Routledge
Taylor & Francis Group

INTERNATIONAL JOURNAL OF STRATEGIC PROPERTY MANAGEMENT
ISSN 1648-715X print / ISSN 1648-9179 online

2011 Volume 15(3): 275–294
doi:10.3846/1648715X.2011.617867

# IDENTIFICATION AND ALLOCATION OF RISKS ASSOCIATED WITH PPP WATER PROJECTS IN CHINA

**Yelin XU [1] ✉, Yunfang YANG [2], Albert P. C. CHAN [3], John F. Y. YEUNG [4] and Hu CHENG [5]**

[1] *Department of Construction Management and Real Estate, Southeast University, Nanjing 210009, China and Department of Engineering Management, Zhejiang Sci-tech University, Hangzhou, China*
*E-mail: xuyelin2007@yahoo.com.cn*
[2] *School of Civil Engineering and Architecture, Zhejiang Sci-tech University, Hangzhou, China*
[3] *Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China*
[4] *College of International Education, School of Continuing Education, Hong Kong Baptist University, Hong Kong, China*
[5] *Department of Construction Management and Real Estate, Southeast University, Nanjing 210009, China*

Received 30 September 2010; accepted 16 May 2011

**ABSTRACT.** As part of a comprehensive research into PPP implementation, nine case studies were scrutinized to explore the critical risks influencing the success of PPP water projects in China. Eleven critical risks were identified from real-life risk events through the content analysis. They were further analyzed in the aspects of risk origin and their allocation mechanism. It has been found that the government risks are considered as the most critical risks encountered by the Chinese project practitioners. To allocate risk, industrial practitioners should not only take into account of their management capability, but they should also pay more attention to the overall balance of risks and benefits, and risk guarantee through rigorous contract structure. The findings presented here are believed to enable interested investors to better understand the risks of PPP water projects in China.

**KEYWORDS:** Public-Private Partnerships; Risk identification; Risk allocation; Water industry; China

## 1. INTRODUCTION

The construction engineering is beset with a high degree of risk due to its complexity, particularly in coordinating a wide range of disparate and interrelated skills and activities under the constraint of time and resources (Deviprasadh, 2007; Tieva and Junnonen, 2009; Leung and Hui, 2005). For PPP projects, such complexity is further compounded by its additional external uncertainties and the wide extension of the disciplines, public agencies and various stakeholders involved (Thomal et al., 2006). PPP stakeholders are exposed to high risks as projects typically involve high capital outlays, long lead times, and long-lived assets with little value in alternative use (Zayed and Chang, 2002). With PPP projects becoming increasingly complex, industrial practitioners have to rethink their measures to risk management

within their projects and organizations (Carr and Tah, 2001). It is reported that a majority of PPP projects in China encountered cost overrun, schedule delay, or failed to deliver service as defined in the concession agreement (Zeng et al., 2008). The main causes for such predicaments include (1) a lack of effective risk evaluation procedure; (2) underestimation of the time and resource limit; (3) insufficient consideration of changes in project implementation; and (4) undervaluing the changes in exchange rates. The need for establishing an effective risk management for PPP projects is becoming more urgent (Choi et al., 2004).

To keep pace with an increasing trend of infrastructure developments, substantial studies have been reported concerning various aspects of PPP projects risk management. They mainly include:

- risk identification - identify critical risk factors of PPP projects;
- risk evaluation - evaluate how the critical risks affect the success of PPP projects;
- risk allocation - establish equitable risk sharing mechanism among stakeholders.

A number of academic researchers provided detailed risk registers for PPP projects (Jin and Doloi, 2008; Yuan et al., 2007; Li et al., 2005; Zeng et al., 2008; Andi, 2006). It is believed that a comprehensive list of risk factors will provide PPP practitioners with an useful tool in setting up and executing a successful PPP concession agreement (Xenidis and Angelides, 2005), which can also serve as a basis for risk identification, evaluation, allocation, and response. To evaluate risk criticality, questionnaires are widely employed to rank the identified risk factors through some kinds of scoring system to account for both the probability of risk occurrence and the consequent impact on the project. Zeng et al., (2008), Roumboutsos and Anagnostopoulos, (2008), and Li et al., (2005) reported the rankings of risk factors in China, Greece, and the UK respectively. Chan et al., (2010, 2009a, 2009b) investigated the critical success factors, drivers for adopting PPP, and obstacles for PPP implementation respectively. The top three obstacles rated by the Chinese respondents were found to be (1) lengthy delays in negotiation; (2) lack of experience and appropriate skills; and (3) lengthy delays due to political debate. Chen and Doloi (2008) considered that the most significant China-specific impeding factors for BOT projects are opaque and inadequate legal system, complex approval system, regulatory constraints on market entry, and low market prices for infrastructure products and services.

Wang (2008) advocated that a reasonable and practical risk evaluation can help: (1) assess how critical risk factors deter the realization of project objective; (2) assess and ascertain project viability; (3) avoid unsatisfactory projects and enhance enterprise margins. Previous researches on risk evaluation mainly focused on traditional construction projects, and actual empirical research studies targeting PPP projects are still limited (Xu et al., 2010b). Risk assessment is usually performed at the pre-contract stage, when it is still flexible to consider how the risks could be managed (Choi et al., 2004). However, data collection at this stage is frequently not available; therefore, risk criticality cannot be evaluated accurately. Xu et al., (2010b) presented a fuzzy synthetic evaluation model for assessing the risk level of PPP highway projects based on the data obtained from a two-round Delphi survey. It revealed that political risk is the most significant risk that places critical barriers for PPP highway projects to succeed in China. Knight and Fayek (2002) applied a fuzzy logic model to predict cost overruns on engineering design projects. Wang and Elhag (2007) developed a fuzzy group decision making approach for bridge risk assessment. Forbes et al. (2008) stated that there are a total of 36 different methods available to identify and evaluate risks. However, the practical application of risk evaluation techniques on construction projects is limited, and it is confined mainly due to a lack of confidence in the technique (Forbes et al., 2008).

Moreover, PPP brings about a redistribution of risks amongst the project participants. Early researches show that the reasonable allocation of risks among the contracting parties in a PPP contract is a critical factor for the success of the project (Li et al., 2005; Majamaa et al., 2008). Jin (2010a) confirmed that the performance of public-private partnership (PPP) infrastructure projects is largely dependent on whether the adopted risk allocation mechanism is equitable. A substantial number of studies have been devoted to seek appropriate approaches to facilitate risk allocation. Questionnaire survey as one of the most commonly adopted techniques was used by Li et al. (2005), Roumboutsos and Anagnostopoulos (2008), and Ke et al. (2010) to investigate the risk allocation preference in the UK, Greece, and China, respectively. Jin and Doloi (2008) interpreted the potential allocation mechanism from the view point of transaction cost theory. Five main features of the transactions related to PPP projects' risk allocation including (1) partners' risk management routine; (2) partners' risk management mechanism; (3) partners' cooperation history; (4) risk management environmental uncertainty; and (5) partners' risk management commitment were identified by Jin (2010b). Although risk allocation in PPP projects is claimed as capability driven, such claim is usually "violated" by recent industrial practice (Jin and Doloi, 2008) because risk allocation is greatly influenced by participants' risk attitude, risk premium, bargaining power and negotiation tactics and level of governmental support (Arndt and Maguire, 1999; Loosemore and McCarthy, 2008). It is a complex and flexible process. A total of 23 factors for risk allocation of PPP projects were identified by Xu et al. (2010a). However, the decision-making of risk sharing, based on the established risk allocation principles expressed in linguistic terms, which requires qualitative judgment of construction experts, is subjective, partial, and implicit in actual application (Lam et al., 2007). To transform the risk allocation principles in linguistic terms into a more usable quantitative-based analysis, Xu et al. (2010a) established a fuzzy risk allocation model based on Fuzzy Synthetic Evaluation and Jin (2010a) developed a neuro-fuzzy decision support system (NFDSS) by combining fuzzy and neural network techniques.

