Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

The perception of residual value risk in Public Private Partnership projects: a critical review

Jingfeng Yuan[1], Albert P. C. Chan[2], Wei Xiong[3], Mirosław J. Skibniewski[4] Qiming Li[5]

1 *Lecturer, Department of Construction and Real Estate, Southeast University, Nanjing 210096, P. R. China. Tel. & Fax: 86 25 8379 3251; Visiting Researcher, Department of Building and Real Estate, Hong Kong Polytechnic University, Hung Hum, Kowloon, Hong Kong, China; E-mail: 101011337@seu.edu.cn*

2 *Professor, Department of Building and Real Estate, Hong Kong Polytechnic University, Hung Hum, Kowloon, Hong Kong, China. Email: bsachan@inet.polyu.edu.hk*

3 *Ph. D. student, Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China. Email: kevinxiong@ust.hk*

4 *Professor, Dept. of Civil and Environmental Engineering, University of Maryland, College Park, MD 20742, USA; E-mail: mirek@umd.edu*

5 *Professor and Head, Department of Construction and Real Estate, Southeast University, Nanjing 210096, P. R. China. Tel. & Fax: 86 25 8379 3251; E-mail: njlqming@163.com*

Abstracts: Given the increased demand for public facilities and the lack of funds and skills to maintain, repair, and replenish the existing facilities, Public Private Partnerships (PPPs) have been adopted widely and they have contributed significantly to the development of new built infrastructures throughout the world. However, as many PPP projects will be transferred back to the host governments upon expiry of the concession period, problems related to the subsequent management of PPP projects have not been studied thoroughly to date. Residual Value Risk (RVR) is a critical issue when the projects revert back to the public sector. Through an extensive literature review and an open-ended questionnaire survey, the perception of RVR in PPP projects is elaborated in this paper which aims at presenting a precise definition and meaning of RVR in PPP projects. The survey results indicate that RVR is viewed as an important issue by

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

professionals and academics. The definition of RVR can be phrased as "the risk that on expiry or earlier termination of the services contract, the asset (tangible or intangible) is not in accordance with the value originally estimated by government, at which the private party agreed to transfer it to government, where public sectors could suffer loss of the residual value, and the private sector partner also could suffer a loss of compensation from the government due to different residual value". Six critical risk factors leading to RVR are identified in this paper, namely, (1) Downfall of product or service performance; (2) Functional problems; (3) Decrease of profitability and low possibility of refinancing; (4) Deterioration of maintainability; (5) Decline in operability; (6) Failure of sustainability. On the basis of the proposed RVR model, the cumulative effects of the interaction of different risk factors are identified. The proposed RVR definition and its associated RVR risk factors in PPP projects can be considered for use by the public sector to better regulate and manage PPP projects and facilitate the development of PPP projects from the regulatory and financial planning perspective.

Key words: Public Private Partnerships (PPPs), Residual Value Risk (RVR), Risk identification, Cumulative effects of risk categories, Key Risk Indicators (KRIs)

Introduction

Public Private Partnerships (PPPs) have been extensively adopted by the public sector in many countries to facilitate the development of infrastructure. The critical objectives for governments to utilize PPPs are to overcome the shortcomings of capital capability, poor management skills, and low technology level (Yuan

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

et al. 2010b; Chan et al. 2010; Jooste et al. 2011). PPP projects should be able to provide quality public goods and services through skilled construction and experienced operation by the private sector during the concession period (Ng et al. 2010; Chan et al. 2010). Value for money (VfM) is commonly used by the public sector to assess the feasibility of PPPs. In order to achieve VfM, efforts should be made by both the public and private sectors in the aspects of project planning and design, construction management, maintenance, facility management, staff training, and technology progress, etc (Heald 2003; Grimsey and Lewis 2005; Sobhiyah et al. 2009). PPP projects with a typical concession period from 15 to 30 years are usually under the operation of the private sector, while the governance of projects has been reported as weak and ineffective in many cases due to limited control and monitoring by the public sector (Yuan et al. 2010a; Wibowo and Kochendoerfer 2011; Zhang 2006). Furthermore, Residual Value Risk (RVR) could arise when the project is to be transferred back to the government at the end of the PPP agreement or in earlier termination because the estimated value cannot be achieved according to Her Majesty's Treasury of United Kingdom (HM Treasury of UK 2007) and Comptroller and Auditor General of India (2009).

Partnerships Victoria (2001) defines RVR as the risk that on expiry or earlier termination of the services contract, the asset does not have the value originally estimated by government at which the private party agreed to transfer it to government. RVR is a structured risk system which would occur at any time before transfer of PPP projects to the public sector, and consequently the Residual Value (RV) to the Government cannot fulfill the specifications. Suitable management of RVR would be of tremendous value for better maintenance, easier transfer of the PPP projects, improvement of on-going management, and sustainable development of the infrastructure (Hall 1998). Otherwise, many problems like high maintenance cost, low

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

quality service, and functional problems of the facilities would occur (Algarni et al. 2007).

Most of the PPP or PFI (Private Finance Initiative) projects have a clear specification in terms of the performance and condition of the transferred project (HM Treasury of UK 2007). Nevertheless, high residual value would be lost upon RVR occurs (Private Finance Panel 1996). The RVR is influenced by many factors. During the processing of project, the public sector may neglect the impact of residual value change and the risk may be huge when the project is being transferred because of the cumulative impacts (Algarni et al. 2007). Many disputes and losses can arise from poor maintenance of the assets, in which the public sector cannot obtain the return in the desired condition (Infrastructure Australia 2008a).

Although prior studies have identified RVR as an important risk factor in PPPs (Private Finance Panel 1996; Hall 1998; Froud 2003; Algarni et al. 2007; Jin 2011), the risks at the stage of transfer have not be studied systematically because most PPP projects have a long concession period and few projects have been transferred at present. As presented by Infrastructure Australia (2008a), the residual value calculation depends on the nature of the asset, historic residual value estimates, the expected market for the assets and the expected monetary benefit (or cost) to government. Therefore, this study attempts to provide an overview on RVR in PPPs, and offers a clear definition of RVR. Additionally, a conceptual model composed of leading indicators of RVR is also established to assist the public sector to measure and manage RVR during the lifecycle of PPP projects.

This paper is organized as follows. The next section describes the methodology used in the paper. The third

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

section gives an extensive literature review on RVR. The fourth section introduces the structured interview survey of opinions from PPP experts and professionals on the definition and contents of RVR in PPPs. The fifth section establishes a conceptual model to monitor and manage RVR by identifying leading indicators of RVR. Finally, the paper closes with conclusions.

