Tsang, Y. T. (2007). "Modeling risk allocation decision in construction contracts." *Int. J. Proj. Manage.*, 25(5), 485–493.
- Li, B., Akintoye, A., Edwards, P. J., and Hardcastle, C. (2005). "The allocation of risk in PPP/PFI construction projects in the UK." *Int. J. Proj. Manage.*, 23(1), 25–35.
- Maslyukivska, O., and Sohail, M. (2007). "European infrastructure procurement through PPP." *Proc., Institution of Civil Engineers: Management, Procurement and Law*, 160(4), 159–167.
- Mass Transit Railway Corporation Limited. (2008). *TA 4724-PRC: Application of public-private partnerships in urban rail-based transportation project*, Asian Development Bank, Hong Kong, 136.
- Medda, F. (2007). "A game theory approach for the allocation of risks in transport public private partnerships." *Int. J. Proj. Manage.*, 25(3), 213–218.
- Ng, A., and Loosemore, M. (2007). "Risk allocation in the private provision of public infrastructure." *Int. J. Proj. Manage.*, 25(1), 66–76.
- Ogunlana, S. O. (1997). "Build operate transfer procurement traps: examples from transportation projects in Thailand." *Proc., CIB W92 Symp. on Procurement, IF Research Corporation*, Montreal, 585–594.
- Parker, D., and Hartley, K. (2003). "Transaction costs, relational contracting and public private partnerships: a case study of UK defence." *J. Purch. Supply Manage.*, 9(3), 97–108.
- Pongsiri, N. (2004). "Partnerships in oil and gas production-sharing contracts." *Int. J. Public Sector Manage.*, 17(5), 431–442.
- Rouboutsos, A., and Anagnostopoulos, K. (2008). "Public-private partnership projects in Greece: Risk ranking and preferred risk allocation." *Constr. Manage. Econ.*, 26(7), 751–763.
- Sachs, T., and Tiong, R. (2009). "Quantifying qualitative information on risks: Development of the QQIR method." *J. Constr. Eng. Manage.*, 135(1), 56–71.
- Sachs, T., Tiong, R., and Wang, S. Q. (2007). "Analysis of political risks and opportunities in public private partnerships in China and selected Asian countries." *Chin. Manage. Stud.*, 1(2), 126–148.
- Salzmann, A., and Mohamed, S. (1999). "Risk identification frameworks for international BOOT projects." *Profitable partnering in construction procurement: CIB W92 (Procurement Systems) and CIB TG 23 (Culture in Construction)*, S. O. Ogunlana, ed., E & FN Spon, London, 475–485.
- Selvanathan, A., Selvanathan, S., Keller, G., and Warrack, B. (2004). *Australian Business Statistics*, 3rd Ed., Nelson, South Melbourne, Australia.
- Sharma, S. (2007). "Exploring best practices in public-private partnership (PPP) in e-Government through select Asian case studies." *Int. Inf. Lib. Rev.*, 39(3–4), 203–210.
- Shen, L. Y., Platten, A., and Deng, X. P. (2006). "Role of public private partnerships to manage risks in public sector projects in Hong Kong." *Int. J. Proj. Manage.*, 24(7), 587–594.
- Shen, L. Y., Wu, W. C., and Ng, S. K. (2001). "Risk assessment for construction joint ventures in China." *J. Constr. Eng. Manage.*, 127(1), 76–81.
- Sheskin, D. (2007). *Handbook of parametric and nonparametric statistical procedures*, 4th Ed., Chapman & Hall/CRC, New York.
- Soliño, A. S., and Vassallo, J. M. (2009). "Using public-private partnerships to expand subways: Madrid-Barajas international airport case study." *J. Manage. Eng.*, 25(1), 21–28.
- Tieman, R. (2003). "A revolution in public procurement: UK's private finance initiative." *Financial Times*, Nov. 24, 4.
- United Nations Development Organization (UNIDO). (1996). *Guidelines for infrastructure development through BOT Projects*, Vienna, Austria.
- United Nations. (2004). "World urbanization prospects: The 2003 revision." New York.
- Utt, R. (1999). "How public-private partnerships can facilitate public school construction." *The Heritage Foundation Background Executive Summary*, The Heritage Foundation, Washington, DC, 1257.
- Wang, S. Q., Dulaimi, M., and Aguria, M. (2004). "Risk management framework for construction projects in developing countries." *Constr. Manage. Econ.*, 22(3), 237–252.
- Wang, S. Q., Tiong, R. L. K., Ting, S. K., and Ashley, D. (2000). "Evaluation and management of political risks in China's BOT projects." *J. Constr. Eng. Manage.*, 126(3), 242–250.
- Wang, Y. D. (2001). "BOT trap." *Global Entrepreneur*, 2, 2 (in Chinese).
- Warburton, W., and Baker, G. (2005). "Integrity systems and local government." *Aust. J. Public Admin.*, 64, 62–68.
- Wiegman, B., Ubbels, B., Rietveld, P., and Nijkamp, P. (2002). "Investments in container terminals: Public private partnerships." *Research Memorandum 2002.3*, Vrije Univ., Amsterdam, Netherlands.
- Yu, A. T. W., Shen, Q. P., Kelly, J., and Hunter, K. (2008). "Comparative study of the variables in construction project briefing/architectural programming." *J. Constr. Eng. Manage.*, 134(2), 122–138.
- Yuan, J., Skibniewski, M. J., Li, Q., and Zheng, L. (2010). "Performance objectives selection model in public-private partnership projects based on the perspective of stakeholders." *J. Manage. Eng.*, 26(2), 89–104.
- Zhang, X. (2005). "Critical success factors for public-private partnerships in infrastructure development." *J. Constr. Eng. Manage.*, 131(1), 3–14.
- Zou, X. W., Wang, S. Q., and Fang, D. P. (2008). "A life-cycle risk management framework for PPP infrastructure projects." *J. Financial Manage. Prop. Constr.*, 13(2), 123–142.

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