Given the massive demand of infrastructure, PPPs are not an option, but a necessity. According to the market report of wastewater treatment of BOT projects, the Chinese government will invest US$100 billion on the sewage treatment in 2010-2015. A majority of projects will be procured by PPP model. However, the success of a construction project depends greatly on the extent that the risks involved can be identified, evaluated, allocated and responded (Tam, 1999). The objectives of this paper are to identify the critical risks of PPP water projects in China and demonstrate their effects by case studies. It is believed to be valuable in directing further PPP research and improving the existing practices of PPP projects.

## 2. RESEARCH METHODOLOGY

Case study was adopted as the primary data collection method, preceded by review of the relevant PPP literature published between 1999 and 2010. Nine PPP water projects were studied and their information was summarized in Table 1. These cases were collected from 8 different provinces of China. They are: Changchun (in Jilin province); Wuhan (in Hubei province); Quanzhou (in Fujian province); Nantong (in Jiangsu province); Zhujiang (in Guangdong province); Jieshou (in Anhui province); Shenzhen (in Guangdong province); Chengdu (in Sichuan province); and Xianyang (in Henan province). The case study approach is adopted mainly because it is considered to be the preferred research strategy when a "how" question is asked about a contemporary set of events over which the investigator has little or no control (Singh and Kalidindi, 2009; Yin, 2009).

**Table 1.** General information of the nine selected PPP water projects in China

| Project name/ location | Water process load | Concessionaire | Year of project | Approx. cost (RMB) | Concession period | Type of PPP | Status |
|---|---|---|---|---|---|---|---|
| 1. Changchun | 390 thousand $km^3$/day | HuiJing Ltd | 2000 | 270 million | 20 years | BOT | Liquidated |
| 2. Wuhan | 25 thousand $km^3$/day | Wuhan Kaidi Ltd | 2001 | 90 million | 20 years | BOT | Liquidated and re-start |
| 3. Quanzhou | 25 thousand $km^3$/day | Eastern City Ltd | 2008 | 60 million | 30 years | BOT | Opened officially |
| 4. Nantong | 100 thousand $km^3$/day | Nantong Pacific Ltd | 2007 | 100 million | 30 years | BOT | Work in process |
| 5. Zhujiang | 100 thousand $km^3$/day | German Ltd | 2006 | 120 million | 25 years | BOT | Suspended |
| 6. Jieshou | 22 thousand $km^3$/day | Anhui Ltd | 2008 | 20 million | 25 years | BOT | Opened officially |
| 7. Shenzhen | 200 thousand $km^3$/day | Shenzhen Lanqing Ltd | 2008 | 210 million | 25 years | BOT | Opened officially |
| 8. Chengdu | 400 thousand $km^3$/day | Chengdu Generale De Eauv-Marubeni | 1999 | 700 million | 30 years | BOT | Opened officially |
| 9. Xianyang | 100 thousand $km^3$/day | Guangdong Cinsheng Ltd | 2005 | 200 million | 30 years | BOT | Opened officially |

## 3. EXAMINATION OF THE CRITICAL RISKS IN IMPLEMENTING PPP WATER PROJECTS IN CHINA

Content analysis was adopted to identify the critical risks affecting the performance of PPP water projects in China. After the analysis, a total of 11 critical risks affecting the performance of PPP water projects in China were identified and categorized, including: (1) political risk; (2) legal risk; (3) government credit risk; (4) market demand change risk; (5) inflation risk; (6) product price risk; (7) inaccurate market forecast risk; (8) contract risk; (9) financing risk; (10) lack of supporting infrastructure risk; and (11) technical risk. Details of the risk items and their occurrence in PPP water projects are delineated in Table 2. Each risk comprises four elements: (1) risk source; (2) risk event; (3) risk consequence and (4) risk allocation. A single risk event may result from a single or multiple sources, and may result in a single or multiple consequences (Wang and Chou, 2003). It can be seen that failure to manage these risks effectively may lead to serious consequences including poor quality, schedule delays, budget over-runs, and contractual disputes (Shen et al., 2006). These risk factors were distilled and classified into three main categories, namely, (1) macro level risks; (2) meso level risks; and (3) micro level risks as shown in Table 3 (Li, 2003). This classification is beneficial to better analyze risk allocation because risk allocation strategies are determined to some extent by the risk category (Wang and Chou, 2003). Risks that fall into different risk categories may have different risk allocation strategies (Li et al., 2005).

**Table 2.** Critical risks affecting the success of PPP water projects in China

| No | Project name/ location | Risk sources | Risk events | Risk consequences | Remarks of risk allocation |
|---|---|---|---|---|---|
| 1 | Changchun | • Legal risk | • The Chinese central government issued a nationwide decree to liquidate PPP projects with fixed rate of investment return.<br>• To carry out the decree issued by the central government, the local government announced to abolish the project regulation on Huijin i.e. "Management rules for sewage treatment plant of Changchun Huijin". Thereafter, Huijin sewage treatment plant became an illegal project. | • The project was liquidated and bought back by the local government. | The loss resulting from legal change was assumed by government.<br>In view of the government has the power to establish and modify laws and thus has a strong ability to control and sustain the legal risk. It is reasonable to allocate legal risk to government. |
| 2 | Wuhan | • Lack of supporting infrastructure<br>• Government credit risk | • The risk of matching network with sewage delivery was undertaken by the government. However, the government did not perform the obligation and the project was left unused for three years after the construction was completed. | • The project was suspended for a period of 36 months and a lake nearby was therefore polluted by sewage.<br>• Finally, the project was liquidated at a price of 90 million CNY by local government. | Providing necessary facilities (such as road, electricity, water, etc) for the construction and operation of PPP projects and fulfilling its promise defined in concession agreement are the obligation of government, so these two risks ought to be assumed by the government. |
| 3 | Quanzhou | • Political risk (Government intervention risk)<br>• Inflation risk | • During the construction period of this project, a peasant sports games was held and the government requested the concessionaire to accelerate construction process and strive for completing all the construction work before the opening ceremony of sports games.<br>• The steel price rocketed from 3300 CNY/tons to 5980 CNY/tons during this acceleration period. | • Cost overrun 5 million CNY. | Without doubt, the loss resulting from undue government intervention should be assumed by the government. However, the private sector obtained no compensation from the government in this project.<br>Inflation factor was usually included in water pricing formula. The project company made an assumption on the inflation within the whole concession period and determined the operational water price for each operational year according to that assumption; the project company should bear the risks arising out of the margin between the actual inflation rate and the assumed inflation rate. |