Research method

In this study, a series of qualitative research methods were used to derive the definition and contents of RVR in PPPs, and to explore the conceptual indicator system of RVR to measure and manage RVR in PPPs effectively.

First of all, an extensive review of relevant research papers was conducted. As the RV mainly contains tangible and intangible assets (Efficiency Unit of Hong Kong 2003), the literature review was developed from these two aspects. These research papers related to PPP and residual value risks provide a good picture of the history and the current perception of RV and RVR in different fields. In addition, the recently published official and political documents provide authoritative evidence of the government's attitudes towards RVR in PPPs (Partnerships Victoria 2001; Efficiency Unit of Hong Kong 2003; European Commission 2003; HM Treasury of UK 2007; Infrastructure Australia 2008a, 2008b; Comptroller and Auditor General of India 2009). Second, the initial definition of RVR proposed by the authors was discussed with 46 PPP experts and professionals to clarify the definition and contents of RVR in PPP projects. The method of web-based interview was used in the empirical survey. Data analysis was then

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

conducted. Third, a conceptual model was established on the basis of findings from the literature review and interview survey. The model contains multiple leading indicators of RVR to help the public sector measure RVR and find ways to reduce RVR. Meanwhile, the potential use of conceptual models was discussed, aiming at not just detecting and explaining but also improving the present state of RVR management in real PPP projects, and to be helpful in developing risk management in PPPs in the future.

INSERT FIGURE 1 HERE

Literature review

Risk management and related studies in PPPs

In the last two decades, PPPs have become a popular way of procuring major infrastructure projects (Tiong et al. 1996; Hodge 2004; Shen et al. 2006; Chan et al. 2011). However, effective risk management has become a critical issue for the success of a project due to long term and sophisticated contract conditions in PPPs (Zhang 2005). Based on the findings of Ke et al. (2009), the top 5 frequently cited papers in the field of PPP are all risk-related research. Tang et al. (2010) also indicate that risks are always an active research topic for PPP projects.

Prior works on PPPs' risk management include risk identification, risk evaluation, risk allocation, and risk management framework (Ke et al. 2009). Risk identification is always the first step for risk management. In

the PPP context, risk identification focuses on specific countries and regions (e.g. China, India, US, UK, et al.) and specific project type (e.g. transportation, water treatment, power plant, education, et al.). Very important conclusion drawn from research on PPPs is that government-related risks and financial risks are the most significant risks for ongoing PPP projects, not only in developing countries but also in developed countries (Lam and Chow 1999; Wang et al. 1999; Thomas et al. 2006; Chan et al. 2011). In view of the high risk features in the context of PPPs, it is very important that risks are deemed to be appropriately allocated to both the public and private sectors considering their risk management capabilities and certain internal and external conditions. Therefore, risk allocation is considered as an effective risk treatment method in many prior studies. Numerous risk allocation mechanisms and frameworks have been designed by using empirical studies and computer-based modeling (Li et al. 2005; Abednego and Ogunlana 2006; Ng and Loosemore 2007; Jin 2010; Ke at al. 2010). Meanwhile, the establishment of a risk management framework is dependent on effective risk evaluation (Akintoye et al. 2005). A series of qualitative risk evaluation frameworks have been proposed to measure overall risks in PPP projects to improve risk management (Wang et al. 2000a; Akintoye et al. 2001; Grimsey and Lewis 2002). Moreover, quantitative models are formulated to measure specific risks like political risks, financial risks, foreign exchange risks, and revenue risks (Wang et al. 2000b; Ye and Tiong 2000; Xenidis and Angelides 2005; Singh and Kalidindi 2006). Overall, researches to date have strengthened the perceptions of industry and academics on PPP risks and can be helpful to explore the appropriate ways for managing important risks.

Residual value risk in PPPs

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Generally, residual value risk in PPPs can be described as the uncertainty that the residual value could be lower than the estimated or anticipated value determined in the PPP contact when being transferred, which means the residual value would suffer losses during the lifecycle of the PPP project under the impact of different factors. However, there are many different perceptions of RVR in PPP projects in prior studies.

- *The significances of RVR are different.*

Previous studies have identified RVR as a critical risk that will have a strong influence on the value of initial bids and the incentives facing contractors. Hall (1998) demonstrates that the assets created under PPP deals typically have an expected useful life beyond the formal contract period and risks associated with how many the assets will be worth when a PPP project is transferred to public sectors is very important. Algarni et al. (2007) advocate that facility assets have been suffering from years of neglect, overuse, deferred maintenance, and delayed repair and finally result in RVR that would harm the sustainable development of the infrastructure. Meanwhile, RVR has a strong relationship with asset ownership as presented by Froud (2003) and Jin (2010).

On the other hand, opposing views are also presented in previous reports and research. The Private Finance Panel (1996) argues that "There is no need for the public sector to concern itself with the residual value of an asset in a carefully structured PFI contract". A recent survey on the opinions of PPP risks shows that RVR is the least important risk factors in China (Xu et al. 2010).

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

The different opinions on RVR firstly reflect the perceptions of different stakeholders based on their own stand. From the perspectives of the public sector, long-term sustainable operation of PPP projects is very important. Hence many official documents confirm that RVR is significant (Partnerships Victoria 2001; Infrastructure Australia 2008a, 2008b; Comptroller and Auditor General of India 2009). In the survey conducted by Xu et al. (2010), data also show that opinions on residual value risk are different for academics and industrial practitioners (most are from private sector) in China. The academics perceived that the problem of residual value is more severe than industrial practitioners believe, based on the viewpoints of the public sector and the general public. Emphasizing and safeguarding the public benefits are the motivation to discuss RVR. On the contrary, the private sector is focusing on short-term return on investment (Koppenjan and Enserink 2009), which hinders the significance of RVR from being recognized. Secondly, the RVR problem could be neglected because many ongoing PPP projects have not been transferred to the public sector and the loss of RV has not been recognized. In the same report, the Private Finance Panel (1996) also cautions that the asset may well not be what was required a long time ago in any case: ‘‘the assumption that any asset created now will be suitable in its present form to deliver a further contract after some 25 years is questionable. The client’s operational needs will change”. A carefully structured contract is the reason for ignorance of RVR according to the Private Finance Panel (1996). However, perfect agreement is almost impossible because future changes cannot be well predicted and corresponding clauses are difficult to be designed (Iyer and Sagheer 2010; Krüger 2012). Therefore, it is very necessary to discuss RVR, which can be identified from the above-mentioned statement.