(Continued)

| No | Project name/ location | Risk sources | Risk events | Risk consequences | Remarks of risk allocation |
|---|---|---|---|---|---|
| (Continued) | | | | | |
| | | • Financing risk | • Without the government's support, the private sector could not obtain loan from commercial banks as the local banks are unfamiliar with the PPP model which usually involved long earning cycle and high policy risk. | • The project was suspended for two months. | Financing risk was totally assumed by the private sector in this project. |
| | | • Price risk<br>• Credit risk | • The initial sewage treatment price of this project was 0.83 CNY/$m^3$; a unit price was set to be adjusted at every five years. The price adjustment cycle is long and the concessionaire was therefore exposed to high price risks. As investments in PPP projects are quasi-irreversible. Once the projects start, the private sector rarely has the bargaining power to threaten to suspend or abandon the projects in face of regulation change (such as, price change) issued by the local government. | • The private sector showed little interest in investing follow-up PPP projects. | The price adjustment was unreasonable in this project, and the implementation of price adjustment may affected by potential government credit risk. |
| 4 | Nantong | • Financing risk | • The concessionaire could not obtain loan from commercial banks in time.<br>• The commercial bank provided loan mainly based on enterprise's property debt table instead of the actual economic viability of PPP projects. This limited the investor's investment ability for PPP projects. | • Schedule delay of six months. | Same with case 3, financing risk was totally assumed by the private sector in this project. |
| | | • Price risk | • The price of water supply has to be approved by the Price Control Bureau every year. The opaque pricing process is a tremendous risk for investors as the price may not rise in accordance with the increase of actual input cost. | • The pricing adjustment mechanism greatly affected the process of negotiation. | Pricing risk was shared by the government and the private sector jointly. Similar with case 3, the implementation of price adjustment would greatly depend on the government support. |

(Continued)

| No | Project name/ location | Risk sources | Risk events | Risk consequences | Remarks of risk allocation |
|---|---|---|---|---|---|
| (Continued) | | | | | |
| 5 | Zhujiang | • Lack of supporting infrastructure | • The input water volume is insufficient due to a lack of matching network for sewage delivery. | • The government had to pay for sewage treatment fee at full price (unit price × full load) based on guarantee clauses. | Same with case 2, risk of lack of supporting infrastructure was totally assumed by the government. |
| | | • Technical Risk | • The project and its process technology were designed based on the standard of household sewage. While more than 60% of sewage was discharged by factories (industrial sewage) in this project. | • The update of technology for processing factory sewage induced cost overrun. | The technology adopted is not able to meet the requirements of project operation. This risk was assumed by the private sector. |
| 6 | Jieshou | • Political risk (Corruption risk) | • An officer was reportedly bribed with 294 thousand CNY by 21 Engineering corporations in the past six years. | • Poor construction and equipment quality. | Corruption risk should be assumed by the government. |
| 7 | Shenzhen | • Inaccurate market forecast | • The design capability of this project was 200,000 $m^3$ per day, but the actual demand was about 100,000 $m^3$ per day. Process capability of sewage was far beyond the local socio-economic development planning. | • The idle capability resulted in inefficient investment and great financial burden to the local government. | As the project scale is determined by the government and the private sector jointly based on local development planning at the feasibility stage. Inaccurate market forecast is usually shared by both parties, as neither party can solely assume the risk. |
| 8 | Chengdu | • Inaccurate market forecast | • There was a big difference between the forecast demand and actual demand. The idle capability was as much as 28,000 $m^3$ per day. | • The idle capability resulted in inefficient investment. | Same with case 7. |
| | | • Contract risk | • According to the "take-or- pay" purchase contract, the government had to pay the private sector for water fee based on the largest productivity rate of 400,000 $m^3$ per day at a fixed price, instead of the actual work load. It is an inequitable risk sharing mechanism between the government and the private sector as the government undertook all the market risks. | • Water company representing the local government suffered a negative net cash flow. | Government guarantees can reduce risk but are not free of cost. Excessive guarantees provided led to high performance costs for the government and cause the concession agreement unable to be fulfilled. |

(Continued)

| No | Project name/ location | Risk sources | Risk events | Risk consequences | Remarks of risk allocation |
|---|---|---|---|---|---|
| (Continued) | | | | | |
| 9 | Xianyang | • Market demand change | • With the gradual transfer of printing enterprises and casting enterprises from other cities to Xianyang, the water quality worsened significantly during the operation period of the water sewage plant.<br>• The amount of input water for depurating is far beyond the designed peak value by about 2-3 times. | • Existing technology and equipment is not effective anymore. | In this project, the market demand risk was shared by the government and the private sector. Both the government and private sector were exempted from their respective liabilities. |

**Table 3.** Critical risk factors extracted from nine case studies

| No | Category | Number | Critical risk factors | Risk description |
|---|---|---|---|---|
| C1 | Macro level risks | R-1 | Political risk | It refers to government official corruption, undue government intervention, or/and inadequate government support. |
| | | R-2 | Legal risk | Local government's inconsistent application of laws and regulations may lead to an increase in construction or/and operation cost, such as changes in land management law, taxation law, etc. |
| | | R-3 | Government credit risk | The government is unwilling or/and unable to fulfill its obligations defined in concession agreement. |
| C2 | Meso level risks | R-4 | Market demand change risk | Market demand change risk refers to the sale risk of project products or services, such as increase or decrease in market demand during the concession period. |
| | | R-5 | Inflation risk | It refers to the rise of overall price level of products and the fall of purchasing power of currency. |
| | | R-6 | Product price risk | A lack of appropriate concession pricing or flexible adjustment mechanism results in insufficient operation revenue. |
| C3 | Micro level risks | R-7 | Inaccurate market forecast | The market forecast deviates greatly from the actual market scale and the local socio-economic development planning, |
| | | R-8 | Contract risk | It mainly includes contract documentation errors, ambiguities or inconsistencies; inequitable risk-sharing; or/and unclear boundary between responsibilities and obligations. |
| | | R-9 | Financing risk | Poor financing market or unavailability of financing instrument results in difficulties in project financing. |
| | | R-10 | Supporting infrastructure risk | Supporting facilities (such as road, electricity, water, etc) which are necessary for the construction, operation, and management of PPP water projects, is not available in a timely manner or at fair rates. |
| | | R-11 | Technical risk | The technology adopted is not mature or able to meet the requirements of project construction or/and operation. |

## 4. DISCUSSIONS ON THE ORIGIN AND ALLOCATION MECHANISM OF CRITICAL RISKS

To handle risks successfully, industrial practitioners need to fully understand the risk origin and their allocation mechanism. However, there are often different interpretations of risk origin and their sharing model between the government and the private sector. Disagreements may result from the absence of related information, unclear stipulations, or queries about the fairness of risk allocation (Wang and Chou, 2003). This section will discuss the origin and allocation mechanism of critical risk factors to highlight and corroborate the risks identified from the aforesaid case studies based on early literatures.

### 4.1. R-1 Political risk

*R1-1 Origin of Political Risk.* Political risk may exist in all aspects and stages of PPP projects, and mainly includes:

1. Government intervention risk: It refers to excessive administrative intervention or ineffective supervision. The government may intervene in the design, site selection, engineering construction, operation, and product sales of PPP projects by means of issuing compulsory regulations, ordering the purchase of raw materials from designated suppliers, and collecting additional charges for the use of chartered rights, and so on (Fan, 2005; Sachs et al., 2007).
2. Government support risk: It relates to the abrogation of the Project Company's franchised right midway, the alteration of taxation policy or the import and export restrictions, as well as the abolishment of the corresponding preferential policies, including those on land requisition, dismantling and relocation, and the compensatory money. Moreover, the government may apply discrimination treatment for the foreign concessionaires of the PPP projects and release a series of policies to protect local enterprises, such as discriminatory tax rate, strict control of selling price, and so on (Sachs et al., 2007).
3. Bureaucracy and corruption risk: It means that the government's officials or representatives solicit or receive unlawful benefits, exert or utilize any unlawful influences to award an agreement to the project developer (Wang and He, 1999; Wang et al., 2000).

*R1-2 Allocation of Political Risk.* It is logical that political risk should be solely borne by the government because only the government has the capability to control it. The private party can seek guarantee from the government through defining the rights and obligations in the concession agreement and try to obtain government's written credit support (Gao, 2002). If the political risk is unavoidable, the government should compensate the project company through financial subsidy or adjusting concession price or/and period based on market rules. In addition, it is advisable to look for insurance from commercial insurance companies or public agencies, such as export credit and multilateral development institutions. Insurance on political risk will not only be beneficial in reducing political risk but also in obtaining project financing from commercial banks (Wang, 2003).

### 4.2. R-2 Legal risk

*R2-1 Origin of Legal Risk.* China lacks a unified national PPP legal system and has not yet formed a legal environment that is favorable for the execution of the PPP projects (Qi et al., 2010). The PPP project-related problems are primarily handled according to the ministerial regulations or the local government regulations (Yuan et al., 2007). Thus, the project company usually needs to consume a high study cost and long adaptation time to familiarize with the local legal environment, and it is likely to be exposed to a high legal risk

(Qi et al., 2010). The PPP project-related legal risks are mainly derived from alterations of the related laws and regulations, such as land, tax, labor, environmental protection laws and the change of the government's macroscopic economic policies (Fan, 2005; Phillips-Patrick, 1991). For water industry, legal risks mainly manifest in the following aspects:

1. Adjustment of land policy increases the expense for the land acquisition, dismantling, and relocation.
2. Adjustment of industrial policy, such as preferential policy on the water project, results in cost overrun or income reduction.
3. Adjustment of service standard (e.g. water quality standard) leads to operation cost overrun.

*R2-2 Allocation of Legal Risk.* With regards to the current PPP water projects in China, the government bears most of the legal risks (Kong and He, 1999). The reasons behind the risk allocation model are mainly due to the controllability of legal risks by the government and the risk sustainability of the concessionaire. The government has the power to establish and modify laws and thus has a strong ability to control and sustain the legal risk, while the concessionaire can only accept legal risks passively. This is in accordance with the risk allocation principle "risks should be assigned to the party who has the most risk management capability" (Lam et al., 2007). The legal risk can be transferred to the government through compensation clauses in the concession agreement in the form of heightened water price or extended concession period. Moreover, if the project company is unable to fulfill its obligations due to legal changes that meet the conditions of a force majeure, the project company has the right to discontinue its obligations (Deng, 2007).

### 4.3. R-3 Government credit risk

*R3-1 Origin of Government Credit Risk.* It is well known that the PPP projects are backed by the effective credit guarantee structure which is composed of many project participators (Deng, 2007). The participators' ability and willingness to fulfill the obligations constitute the credit risk of PPP projects (Wang and Jia, 2005). Government credit risk refers to the risk that the government fails to fulfill and/or rejects to fulfill the contractual responsibilities and obligations (Yan, 2005). Under the uncertain institutional condition, the administrative system has not yet begun to process of institutionalization, standardization, and proceduralization, and the rules for the pricing model of the governed industry have not been established (Deng, 2007). Governments at different levels are unable to make credible commitment to the future degree of marketization and profitability of project. Thus, using fixed repayment to attract private capital almost becomes the only strategy (Yu and Qing, 2005). However, the local government did not make necessary institutional arrangements such as centering on the rate of return on investment (ROF) and listing it under the institutional management or assigning a special management organization to settle disputes independently. It is inevitable to accumulate enormous credit risk (Yan and Ruan, 2003). Credit risk of Chinese local government usually appears as the government's default risk in the form of performing obligation in arrears or terminating the concession agreement.

*R3-2 Allocation of Government Credit Risk.* Naturally, government credit risk should be wholly borne by the government. In China, the Internal Rate of Return of many PPP projects is very high, allowing it to become the "gold mine" in many investors' eyes (Yan and Ruan, 2003). However, it also results in a high performance cost for the government, and heightens the uncertainty of government credit risk (Yan and Ruan, 2003). No matter how passionate the government is and how alluring the promise made when a contract is signed, the adequate market investigation

and analysis is still the key for the success of PPP projects. Changchun sewage treatment project as introduced previously is a convincing example.

### 4.4. R-4 Market demand change risk

*R4-1 Origin of Market Demand Change Risk.* Market risk refers primarily to the sales risk of project products or services, such as an increase or decrease in market demand. Market demand increase may require the concessionaire to expand the original project to meet the expanded demand of water volume, such as that in case 9. On the contrary, market demand decrease may result in the operation revenue risk to the private sector. Unless the project company obtains the government's promise that it will purchase the products as a whole or in parts at a reasonable price after the completion of the project, or the concessionaire will face a high market risk (Wang and He, 1999). The commonly adopted measures to avoid market decrease risk are:

1. Obtain purchase guarantee from the government (Wang and Tiong, 2000; Kong and He, 1999). However, the host country or the third party will bear significant risks and their compliance cost will thus increase greatly.
2. Obtain preferential policies from the government as compensation to the risk loss, (Kong and He, 1999) such as the provision of other PPP project facility or land development right to the private sector.
3. Obtain competition protection from the government (Kong and He, 1999). Early project practice indicates that obtaining competition protection from the government is an effective response measure for market risk. Take the Anglo-French Channel Tunnel Project as an example, the government promised that no more cross harbor connection facilities would be built in the next 33 years. This is also an efficient method to reduce the market risk for the water industry.

*R4-2 Allocation of Market Demand Change Risk.* For the allocation of market demand change risk, two commonly used risk allocation strategies are:

1. The government and the private sector share the market risk. In order to ensure relatively stable cash flow, the government will generally sign an agreement with the project company to offer a guarantee on market risk through articles of "guarantee for minimum revenue" and "competition protection". This design of risk-sharing mechanism could attract private investors and achieve the goal of developing PPP procurement. For instance, the contract of the largest PPP transport project in Australia: Melbourne Round-the-city Express Highway Project stipulated that if the government's behavior led to a decrease in the expressway profits, it had to make full compensations. On the other hand, if the government's action helped increase the expressway profits, it could only share 50% of the increased profits (Arndt and Maguire, 1999).
2. Market risk is usually shared by the government and the private sector in the water industry. However, in other industries, this risk is often fully assumed by the private sector, such as that in the Hong Kong Tunnel project. In this project, the concessionaire of HK tunnel assumed all risks related to construction, geology, environment, climate, financing, inflation, and cost escalation. And the government only provided guarantee on the risk of land acquisition, no guarantees or warranties are given with regard to the program for minimum traffic flows or economic returns, and future competitive routes (Zhang and Kumaraswamy, 2001).

### 4.5. R-5 Inflation risk

*R5-1 Origin of Inflation Risk.* Inflation is an important indicator to measure whether an economy is stable and healthy (Chen and Ma,

2007). In modern economy, inflation means the rise of the overall price level as well as the fall of the purchasing power or the market value of currency. This risk is more apparent during the construction phase of PPP projects (World Bank, 2006).