- *The methods to treat RVR are different.*

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Froud (2003) deliberated that RVR can be dealt with by writing off the asset completely over the life of the contract and should be transferred to public when contract ends. On the contrary, Arndt (1998) illustrated that RVR should be transferred to the private sector. Li et al. (2005) conducted a survey on risk allocation preference in the UK. The results indicated different opinions amongst the respondents (22% of respondents thought that RVR should be transferred to the public sector, sharing the RVR is proposed by 23% respondents, and transferring to the private sectors is proposed by 55% respondents). Ke et al. (2010) also concluded that residual (value) risks should be shared by the public and private sectors. The differences amongst methods to treat RVR reflect that the perception of RVR is still unclear. RV would suffer loss due to many factors during the concession period of PPP projects. Public and private sectors should both be responsible for the management of RVR. Therefore, how to keep RV at a high level should be further explored.

Knowledge gap

Although prior works have mentioned RVR in PPPs as presented earlier, there are few works focusing on the residual value risk in PPP projects so far. The significance of RVR in PPPs has not been fully recognized by both the public and private sectors. Xu et al. (2010) illustrated that RVR has been viewed as a potential threat to successful implementation of PPP projects. Prior research indicated that RVR should be allocated to the public sectors as they are the asset owner on the expiry of the PPP contract (Marques and Berg 2011; Krüger 2012). However, Chan et al. (2011) concluded that residual (value) risk is a result of

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

investors' overuse resources like equipment or other technical instruments, etc., which cause insufficient materials and equipment with depreciation at the end of the concession period. Consequently, RVR affects the continuous operation of the projects. Before RVR occurs, the infrastructure itself might have massively deteriorated already. In the light of important impacts on society and economy, it would be too late to deal with RVR only when the project is transferred.

According to the review on previous studies, the knowledge gaps can be identified. The different opinions on the significance of RVR are caused by three knowledge gaps: (1) The RV of PPP projects can be viewed as a type of asset. However the importance of RVR for different stakeholders could be various because they do not have a very clear perception on RVR in PPPs. Therefore the definition and content of RVR should be further clarified, although RVR has been classified to asset ownership-based risk. What is RVR in PPPs? What are the assets in PPP projects and how will they vary in the lifecycle of PPP project? (2) Most PPP projects are at the stage of planning, negotiation, construction, or operation. More attention is put on current issues or possibly important issues in the near future as a matter of course. However, long-term vision on the PPP projects is essential for pursuing public benefits. In order to realize public benefits, the RV of PPP projects should be kept at a high level, and government should identify what factors would lead to RVR and which indicators can be used to measure and indicate risk factors? (3) Different opinions on the methods to treat RVR can not only reflect the unclear definition of RVR, but also propose another question: What is an effective risk management framework to evaluate risk in advance, and what are the corresponding risk treatment measures? This paper attempts to fill these knowledge gaps with particular emphasis on (1). The knowledge gap (2) and (3) will be partially involved.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Residual Value and potential risks in PPPs

Residual value is one of the constituents of a leasing operation, which describes the future value of goods in terms of the percentage of depreciation from its initial value. As advocated by Lucko and Vorster (2003), terminology that is used to describe the concept of residual value varies widely in the literature, including market value, salvage value, resale value, and trade-in value. In accounting, the residual value can be defined as an estimated amount that an entity can obtain when disposing of an asset after its useful life has ended (Pirottea and Vaessen 2008). When doing this, the estimated costs of disposing of the asset should be deducted. The residual value of equipment therefore could be the price that can be achieved by disposing of a used machine in a fair transaction between an equally well informed buyer and seller in the overall market with a particular economic situation (Lucko et al. 2007; Fan et al. 2008).

However, it would be hard to define the value of PPP projects when they are transferred to the public sector. RVR usually is defined as asset ownership-based risk (Sobhiyah et al. 2009; Ke et al. 2010; Xu et al. 2012; HM Treasury of UK 2007; Comptroller and Auditor General of India 2009; Xu et al. 2010; Chan et al. 2011). Based on the *Oxford Dictionary* definition, an asset is a thing of value, especially property, that a person or company owns which can be used or sold to pay debts. In essence, an asset could be capital, estate, funds, goods, holdings, means, money, possessions, property, resources, savings, securities, and wealth. Hence, the RV of a PPP project should be the RV of assets for PPP projects. In this case, the RV mainly contains two parts: tangible assets and intangible assets.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

- Tangible assets are those that have a physical substance and can be touched, including current assets and fixed assets. Current assets include inventory, while fixed assets include facilities, technical files, tolls, equipment and instrument etc.
- Intangible assets are nonphysical resources and rights that have a value to a company because they give some kind of advantage in the market place. Examples of intangible assets are organization, intellectual property, reputation, and market share, and financial assets, including such items as accounts receivable, bonds and stocks.

On the other hand, the private sector actually delivers services and not assets through PPPs (Comptroller and Auditor General of India 2009). Thus the focus of the public sector should be more on the performance of the private sector in delivering the services according to the stipulated service levels to ensure that the asset could revert back in a reasonable (but not new) condition at the time of transfer, when the assets should still have residual economic lifespan.

Therefore, the residual value of a PPP project is the value of PPP assets at the end of a specified period of time in a given conditions, where the value of PPP projects can be classified to value of tangible asset and intangible asset. Both of tangible assets and intangible assets should ensure that the infrastructure facility can be operated with perfect function and performance, favorable capital status, and complete organization structure and human resource to keep on delivering high quality service after PPP projects being transferring back to public sectors or other service providers, which means the given conditions include not only financial conditions like equipment market price or historical leasing data for a building but also

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

non-financial conditions (e.g. physical conditions of facilities and historical risk events) that would strongly influence RV of a PPP projects. As a result, the implication of RV in PPPs has surpassed the scope of traditional definition of RV in accounting or in leasing industry. Intangible assets play very important roles in the change.

In prior studies, residual value of a PPP project has a close relationship with depreciation (Heald 2003). Lucko and Vorster (2003) indicate that residual value is fundamentally different from depreciation whose originated meaning in cost accounting is the process of determining the book value of an asset for administrative and taxation purposes by regularly charging expenses to the initial capital investment based on a prescribed model. Numerous models, like the straight line model and the declining balance model, have been used in the calculation of depreciation (Lucko 2003). However, these models cannot consider any actual changes in the projects or the external circumstances under which it is transferred. For example, a toll road's residual value could be influenced by the level and frequency of maintenance, the private sector's capability of facility management, the change of traffic flow, and the market shares at the time of being transferring. In some PPP guidelines (Infrastructure Australia 2008b), the value is assumed to a zero book value by depreciation at the end of PPP contract and possibly used for the purpose of minimizing the tax liability of the company, which cannot reflect the real value and operating cost of PPP projects and the real-time market place. From this perspective, the confusion of depreciation and residual value would clearly demonstrate why RVR have not been paid enough attention. In fact, the possible loss of value in PPP projects could result from multiple factors. For example, government-related risks and financial risks are the most important risks in PPPs as mentioned above. These risks could finally impact on RV and

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

consequently lead to RVR. Therefore, further research on RVR in PPP projects should be conducted to help the public sector better understand how the RVR occurs and how to manage and measure the RVR.