*R5-2 Allocation of Inflation Risk.* For PPP projects, there are two views on the allocation of inflation risks. The first view holds that the government shall provide a guarantee concerning inflation risks, i.e. risk should be allocated to the government primarily, as it is non-commercial risk and beyond the control of the concessionaire. Such risk can only be dealt with by the government and only the government has the power to take corresponding measures to avoid the risk or make up for the loss. Contract clauses on price fluctuations can be included in the concession agreement (payment agreement) against inflation risk. However, it is not easy to carry out this measure because the price adjustment formula can hardly cover actual additional cost precisely (Wang and He, 1999). A second view holds that inflation risk should be equally shared by the government and the private sector. Take the water supply project in Chengdu as an example. The price of water is decided by the bidder in the tender. The private sector needs to make an assumption on the inflation rate, and assume risks arising from inconsistency between the actual and the forecasted inflation rate. In actual application, the second view seems more popular than the first view.

### 4.6. R-6 Product price risk

*R6-1 Origin of Product Price Risk.* The PPP products or services are necessities for the development of national economy and people's livelihood (Wang et al., 2000). Undervalued prices may decrease the expected profits of the investment and the enthusiasm of the private investors, which could further deter the development of regional PPP projects. While, outrageous prices may decrease the service efficiency of the infrastructure and the fairness of social welfare, even cause chaos to the pricing system, which may further induce economic and social problems. The water price under the purchase agreement is usually determined on the basis of a price formula that is agreed upon after negotiations among the private sector, the prospective water purchaser, the local governments, and the pricing bureau. Once established, the price is subjected to an annual review by the pricing bureau and adjustments are made in accordance with the formulae (Wang et al., 2000). As time goes by, there is no assurance that the formulae would not be renegotiated and subsequently changed. Therefore, the adjustment may not be sufficient to cover increased cost due to various reasons, such as inflation and changes in regulations.

*R6-2 Allocation of Product Price Risk.* Product price risk should be investigated, predicted, negotiated, and determined at the bidding phase after a detailed feasibility study is conducted by both parties. This risk should be shared by the government and the private sector jointly. The private sector can transfer part of the price risk to the government by obtaining a guarantee from the government and establishing an appropriate adjustment formula to balance the actual operation cost and water price. The operation costs should cover the local inflation, exchange rate and input costs (Yang and Chen, 2004). This allocation model can not only make full use of capability of government in policy support, but it also benefits the enhancement of the service quality of the private sector.

### 4.7. R-7 Inaccurate market forecast

*R7-1 Origin of Inaccurate Market Forecast Risk.* Inaccurate market forecast risk is usually caused by substandard decision-making procedures, lack of PPP project operational experience and capacity, inadequate prepa-

rations, or unequal information-sharing (Qi et al., 2010). From the before mentioned practical cases, it can be seen that the main decision-making error is that of inaccurate determination of project size. If the size of a water plant exceeds the actual needs or is beyond the local socio-economic development planning, its idle processing power will result in inefficient investment and great financial burden to the government. In contrast, deficient volume scale will result in rebuilding and expansion risk.

*R7-2 Allocation of Inaccurate Market Forecast Risk*. PPP projects are often initiated by the government and a feasibility study is conducted by the private sector. Because the decision-making of the project scale is made by both parties, the risk of decision-making error should be shared by both sides.

### 4.8. R-8 Contract risk

*R8-1 Origin of Contract Risk*. Contract risk mainly includes: (1) contract documentation errors, ambiguities and inconsistencies; (2) unreasonable risk-sharing; (3) a lack of commitment from both parties; and (4) unclear boundary between parts' responsibilities and obligations (Deng, 2007; Macneil, 1978). As a PPP project usually lasts for several decades, great changes can take place in the social, political, and economic environment as time goes by. If the contract documents lack flexibility, some of the provisions will very likely become shackles to parties in the future.

*R8-2 Allocation of Contract Risk*. According to the fault rule that risk should be borne by the party who makes the mistake or fails to perform the obligation (Deng, 2007), contract document risk arising from different reasons has different risk allocation models.

1. Risks arising from poor contract management in the private institutions should be assumed by the private sector.
2. Risks arising from imprecise contract terms should be shared by the government and the private sector.
3. Risks arising from changes in policies/regulations should be borne by the government.

### 4.9. R-9 Financing risk

*R9-1 Origin of Financing Risk*. Financing risk is usually caused by a unreasonable financing structure (Standard & Poor, 1997), an unhealthy financing market, a single financing channel, an imperfect financial security system, financing availability (Li et al., 2005), and other factors. The most common financing risk is the difficulty in fundraising. Two out of the nine cases encountered this risk. To obtain a loan, two major elements should be appropriately handled. The first one is the revenue stream of the project, which is linked with the payment mechanism defined in the purchase agreement that is signed by the government and the concessionaire. The second element is the payout stream of the concessionaire, which depends on the complexity of construction, the length of the building period, the experience of the building contractor and the operational cost. Therefore, to facilitate project financing, the best method is to transfer the revenue stream risk to the government through a purchase agreement and transfer the payout risk to the general contractor by an Engineering Procurement Construction (EPC) contract.

*R9-2 Allocation of Financing Risk*. The main allocation model for financing risk is that the private sector entirely bears the financing risk. The essence of PPP procurement is to allow the private sector to finance, build, and operate a project under the concession contract. However, under specific circumstances, if the government can provide a loan or loan guarantee to the private sector, then the financing risk and the success of the project may be reduced and promoted, respectively. For example, 1) the Australian government provided long-term loans and operating costs subsidies to the concessionaire in the Harbor Tunnel

Project (Kong and He, 1999); 2) The Taiwanese government developed special "bonuses" and preferential policies in interests and loans, including tax deduction and exemption, and preferential land rent and development to encourage private participation in infrastructure during the construction period of Taiwan's high-speed railroad (Song, 2006). From these practical experiences, it can be concluded that financing risk can not only be exclusively assumed by the private sector but can be shared by the government and private sector jointly.

### 4.10. R-10 Lack of supporting infrastructure risk

*R11-1 Origin of Supporting Infrastructure Risk.* Supporting infrastructure risk represents the condition in which the facilities that are necessary for the construction, operation, and management of PPP water projects are not available in a timely manner or at a fair price (Ke et al., 2010). Although the supporting infrastructure is not generally part of a PPP project, it has significant influence on a PPP project's normal construction and operation. Take the Wuhan Lake Tomsh Sewage Treatment Plant as an example: the matching network for sewage delivery was not available in time and the sewage plant was therefore suspended for a period of 36 months and polluted a nearby lake. Eventually, the plant was liquidated and transferred to the Wuhan municipal government by way of asset evaluation (Qi et al., 2010).

*R11-2 Allocation of Supporting Infrastructure Risk.* Without a doubt, the supporting infrastructure risk should be borne by the government. The private sector needs to transfer this risk to the government through a "take-or-pay" agreement so as to ensure project returns and avoid any supporting infrastructure risk. Even if the input water volume is seriously underestimated due to a lack of matching network for sewage delivery, the project company can still obtain a reasonable sewage treatment fee based on guarantee clauses.

### 4.11. R-11 Technical risk

*R11-1 Origin of Technical Risk.* Technical risks are usually reflected in the following three aspects:

1. The technology used is unable to meet the predetermined standards and requirements (Deng, 2007; Zhou and Wu, 2003).
2. Since new technologies (such as new materials, new energies, new equipment) adopted are immature, the production efficiency of PPP projects is lower than the anticipated level, and the project quality fails to meet the expected quality standards (Deng, 2007).
3. The progress in science and technology requires the continuous update of materials, construction, and products. The failure to keep up the pace of technological renewal can bring about high project costs and poor applicability, thus forcing the private sector to make additional investments for project renovations or transformations (Deng, 2007).

*R11-2 Allocation of Technical Risk.* It is widely accepted that technical risk should be borne by the project company. This can be explained by the fact that the project company has more competence to control this sort of risk than the government. For technical risk prevention and control, the project company needs to select qualified and experienced construction contractors and operators with advanced and mature technologies to construct and operate project. If a technical malfunction is caused by the contractor, the contractor's performance bond can be used to compensate the risk loss. Usually, the contractor's performance bond will not be refunded until several months or years after the project completion and commissioning (Gao, 2002).

## 5. LESSONS LEARNED FROM THE NINE CASE STUDIES

Earlier research studies showed that risk allocation strategies were determined, to some extent, by the risk category (Wang and Chou, 2003). Risks that fall into different risk categories may have different risk allocation strategies (Wang and Chou, 2003). According to the aforesaid discussions, the risk factors and their risk allocation models are summarized in Table 4. Risks from the macro level including political, legal risks and government credit risk, or risks that are directly related to government action or beyond the management capability of the private sector, such as supporting infrastructure risk, should be allocated to the government. Likewise, risks that can be effectively controlled by the private sector's aptitude altitude and experience, such as technical risk, should be borne by the private sector. For inflation risk, product price risk and inaccurate market forecast from the meso level, it is advisable to share them between the public and private sectors, as neither the public nor private sectors can tackle these risks independently. Moreover, market demand change risk, contract document risk and financing risk have no proposed explicit allocation strategy as it is difficult to clearly determine who should bear or share these risks; their risk allocation model strongly depends on specific project circumstances. Based on the risk allocation matrix, the private sector can further allocate private risk to construction contractors, operations contractors, and insurers. The government can also further allocate the government risk to the end-user, which forms a risk guarantee structure as shown in Table 5.

**Table 4.** Risk allocation matrix of critical risks

| No | Risk factor | Risk Allocation | | | |
|---|---|---|---|---|---|
| | | Government | Shared | Private | Undecided |
| R-1 | Political risk | * | | | |
| R-2 | Legal risk | * | | | |
| R-3 | Government credit risk | * | | | |
| R-4 | Market Demand Change Risk | | * | * | √ |
| R-5 | Inflation risk | | * | | |
| R-6 | Product price risk | | * | | |
| R-7 | Inaccurate market forecast | | * | | |
| R-8 | Contract risk | * | * | * | √ |
| R-9 | Financing risk | | * | * | √ |
| R-10 | Supporting infrastructure risk | * | | | |
| R-11 | Technical risk | | | * | |

Note: "Government" denotes that risks should be wholly borne by the government; "Private" denotes that risks should be holly borne by the private sector ; "Shared" denotes that risks should be shared by the government and the private sector; "Undecided" denotes that risks have no explicit allocation strategy

**Table 5.** Risk guarantee structure of PPP water projects in China

| No | Critical risk factors | Guarantee type | Contract type |
|---|---|---|---|
| R-1 | Political risk | Government guarantee<br>Government involves project directly<br>Insurance | Concession agreement<br><br>Insurer contract |
| R-2 | Legal risk | Government guarantee | Concession agreement |
| R-3 | Government credit risk | Government guarantee | Concession agreement |
| R-4 | Market demand change risk | Lowest purchasing volume guarantee<br>Competition guarantee<br>Market study<br>Price or concession period adjustment | Purchase agreement<br>Concession agreement<br>Consultation contract<br>Concession agreement |
| R-5 | Inflation risk | Price or concession period adjustment | Concession agreement |
| R-6 | Product price risk | Price or concession period adjustment | Concession agreement |
| R-7 | Inaccurate market forecast | Feasibility study | Consultation contract |
| R-8 | Contract risk | | |
| R-9 | Financing risk | Government guarantee letter | Loan agreement |
| R-10 | Supporting infrastructure risk | Government guarantee | "Take or pay" purchase contract |
| R-11 | Technical risk | Performance guarantee | Construction/Operation contract |

It is worth noting that different PPP projects differ in the following aspects, (1) frequency and severity of risk; (2) the participator's risk control and project loss-bearing capability; (3) the contractual party's negotiation ability; (4) the PPP project competition situation; (5) the private sector's investment strategy; and (6) the risk preference (Arndt and Maguire, 1999; Loosemore and McCarthy, 2008; Thomas et al., 2003). They are a large number of factors affecting the allocation of risk, risk allocation of the PPP project can be uncertain and can change continuously according to the actual context of the project. Hence a partnership established on the basis of mutual trust and mutual benefit is more important than the pursuit of optimum risk allocation. The project participators should pay more attention to the overall balance of risks and benefit, and the intrinsic risk guarantee structure of PPP projects. Moreover, it can be seen from Table 2 that most risk events for PPP water projects in China were incurred by the government or directly connected to government action. Currently in China, government risks are considered as one of the most important risk factors to be tackled by project practitioners (Sachs et al., 2007). The Chinese central government and local governments lack requisite experience, laws and policies to guide the execution of PPP ventures (Ke et al., 2010; Sachs et al., 2007). These could result in government imposing illegal or undue interference and constraints on the private sector during the execution of PPP projects. A definition solution is to transfer these risks to the government through concession agreement.

## 6. CONCLUSIONS

A large number of public–private partnership projects have been developed during the infrastructure development in China and a variety of risks have been encountered. This

necessitates the identification, analysis and allocation of critical risks to promote the success of PPP projects. Nine PPP water projects in China were scrutinized and 11 critical risks including (1) political risk; (2) legal risk; (3) government credit risk; (4) market demand change risk; (5) inflation risk; (6) product price risk; (7) inaccurate market forecast risk; (8) contract risk; (9) financing risk; (10) supporting infrastructure risk; and (11) technical risk were identified from real-risk events. The origin of risk factors was then analyzed and discussed based on China's current political, economic, and legal circumstances. Preferred risk allocation strategies were also suggested as follows:

- Political, legal, government credit, and supporting infrastructure risks should be allocated to the government.
- Technical risk should be borne by the private sector.
- Inflation risk, product price risk, and inaccurate market forecast risk should be shared between the public and private sectors.
- Market demand change, contract, and financing risk have no explicit allocation strategy, as these depend on specific project circumstances.

The proposed risk sharing mechanism could help the government and the private sector to achieve a more equitable allocation of tasks and thus decrease the time and cost of contract negotiation. It is believed that the experience gained from the case studies will benefit the execution of ongoing and subsequent PPP projects. To enhance its general application, the further validation of research findings through additional cases or empirical studies should be conducted.

## ACKNOWLEDGMENTS

The work described in this paper was supported by the National Natural Science Foundation of China (Project No. 71101130). Special gratitude is also extended to a joint grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (RGC Project No. N_PolyU5114/05E) and the National Natural Science Foundation of China (Project No. 70731160634).

## REFERENCES

Andi (2006) The importance and allocation of risks in Indonesian construction projects, *Construction Management and Economics*, 24(1), pp. 69–80. doi:10.1080/01446190500310338

Arndt, R. and Maguire, G. (1999) *Risk allocation and identification project – survey report*, Unpublished report, University of Melbourne, Department of Treasury and Finance, Australia.