The research survey on RVR

Introduction of survey

As the definition and content of RVR are not clear, a research survey was conducted to tap in expert knowledge of PPP practitioners and professionals. Because of the exploratory character of the research, the defined survey method was by questionnaire using open-ended questions. The advantage of open-end questions is that the information gathered by way of the responses is more likely to reflect the full richness and complexity of the views held by the respondents (Ling et al. 2009). Many previous studies use open-ended questions as primary survey methods (Keane et al. 2010; Kheni et al. 2010; Xia and Chan, 2012). Open-ended questions allow respondents to have greater freedom in sharing their experience and knowledge.

In the questionnaire, an initial definition based on a literature review from the perspective of the public sector was presented. The respondents were asked in an open-ended manner to indicate their full opinion on the definition without restriction and to provide any supplements to the definition. The questionnaire consists of two parts (Appendix 1). Part *A* consists of six questions aimed at gathering data on the respondents' background. The first question in part *B* helps improve the definition of RVR. The second question in part *B* collects useful information from respondents about the contents of RVR and helps

identify the most common elements. The third question in part *B* asks about the magnitude of RVR. The fourth question in part *B* is another open-ended question to identify respondents' perceptions on how to treat RVR by using PPP contracts. The last question gathers experts' further suggestions on the research.

It is important to identify and select potential members to constitute a panel of experts to provide answers to open-end questions in an exploratory survey. Therefore, the participants are selected based on two criteria (1) Practitioners who have extensive working experience within the construction industry; (2) Experts who have been involved in the management of PPP projects or have gained in-depth knowledge of the PPP model through research.

The survey was sent to a sample of 148 experts from March 2010 to May 2010 (Table 1). Answers were obtained from 46 respondents. The information of respondents can be obtained from Part *A*. 15 respondents were from mainland China, 8 respondents from Hong Kong, 7 respondents from United States, 5 respondents from Singapore, 5 respondents from Australia, and the others from Europe (UK and Netherland). The questions were designed to collect data on the respondents' profiles and the definition and content of RVR in PPPs. A response rate of 38.02% was achieved, which can be considered acceptable when compared with other recent construction research surveys using open-end questions: 37% in Keane et al. (2010), 37% in Kheni et al. (2010), and 48.38% in Xia and Chan (2011). Demographic details of the experts can be found in Table 2. These experts represent a wide spectrum of PPP professionals and they can provide a balanced view for the survey. 28.26% of the respondents came from the private sector, 47.83% from the public sector and the remaining respondents mainly comprised researchers and academics. More

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

than 75% of the respondents had at least 5 years of industrial experience, and nearly 75% of the respondents had been involved with more than one PPP project. This hands-on working experience and the relevant organizations of the selected experts uphold the validity of this study.

INSERT TABLE 1 HERE

INSERT TABLE 2 HERE

Analysis of the results

As shown in Table 3, some information can be analyzed by using descriptive statistics method to obtain research findings.

INSERT TABLE 3 HERE

- **The significance of RVR in PPPs**

Actually, the significance of RVR in PPPs cannot be directly obtained by open-end questionnaire. Therefore, the opinions of respondents on the significance of RVR in PPPs can be derived from the answers of question 3 and 4 in Part B. The answers of question 3 can reflect the urgency of considering RVR in PPPs in real projects, which indicates that high urgency means high significance. In the answer of question 3, whether the RVR has been considered in the contract in PPP projects can also reflect the significance of RVR in PPPs. The detailed scale from “extremely important” to “not important” is also shown in Table 3.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

58%, 25%, and 12% of respondents considered RVR as an extremely important, very important, and important issue in formulating PPPs, respectively. Notwithstanding slightly different opinions on RVR in PPPs, the RVR can be viewed as very significant issue with high urgency based on the survey data. As there are many maintenance problems in ongoing PPP projects, RVR in PPPs could occur with very high possibility by respondents in prior studies (European Investment Bank 2005; Xu et al 2012; Javed et al 2013; Cruz and Marques 2013). The evidence is that the output specification set in the PPP contract will be obsolete and cannot meet the requirements when transferring projects back to the public sector because the technological and economical lifespans are shorter than the physical lifespans for an infrastructure project (Javed et al 2013). Technology progress and reasonable equipment renewal would greatly benefit reducing RVR in PPPs. Only 5% of respondents considered RVR as an important issue, and no respondents think RVR is not important issue. In their opinions, very detailed specification for transferring PPP projects and strict contract conditions, which are obtained from respondents' suggestions based on the answers of question 5 in Part B, can help avoid the RVR in PPPs.

- **The definition of RVR in PPP projects**

According to the report of Partnerships Victoria (2001), the RVR can be defined as "*the risk that on expiry or earlier termination of the services contract the asset does not have the value originally estimated by government at which the private party agreed to transfer it to government based on the perspective of public sectors*", and was proposed in the survey and sought respondents' opinions. The respondents' opinions of question 1 in Part B indicated a high degree of agreement on the definition. No respondents disagreed with the definition. 78.25% of respondents agreed with the definition, and 21.75% of respondents

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

basically agreed with the definition. More useful information can be obtained from the survey, profiting from the open-ended manner. Some typical suggestions provided by respondents are shown in Table 4.

INSERT TABLE 4 HERE

- **The contents of RVR in PPP projects**

Based on the answers of question 2 in Part B, RVR in PPPs has relationships with facilities that was mentioned by 100% of respondents, technical documents (95%), project organization (95%), equipment (87%), intellectual property (86%), instruments (65%), project reputation and goodwill (54%), and market shares (49%). In the PPP context, the meaning of the content could be varied, and explanations and examples or references are shown in Table 5.

INSERT TABLE 5 HERE

- **The methods to treat RVR in PPPs by using contract**

With respect to the treatment of RVR, a contract signed by both the public and private sectors is an effective approach to manage, control, and reduce risks including RVR (Nisar 2006). The information collected by the answers of question 4 in Part B also showed that RVR has been considered in contracts in most actual PPP projects. Based on the data presented in Table 3, 14 respondents have not considered RVR in the project contract. As 12 respondents have not been involved in any PPP projects according to Table 2, the RVR was not considered by only 2 respondents.

However, respondents have different opinions on using renegotiation to dynamically treat RVR in the

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

project process. 19 respondents that agreed with renegotiation insisted that not all risks as well as their impacts can be included and predicted in the contract. Once RV is influenced by related risks and cannot meet the expectation of public sectors, renegotiation is a possible method to resolve problems (Medda 2007; Koppenjan and Enserink 2009). Meanwhile, the prerequisite of renegotiation should be clarified in the contract. On the other hand, 13 respondents that disagreed with renegotiation insisted that renegotiation was not reasonable because renegotiation could cause changes of PPP contracts, which would result in subsequent risks. For example, renegotiation was believed to lead to more disputes and arguments between the public and private sectors. Because of strong background of public sectors, renegotiation would result in unfairness for the private sectors (Cruz and Marques 2013). Simultaneously, the termination payment to private sector is viewed as an effective method to reduce RVR without renegotiation (Chou et al. 2012).

Findings from survey

Based on the open-ended questionnaire survey, some important findings can be derived. The respondents opined that current PPP contracts cannot resolve the problems related to maintenance, technology progress, and facility renewal in a long-term concession period, and consequently recognized the significance of RVR.

Although most respondents agreed with the authors' definition on RVR, some suggested using the stakeholder perspective to improve the definition. Accordingly, the definition of RVR in PPPs is revised to "the risk that on expiry or earlier termination of the services contract, the asset (tangible or intangible) is

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

not in accordance with the value originally estimated by government, at which the private party agreed to transfer it to government, where public sectors could suffer loss of the residual value, and the private sector partner also could suffer a loss of compensation from the government due to different residual value".

The interpretation of RVR can be obtained from the description of respondents' opinions on the contents of RVR. As mentioned before, residual value in PPP projects includes tangible and intangible assets. According to the character of different content above, facilities, technical documents, equipment, and instruments belong to tangible assets. Concurrently, project organization, intellectual property, project reputation and goodwill, and market shares belong to intangible assets. Both tangible and intangible assets greatly contribute to the RV. Any losses in tangible and intangible assets could result in RVR. Because of the diversification of the representation form of RVR, the method to treat RVR can be complicated in reduce the risks. According to the survey results, a contractual arrangement is one of the most commonly used management and treatment methods. However, the contractual arrangement is also **a** compromising approach because rigid contract clauses could not completely allow any change in the project. Thus, a dynamic risk management method is needed, in which the critical factors that influence RV of PPP projects should be identified first.

A conceptual framework of critical factors leading to RVR

Identification of critical factors leading to RVR

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Though RVR has been redefined from stakeholder perspectives and the loss of compensation from government due to excess residual value also has been considered, the authors still concentrate on the loss of RV in RVR from the perspective of public sectors.

In the context of projects, risk is a factor that can jeopardize the successful conclusion of a project by causing cost overruns, time delay, and under-specification. All projects have risks associated with them, and the extent to which a risk factor exists within a particular area is related negatively to the likelihood of a successful outcome to the project (Chapman 2006). Hence, the critical factors leading to RVR should positively impact on the final loss of RV in PPP projects.

In prior studies, risk factors of PPP projects have been identified from various perspectives. Shen et al. (2006) group risks in PPPs into project-related, government-related, client-related, design-related, contractor-related, consultant-related, and market-related risks. Unkovski and Pienaar (2009) categorize PPP risks into technical, financial and legal dimension. Xu et al. (2010) identify six risk factors including macroeconomic risk, construction and operation risk, government maturity risk, market environment risk, and government intervention risk by using factor analysis. Furthermore, all risk factors in PPPs identified by different research are similar, as concluded by Cheung and Chan (2011). All these risk factors can be classified into external risks and internal risks. External risks in PPPs come from the external environment of PPP projects and are relatively uncontrollable (Frilet 1997; Wang et al. 2000). Internal risks come from the internal environment and are relatively more controllable and will vary between projects. All external risks would indirectly impact on PPP projects combining with the influence of internal risk factors.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

When identifying the critical factors leading to RVR, a similar framework can be used. The factors can be divided into external and internal risk factors. With respect to external risks, there is a need for the continual scanning and forecasting of these risks and for the development of the project for responding to the effects of external forces because of their uncontrollable nature. The external factors contain the changes of political, social, legal, economic conditions of specific PPP project. As a result of the indirect impact of external factors, these external risk factors are similar in different PPP projects, and their descriptions are also similar to prior works on risk factors of PPP projects explored by Shen et al. (2006). Hence, the authors are focusing on internal factors leading to RVR. For PPPs, different PPP projects have different characteristics. Thus the internal factors leading RVR would be different. However, RVs at the end of the PPP contract are similar to those presented in the survey results, which are tangible assets (facilities, technical documents, equipment, and instruments) and intangible assets (project organization, intellectual property, project reputation and goodwill, and market shares). Consequently, critical factors must have cause-and-effect connections with any losses of tangible or intangible assets. Meanwhile, PPP projects are designed and planned to provide specific public goods and services to meet the requirements of the public sector and the general public. In this case, 6 critical factors are identified by authors based on the requirements of the public sector and general public and cause-and-effect relationship between the critical factors and RV.

The 6 critical factors include Downfall of product or service performance, Functional problems, Decrease of profitability and low possibility of being refinanced, Deterioration of maintainability, Decline of

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

operability, Failure of sustainability. From the perspective of public goods or services provided by PPP projects, the need for public facilities means high project quality as well as timely and convenient service (Li et al. 2005; Yuan et al. 2009), which strongly influence the level of performance and the completeness of the functions that are the content of the tangible assets of RV. At the same time, good financial management would support development of PPP projects (Xenidis and Angelides 2005; Wibowo et al 2012). Otherwise, RV would be reduced if the financial conditions cannot be well kept. Therefore, another important factor influencing the RVR should come from financial and financing aspect, where profitability and the ability to refinance are both important. Furthermore, both tangible and intangible assets in the RV of PPPs can be enhanced when the work on maintenance and operation are well organized (Sharma 2007; Chan et al. 2009), on the basis of which continuous improvement can be provided during longstanding operation period on PPP projects. Moreover, social, environmental, and financial sustainability in PPPs can provide a good basis for long-term realization, maintenance, and operation of public infrastructures (Koppenjan and Enserink 2009). Detailed justification and description of 6 factors are presented below.

Downfall of product or service performance - Performance hereby focuses on goods and services delivered by PPPs (Cliftona and Duffield 2006). For example, high performance in a highway project means short traffic time, high safety, and comfortable travel. Therefore, more congestion, traffic accidents, low quality pavement indicate a decline in performance. Once a PPP project cannot achieve the prescribed performance, the reputation of the project could be harmed, the market share would decrease, and the project organization would be questioned by general public (Efficiency Unit of Hong Kong 2003). Meanwhile, more vehicles also would damage the facilities and equipment. Although the problem could be

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

resolved in a short time, the influence could be long-term and invisible. Hence, the decline of performance would greatly influence RV of PPPs. This kind of decline could result from unreasonable design, low construction quality, outdated technologies, unmanageable organization, and maintenance cost overrun.