Carr, V. and Tah, J. H. M. (2001) A fuzzy approach to construction project risk assessment and analysis: construction project risk assessment system, *Advance in Engineering Software*, 32(10-11), pp. 847–857. doi:10.1016/S0965-9978(01)00036-9

Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E. and Ke, Y. J. (2010) Critical success factors for PPPs in infrastructure developments: Chinese perspective, *Journal of Construction Engineering and Management-ASCE*, 136(5), pp. 484–494. doi:10.1061/(ASCE)CO.1943-7862.0000152

Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E. and Ke, J. Y. (2009a) Drivers for adopting public private partnerships-empirical comparison between China and Hong Kong special administrative region, *Journal of Construction Engineering and Management-ASCE*, 135(11), pp. 1115–1124. doi:10.1061/(ASCE)CO.1943-7862.0000088

Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E. and Ke, J. Y. (2009b) Potential obstacles to successful implementation of public private partnerships (PPP) in China and the Hong Kong special administrative region, *Journal of Management in Engineering-ASCE*, 26(1), pp. 30–40. doi:10.1061/(ASCE)0742-597X(2010)26:1(30)

Chen, C. and Doloi, H. (2008) BOT application in China: driving and impeding factors, *International Journal of Project Management*, 26(4), pp. 388–398. doi:10.1016/j.ijproman.2007.07.002

Chen Y. B. and Ma L. L. (2007) The study of the cost of inflation in China, *Economic Research Journal*, 4(2), pp. 36–40.

Choi, H. H., Cho, H. N. and Seo, J. W. (2004) Risk assessment methodology for underground construction projects, *Journal of Construction Engineering and Management-ASCE*, 130(2), pp. 258–272. doi:10.1061/(ASCE)0733-9364(2004)130:2(258)

Deng, X. P. (2007) *A study of risk allocation and countermeasures in implementing PPP projects*, PhD thesis, Department of Building and Real Estate, Southeast University. (In Chinese)

Deviprasadh, A. (2007) *Risk assessment and management in construction projects*. Department of Civil Engineering, College of Engineering Guindy campus, Anna University, Chennai. Master thesis.

Fan, J. C. (2005) Risk identification and management of a BOT project financing, *Construction Technology*, 34, pp. 69–73. (In Chinese)

Forbes, D., Smith, S. and Horner, M. (2008) Tools for selecting appropriate risk management techniques in the built environment, *Construction Management and Economics*, 26(11), pp. 1241–1250. doi:10.1080/01446190802468487

Gao, X. (2002) The risk analysis on the BOT financing model, *Water Power*, 4, pp. 10–14. (In Chinese)

Jin, X. H. (2010a) A neurofuzzy decision support system for efficient risk allocation in public-private partnership infrastructure projects, *Journal of Computing in Civil Engineering-ASCE*, 24(6), pp. 525–538. doi:10.1061/(ASCE)CP.1943-5487.0000058

Jin, X. H. (2010b) Determinants of efficient risk allocation in privately financed public infrastructure projects in Australia, *Journal of Construction Engineering and Management-ASCE*, 136(2), pp. 138–150. doi:10.1061/(ASCE)CO.1943-7862.0000118

Jin, X. H. and Doloi, H. (2008) Interpreting risk allocation mechanism in public-private partnership projects: an empirical study in a transaction cost economics perspective, *Construction Management and Economics*, 26(7), pp. 707–721. doi:10.1080/01446190801998682

Ke, Y. J., Wang, S. Q., Chan, A. P. C. and Lam, P. T. I. (2010) Preferred risk allocation in China's public-private partnership (PPP) projects, *International Journal of Project Management*, 28 (5), pp. 482–492. doi:10.1016/j.ijproman.2009.08.007

Knight, K. and Fayek, A. R. (2002) Use of fuzzy logic for predicting design cost overruns on building projects, *Journal of Construction Engineering and Management-ASCE*, 128(6), pp. 503–512. doi:10.1061/(ASCE)0733-9364(2002)128:6(503)

Kong, D. Q. and He, B. S. (1999) Analysis of key factors of BOT project financing, *China Harbour Engineering*, 5, pp. 57–61. (In Chinese)

Lam, K. C., Wang, D., Lee, P. T. K. and Tsang, Y. T. (2007) Modeling risk allocation decision in construction contracts, *International Journal of Project Management*, 25(5), pp. 485–493. doi:10.1016/j.ijproman.2006.11.005

Leung, B. Y. P. and Hui, E. C. M. (2005) Evaluation approach on public-private partnership (PPP) urban redevelopments, *International Journal of Strategic Property Management*, 9(1), pp.1–16.

Li, B. (2003) *Risk management of PPP projects*, PhD thesis, School of the Built and Natural Environment, Glasgow Caledonian University. doi:10.1016/j.ijproman.2004.04.006

Li, B., Akintoye, A., Edwards, P. J. and Hardcastle, C. (2005) The allocation of risk in PPP/PFI construction projects in the UK, *International Journal of Project Management*, 23(1), pp. 25–35. doi:10.1016/j.ijproman.2004.04.006

Loosemore, M. and McCarthy, C. S. (2008) Perceptions of contractual risk allocation in construction supply chains, *Journal of Professional Issues in Engineering Education and Practice-ASCE*, 134(1), pp. 95–105. doi:10.1061/(ASCE)1052-3928(2008)134:1(95)

Macneil, I. R. (1978) Contracts: adjustment of long-term economic relationship under classical, neoclassical, and relational contract law, *Northwestern Law Review*, 72(6), pp. 854–905.

Majamaa, W., Junnila, S., Doloi, H. and Niemistö, E. (2008) End-user oriented public-private partnerships in real estate industry, *International Journal of Strategic Property Management*, 12(1), pp. 1–17. doi:10.3846/1648-715X.2008.12.1-17

Phillips-Patrick, F. J. (1991) Political risk and organizational form, *Journal of Law and Economics*, 34, pp. 675–693. doi:10.1086/467239

Qi, X., Ke, Y. J. and Wang, S. Q. (2010) *Analysis of critical risk factors causing the failures of*

*China's PPP projects*. Available at: http://bpmachina.org/news/091014/091014_2.doc. 2010, 07 (In Chinese)

Roumboutsos, A. and Anagnostopoulos, K. P. (2008) Public-private partnership projects in Greece: risk ranking and preferred risk allocation, *Construction Management and Economics*, 26(7), pp. 751–763. doi:10.1080/01446190802140086

Sachs, T., Tiong, L. K. R. and Wang, S. Q. (2007) Analysis of political risks and opportunities in public private partnerships (PPP) in China and selected Asian countries, *Chinese Management Studies*, 1(2), pp. 126–148. doi:10.1108/17506140710758026

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, *International Journal of Project Management*, 24(7), pp. 587–594. doi:10.1016/j.ijproman.2006.07.006

Singh, L. B. and Kalidindi, S. N. (2009) Criteria influencing debt financing of Indian PPP road projects: a case study, *Journal of Financial Management of Property and Construction*, 14(1), pp. 34–60. doi:10.1108/13664380910942635

Song, L. S. (2006) *The study of government encouraging to participate in public construction by OT & BOT mode*, PhD thesis. National Taiwan University of Science and Technology. (In Chinese)

Standard & Poor (1997) Revised criteria for special-purpose entities in project finance transactions, *Standard & Poor's Global Project Finance*, pp. 7–116.