Functional problems - Necessary function traditionally is the basis for providing quality goods and services for a public facility (Ravindran 2010). A series of facilities, equipment, instruments, and technical or management documents would be used in a PPP projects to meet the function requirements in order to ensure that high performance can be achieved. For instance, effective traffic control, strict traffic isolation by different subsidiary facilities, high design standard of pavement, and perfect service facilities are very important for a highway project. Functional problems can be described as lacking or missing certain functions that can meet the prescribed requirements in PPP contract. Functional problems would lead to dissatisfaction of users, further damage of related facilities, equipment, and instruments, negative impact on reputation and goodwill, and decreased market shares.

Decrease of profitability and low possibility of being refinanced- Profitability refers to the potential of a PPP project to be financially successful (European Commission 2003). This may be assessed before investment or it may be used to analyze a project that is currently operating. When there is constant or abundant cash flow, it can be difficult to determine profitability. Spending and earning money, however, does not mean a project is in a healthy financial state. To determine profitability, it is necessary to access the price of the goods or services being offered. There are several things that need to be considered when prices are established, including variable costs and fixed costs. Hence prices and costs are the most

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

important factors for profitability. Meanwhile, low profitability would lead to a lower possibility of being refinanced when a PPP project is transferred. In this case, refinancing has changed from an attractive opportunity to become a risk for RV. As concluded by Salman et al. (2007), financial ability is critical to the viability for a PPP project. Decrease of profitability and the low possibility of being refinanced are very dangerous to a PPP project due to potentially small investments on tangible and intangible assets.

Deterioration of maintainability- It is the ease with which a project can be maintained in order to isolate defects or their causes, correct defects or their causes, meet new requirements, make future maintenance easier, and cope with a changed environment (Li et al. 2005; Chan et al. 2009). In some cases, maintainability involves a system of continuous improvement - learning from the past in order to improve the ability to maintain systems, or to improve reliability of systems based on maintenance experience. Thus effective maintainability, which relies on reasonable planning and design, effective quality and cost control, can substantially improve reliability and serviceability for infrastructure projects, and therefore would reduce RVR.

Decline of operability- Operability is the ability to keep a system or a whole PPP project in a safe and reliable functioning condition, according to predefined operational requirements. Moreover, operability stresses that not only tangible assets but also intangible assets can be operated well. For tangible assets, facilities, technical documents, equipment, and instruments should be kept at a high level. For intangible assets, operability refers that every ingredients of the whole project including stakeholders, sub-systems, and interface of different project phases or contracts should be integrated together by technology progress

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

and efficient project organization, which is also called as interoperability (Sharma 2007). Therefore, RV is also strongly influenced by operability.

Failure of sustainability- The PPP infrastructures are supposed to keep up with living standards and to create conditions for sustainable development. Sustainable development was defined by the Brundtland Commission in 1987 as development that fulfills the needs of the present generation without compromising the ability of future generations to fulfill their needs (World Commission on Environment and Development 1987). Sustainability in PPPs is defined by Koppenjan and Enserink (2009) as social, environmental, and financial sustainability. Social sustainability refers to the impacts of PPP projects on the affordability of and access to public service delivery by poorer groups within society. Environmental sustainability refers to the impacts of PPP projects on the related population (health, well-being), environments (air quality, water quality), and the wider surroundings (ecological impacts, energy use). Financial sustainability refers to the possibility of local authorities living up to the financial obligations that result from investments in PPP projects in the long run. As a result, sustainable development is a process of harmoniously exploiting resources, directing investment, and accomplishing institutional change to enhance both current and future potential to meet present and future needs (Mirza 2006). In other words, long-term improvement of RV after a project is transferred is firmly affected by sustainability.

Establishment of conceptual model

Although the aforementioned 6 critical factors leading to RVR have been identified, the occurrence of RVR

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

however is a complicated and long-term process through the whole concession period. Actually, the interaction among risk factors of PPPs and their changes during the concession period could finally result in RVR due to long-term cumulative impacts, which means many risk factors of a PPP project would impact on the final RV. Certainly, some changed risks only affect a particular activity or individual aspect of project performance, but it is clear that few risks occur in isolation. The cumulative impacts of different risk factors reflect a broadened perspective on the nature of interactions. This perspective acknowledges that:

Firstly, RV change originates not only from single factor but also from interactions of multiple factors. These interactions need to be considered in risk planning and monitoring to ensure that RV limits are not breached; and *Secondly*, change accumulates through additive or interactive processes. The impact of two actions on the RV can be complex and may result in loss of RV that is worse than originally thought because of interactions between factors.

Hence, a conceptual framework of critical factors leading to loss of RV can be established on the basis of literature review, survey results, and viewpoint of cumulative impacts. The proposed framework is shown in Figure 2.

INSERT FIGURE 2 HERE

In Figure 2, the proposed model cannot only help industry and academia identify the critical factors of RVR, but also help managers further identify the Key Risk Indicators (KRIs) of RVR in different stages. KRIs are measures used in management to indicate how risky an activity is. Therefore, KRIs identified by 6 risk

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

factors can be used to measure RVR. KRIs play critical roles in risk management framework. As tools for monitoring controls, risk drivers, and exposures, they can shed light on the potential risk events. As presented by Beasley et al. (2010), a goal of developing an effective set of KRIs is to identify the relevant metrics that provide useful insights about potential risks that may have an impact on the achievement of the organization's objectives. In the context of RVR of PPP projects, the selection and design of effective KRIs starts with a firm grasp of objectives for RVR management and risk-related events that might affect the achievement of those objectives. In our research, the objectives for RVR management are the improvement of tangible and intangible assets that can be viewed as strategic initiatives in the management process. The identified 6 risk factors are the potential risk-related events that are important linkages between RVR and KRIs and can be used to identify KRIs. The linkage of RVR to core strategies helps pinpoint the most relevant information that might serve as an effective leading indicator of an emerging RVR. Therefore KRIs can be identified from the project stage-based perspective according to the above-mentioned relationship between KRIs and RVR. The findings of this research can provide the foundation for future work on identification of KRIs.

The framework can clearly present how RVR comes into being.