Tam, C. M. (1999) Build-operate-transfer model for infrastructure developments in Asia: reasons for successes and failures, *International Journal of Project Management*, 17(6), pp. 377–382. doi:10.1016/S0263-7863(98)00061-1

Thomal, A. V., Kalidindi, S., Ganesh, L. S. (2006) Modelling and assessment of critical risks in BOT road projects, *Construction Management and Economics*, 24(4), pp. 407–424. doi:10.1080/01446190500435275

Thomas, A. V., Kalidindi, S. N., Ananthanaryanan, K. (2003) Risk perception analysis of BOT road project participants in India, *Construction Management and Economics*, 21(4), pp. 393–407. doi:10.1080/0144619032000064127

Tieva, A. and Junnonen, J. M. (2009) Proactive contracting in Finnish PPP project, *International Journal of Strategic Property Management*, 13(3), pp. 219–228. doi:10.3846/1648-715X.2009.13.219-228

Wang, F, Y. (2008) The application of risk assessment for construction engineering, *Science & Technology Information*, 19(1), pp. 137. (In Chinese) doi:10.1061/(ASCE)0742-597X(2003)19:2(60)

Wang, Y. (2003) Tropism of financing channels on PFI construction of water supplying works in China, *Water & Wastewater Engineering*, 29(10), pp. 9–12. (In Chinese) doi:10.1016/j.cie.2007.04.009

Wang, M. T. and Chou, H. Y. (2003) Risk allocation and risk handling of highway projects in Taiwan, *Journal of Management in Engineering-ASCE*, 19(2), pp. 60–68.

Wang, Y. M. and Elhag, T. M. S. (2007) A fuzzy group decision making approach for bridge risk assessment, *Computers & Industrial Engineering*, 53(1), pp. 137–148. doi:10.1016/j.cie.2007.04.009

Wang, H. and He, B. S. (1999) A study of project financing risk for BOT model, *China Soft Science*, 5, pp. 113–121. (In Chinese)

Wang, G. Q. and Jia, X. L. (2005) Risk management on the BOT investment and financing model, *China Water & Wastewater*, 21(9), pp. 85–88. (In Chinese)

Wang, S. Q. and Tiong, L. K. (2000) Case study of government initiatives for PRC's BOT power plant project, *International Journal of Project Management*, 18(1), pp. 69–78. doi:10.1016/S0263-7863(98)00072-6

Wang, S. Q., Tiong, L. K. R., Ting, S. K. and Ashley, D. (2000) Foreign exchange and revenue risks: analysis of key contract clauses in China's BOT project, *Construction Management and Economics*, 18(3), pp. 311–320. doi:10.1080/014461900370672

World Bank (2006) *Tools to mitigate risks in highway PPPs. Presented by Cledan Mandri-Perrott in Infrastructure Economics & Finance Department (IEF) Workshop*, PPP in Highways, World Bank. Available at: http://www.worldbank.org.

Xenidis, Y. and Angelides, D. (2005) The financial risks in build-operate-transfer projects, *Construction Management and Economics*, 23(4), pp. 431–441.

Xu, Y. L., Chan, A. P. C. and Yeung J. F. Y. (2010a) Developing a fuzzy risk allocation model for

PPP projects in China, *Journal of Construction Engineering and Management-ASCE*, 136(8), pp. 894–903. doi:10.1061/(ASCE)CO.1943-7862.0000189

Xu, Y. L., Yeung, J. F. Y., Chan, A. P. C., Chan, D. W. M., Wang, S. Q. and Ke, Y. J. (2010b) Developing a risk assessment model for PPP projects in China – a fuzzy synthetic evaluation approach, *Automation in Construction*, 19(7), pp. 929–943. doi:10.1016/j.autcon.2010.06.006

Yan, B. L. (2005) Legal issues concerning the attraction of the private sector's investment in infrastructure, *Shandong University (Philosophy and Social Science Edition)*, 6, pp. 134–138. (In Chinese)

Yan, B. and Ruan, N. (2003) Credit risk: a key factor leading to the success of BOT proejcts, *International Economic Cooperation*, 1, pp. 46–49. (In Chinese)

Yang, S. H. and Chen, L. J. (2004) Experiences with Exercise of BOT approach in Zigong city waste-water project, *China Water & Wastewater*, 20(7), pp. 89–91. (In Chinese)

Yin, R. (2009) *Case study research: design and methods*, 4th edition. Beverly Hills, CA: Sage Publications, Inc.

Yu, H. and Qing, H. (2005) *Experiment of public-private partnership procurement model in China*. Shanghai Ren Min press, Shanghai, China.

Yuan, J. F., Deng, X. P., Li, Q. M. and Wang, W. X. (2007) Research on legislative regulation of PPP model and its application in China, *Construction Economy*, 3(1), pp. 95–99. (In Chinese)

Zayed, T. M. and Chang, L. M. (2002) Prototype model for build-operate-transfer risk assessment, *Journal of Management in Engineering-ASCE*, 18(1), pp. 7–16. doi:10.1061/(ASCE)0742-597X(2002)18:1(7)

Zeng, S. X., Wan, W., Tam, C. M. and Liu, D. (2008) Identifying risk factors of BOT for water supply projects, *Proceedings of the ICE - Water Management*, 161(2), pp. 73–81. doi:10.1680/wama.2008.161.2.73

Zhang, X. Q. and Kumaraswamy, M. M. (2001) Hong Kong experience in managing BOT projects, *Journal of Construction Engineering and Management-ASCE*, 127(2), pp. 154–162. doi:061/(ASCE)0733-9364(2001)127:2(154)

Zhou, F. and Wu. H. T. (2003) Research on the investment in urban sewage treatment in China by the mode of BOT, *Industrial Water*, 23(12), pp. 53–56.

## SANTRAUKA

### SU KINIJOS VANDENS PROJEKTAIS, PAGRĮSTAIS VIEŠOJO IR PRIVAČIOJO SEKTORIŲ PARTNERYSTE, SUSIJUSIŲ RIZIKOS RŪŠIŲ NUSTATYMAS IR PASKIRSTYMAS

**Yelin XU, Yunfang YANG, Albert P. C. CHAN, John F. Y. YEUNG, Hu CHENG**

Atliekant išsamų tyrimą dėl viešojo ir privačiojo sektoriaus partnerystės diegimo, buvo išnagrinėti devyni atvejo tyrimai, siekiant ištirti svarbiausias rizikos rūšis, kurios daro įtaką sėkmingai viešojo ir privačiojo sektoriaus partnerystei Kinijos vandens projektuose. Analizuojant turinį, pagal realius rizikos atvejus nustatyta 11 svarbiausių rizikos rūšių. Jos buvo nagrinėjamos papildomai, apžvelgiant į su rizikos kilme ir jos paskirstymo mechanizmu susijusius aspektus. Nustatyta, kad su vyriausybe susijusios rizikos rūšys laikomos svarbiausiomis rūšimis, su kuriomis susiduria Kinijoje projektus diegiantys asmenys. Siekdami paskirstyti riziką, pramonės atstovai turėtų ne tik atsižvelgti į savo vadybinius pajėgumus, bet ir daugiau dėmesio skirti bendrai rizikos ir naudos pusiausvyrai bei rizikos garantijoms per griežtą sutarčių struktūrą. Manoma, kad čia pateikiamos išvados susidomėjusiems investuotojams leis geriau suprasti, kokia rizika kyla vykdant viešojo ir privačiojo sektoriaus partneryste pagrįstus vandens projektus Kinijoje.