Firstly, the model consists of *6 internal critical factors* and *one external risk factor group* as shown in Figure 2. These factors, which can be measured by different KRIs in different stages, would impact on the RV of PPP projects in the lifecycle. The identified 6 internal factors would concurrently affect RV during whole concession period. Meanwhile, these factors could change from one stage to the next stage. In different stages, critical factors leading to RVR would impact on RV and potentially result in loss of RV.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

These factors would then still exist or be transformed to other factors in the next stage, and keep on influencing RV. Finally, RV would suffer great losses due to the aforementioned cumulative impacts through the entire project implementation.

Secondly, the proposed conceptual model is *a project stage-based framework*. The influence of identified factors would vary in different stages. There are many leading indicators (KRIs) that can indicate how the risk factors influence the RV. The list detailed KRIs is not provided in this paper because KRIs would vary in different PPP projects. More case studies would be helpful for the identification of KRIs. On the other hand, the proposed model allows that KRIs can flexibly change when the projects move from one stage to another. For example, the indicators in the stage of pre-construction could be related to the problems like the quality of planning, the selection of concessionaire, the appropriateness of financing, the reasonableness of technologies, and the speed of land acquirement. Some of these problems could be resolved within the stage of pre-construction. Other unresolved problems would still impact on subsequent stages of the project. Thus the influence of identified factors during the construction period may change. For example, design problems could be invisible in the pre-construction stage, which would result in quality problems in the construction stage and maintenance stage. Hence, the critical factors may change quantitively and qualitatively (e.g. downfall of product or service performance could be enlarged or functional problems change due to deterioration of maintainability in different stages). In the construction stage, the identified factors will keep changing due to cost overruns, poor quality, delayed completion, and resource overuse. Unresolved problems in the construction stage would influence project operation. The operation period is divided into the early stage of operation and the late stage of operation because of great differences

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

between the early and late periods of operation. In the early stage of operation, external factors could still be unchanged. The possible loss of RV at this stage could result from operation cost overruns, low standard service, maintenance cost overrun, market changes, price changes, and environmental changes. In the late stage of operation, all external factors could change because of the long time since the concession agreement was signed. In this case, external factors should be re-evaluated in the late stage of operation. At the same time, technologies used in PPP projects would become outdated or inappropriate at this stage, which is not necessary considered in the early stage of operation. Furthermore, physical problems such as damage to structures, equipment, labor, etc. are more critical during the late operation phases of the projects (Iyer and Sagheer 2010). Similarly, the market and environment would also be different. Hence related factors also should be re-considered.

Thirdly, the identified 6 risk factors always exist in any stage of a PPP project, but the KRIs would change in different stages. The 6 risk factors could finally impact on the RV through the *cumulative impacts* of multiple project stages. The cumulative impacts on the change of RV in PPP projects are very important reasons for causing the loss of tangible assets and intangible assets at any time within concession period. (Algarni et al. 2007). During long-term process of planning, construction, operation, and transfer, the public sector is indeed the organizer that can greatly influence the success of a PPP project. However, the public sector may neglect the impact of residual value change and the risk may be huge when the project is being transferred because of the cumulative effects (Fandel et al 2012; Regan et al 2011). Many PPP projects were designed to provide quality public goods and services through good construction and operation by the private sector during the concession period (Ng et al. 2010; Chan et al. 2010). Although many PPP projects

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

may have a clear specification (HM Treasury of UK 2007), RVR occurs and leads to high loss of residual value (Private Finance Panel 1996) because the RVR is influenced by many factors including performance, function, profitability and the possibility of refinancing, maintainability, operability, and sustainability, as shown in proposed conceptual model.

Furthermore, the proposed model can be used to track and monitor the change of RV during the concession period for improving the RVR management. In Figure 2, the relationships amongst RVR, 6 risk factors, and KRIs are clearly presented. The cause-and-effect relationship between KRIs and 6 risk factors can be used to find how the RVR occurs in a real PPP project. As shown in Figure 3, 6 KRIs during the period of construction in a PPP tunnel project in Nanjing, China have been identified (The detailed information can be found in Yuan et al. 2010 a). The external impacts were from Global Financial Crisis (GFC), the political pressure to facilitate the construction, and the inflation led by GFC, on the basis of which 6 risk factors leading to RVR can be indicated by 6 KRIs (e.g. complexity, costs, schedule, quality, and Health Safety Environment (HSE) of construction). Meanwhile, the financing problem would also be very important. Thus the KRIs can be identified as well, and can be used to track and monitor the change of RV. In other stages, a similar method can be adopted by using 6 risk factors and corresponding KRIs in each stages, which can help both the public and private sectors track the change of RV and improve the level of RVR management to deliver VfM. In this case, the RVR management can be better conducted by using the conceptual model to minimize the incongruence between the prescribed performance in the PPP contract and the actual performance. As presented by Appuhami et al. (2011), two strategies named the Performance Evaluation Strategy (PES) and the Trust-based Strategy (TBS) can be useful to enhance the RVR

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

management. In the proposed model, the goal of RVR management is to improve the tangible and intangible assets. In order to achieve the goal, the efforts to minimize the effects of goal incongruence by PES and to make the partners like-minded by TBS can all be made on the basis of conceptual model.

INSERT FIGURE 3 HERE

Conclusions

Given the increased needs for public facilities and the lack of funds and skills to lifecycle management of existing facilities, PPPs have been used extensively and have contributed to the development of infrastructures in many countries. However, the problems related to the management of on-going PPP projects when transferred to the public sector have not been studies thoroughly. The RVR has been identified as an important risk in PPPs at the time of project transfer, but the perception and definition of RVR in PPP projects, the contents and changes of RV during concession period, and the treatment methods of RVR are not clear, which leads to disputes between public and private sectors, unsuccessful project transfer, and great losses in project value. Therefore, the benefits to the general public, who are the end-users of PPP projects, could be influenced greatly. Therefore, this study is focusing on the perception of RVR in PPP projects.

Based on the extensive review of relevant research papers, the meaning of RV in PPPs is explored based on

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

two aspects, tangible and intangible assets. By using an open-end questionnaire, the RVR's significance, the initial definition proposed by authors, the contents, and the treatment methods were discussed with 46 PPP experts and professionals. Most of the respondents (95%) considered that RVR was an important or extremely important issue in PPPs. According to the opinions of the respondents, the definition of RVR in PPPs can be proposed as "*the risk that on expiry or earlier termination of the services contract, the asset (tangible asset and intangible asset) is not in accord with the value originally estimated by government at which the private party agreed to transfer it to government, and where public sectors could suffer loss of residual value, and the private sector also could suffer loss of compensation from the government due to excess residual value*". The contents of RVR in PPPs can be concluded as *facilities*, *technical documents*, *project organization*, *equipment*, *intellectual property*, *instruments*, *project reputation and goodwill*, and *market shares*. However, there are very different opinions on the treatment methods of RVR. Though the contract was considered as an effective approach to manage, control and reduce RVR, the agreement cannot predict the long-term changes. Renegotiation was proposed as a possible method to resolve problems.

On the basis of the survey results, a conceptual model is established with six risk factors leading to RVR including: (1) Downfall of product or service performance; (2) Functional problems; (3) Decrease of profitability and low possibility of being refinanced; (4) Deterioration of maintainability; (5) Decline of operability; (6) Failure of sustainability. A critical contribution of the proposed model is to identify the cumulative impacts of the interactions of different risk factors on the RV changes, which can reflect a dynamic situation in a PPP project and help the public sectors measure RVR and find ways to reduce RVR. The conceptual model can be used to explain how the RVR occurs, how the RV changes, and which factors

would influence the RVR.

This study gives an overall view on the RVR of PPP projects, which could help the public and the private sectors understand that RVR management is very important and should be managed from the proposed six perspectives. As different risk factors have their corresponding leading indicators, further research should identify detailed KRIs that are belong to specific risk factors at different project stages and can indicate the risk factors leading to RVR. Future works also should focus on the exact nature and measurement of the RVR. Such research may hopefully provide a RVR prediction model based on actual project data.

Acknowledgments

The authors' special thanks go to all survey participants and reviewers of the paper, and to the National Natural Science Foundation of China (NSFC-71001027), Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD), and Social Foundation of the Department of Education, Jiangsu Province, China (2011SJD630003) for financially supporting this research.

References

Abednego, M. P., and Ogunlana, S. O. (2006). "Good project governance for proper risk allocation in public-private partnerships in Indonesia." *International Journal of Project Management*, 24(7), 622–634.

Arndt, R. H. (1998). "Risk allocation in the Melbourne City Link Project." Journal of Project Finance, 4 (3), 11-25.

Akintoye, A., Beck, M., Hardcastle, C., Chinyio, E., and Asenova, D. (2001). *Framework for risk assessment and management of private finance initiative projects*, Glasgow Caledonian University, Glasgow, Scotland, U.K.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Akintoye, A., and Chinyio, E. (2005). "Private finance initiative in the healthcare sector: Trends and risk assessment." *Engineering, Construction, Architecture, Management*, 12(6), 601–616.

Algarni, A. M., Arditi, D., and Polat, G. (2007). "Build-Operate-Transfer in Infrastructure Projects in the United States." *Journal of Construction Engineering and Management*, 133(10), 728-735.

Appuhami, R., Perera, S., and Perera, H. (2011). "Management Controls in Public–Private Partnerships- An Analytical Framework." *Australian Accounting Review*, 21(1), 64-79.

Beasley, M. S., Branson, B. C., and Hancock, B. V. (2010) "How Key Risk Indicators can Sharpen Focus on Emerging Risks." Research report of Committee of Sponsoring Organizations of the Treadway Commission, available at http://www.coso.org/documents/COSOKRIPaperFull-FINALforWebPostingDec110_000.pdf (accessed 19 March 2012)

Bloomfield, P. (2006). "The challenging business of long-term public-private partnerships: reflections on local experience." *Public Administration Review*, 66(3), 400–411.

Brinkerhoff, D. W., Brinkerhoff, J. M. (2011). "Public–private partnerships: Perspectives on purposes, publicness, and good governance." *Public Administration and Development*, 31(1), 2-14.

Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E., and Ke, Y. (2009). "Drivers for Adopting Public Private Partnerships—Empirical Comparison between China and Hong Kong Special Administrative Region." *Journal of Construction Engineering and Management*, 135(11), 484-494.

Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Cheung, E., and Ke, Y. (2010). "Critical Success Factors for PPPs in Infrastructure Developments: Chinese Perspective." *Journal of Construction Engineering and Management*, 136(5), 1115-1124.

Chan, A. P. C., Yeung, J. F. Y., Yu, C. C. P., Wang, S. Q., and Ke, Y. (2011). "Empirical Study of Risk Assessment

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

and Allocation of Public-Private Partnership Projects in China." *Journal of Management in Management*, 27(3), 136-148.

Chapman, C. (2006). "Key points of contention in framing assumptions for risk and uncertainty management." *International Journal of Project Management*, 24(4), 303-313.

Chou, J.-S., Tserng, H. P., Lin, C. Yeh, C.-P. (2012) "Critical factors and risk allocation for PPP policy: Comparison between HSR and general infrastructure projects." *Transport Policy*, 22(1), 36–48.

Cheung, E., Chan, A. P. C. (2011). "Risk Factors of Public-Private Partnership Projects in China: Comparison between the Water, Power, and Transportation Sectors." *Journal of Urban Planning and Development*, 137(4), 409-415.

Cliftona, C., Duffield, C. F. (2006). "Improved PPP/PFI service outcomes through the integration of Alliance principles." *International Journal of Project Management*, 24(7), 573-586.

Comptroller and Auditor General of India. (2009). "Public Private Partnerships (PPP) in Infrastructure Projects: Public Auditing Guideline." available at http://infrastructure.gov.in/pdf/PPP-PROJECT.pdf (accessed 19 March 2012).

Cruz, C. O., Marques, R. C. (2013). "Integrating infrastructure and clinical management in PPP for health care." Journal of Management in Engineering, accepted paper, doi:10.1061/(ASCE)ME.1943-5479.0000166

Efficiency Unit of Hong Kong (2003) "Case Summary Provision of Vehicle Fleet Services by Public Private Partnerships Victoria, Australia." available at http://www.eu.gov.hk/english/psi/psi_case/files/ppp_case_vehicles.pdf (accessed 19 March 2012)

European Commission. (2003). "Guidelines for Successful Public – Private Partnerships." available at http://ec.europa.eu/regional_policy/sources/docgener/guides/ppp_en.pdf (accessed 19 March 2012)

European Investment Bank. (2005). "Evaluation of PPP projects financed by the EIB." available at http://www.eib.org/attachments/ev/ev_ppp_en.pdf (accessed 19 March 2013)

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Fan, H., AbouRizk, S., Kim, H., and Zaïane, O. (2008). "Assessing Residual Value of Heavy Construction Equipment Using Predictive Data Mining Model." *Journal of Computing in Civil Engineering*, 22(1), 181-191.

Frilet, M. (1997). "Some Universal Issues in BOT Projects for Public Infrastructure." *The International Construction Law Review,* 14(4). 499-512.

Froud, J. (2003). "The Private Finance Initiative: risk, uncertainty and the state." *Accounting, Organizations and Society*, 28(6), 567-589.

Grimsey, D., Lewis, M.K. (2002). "Evaluating the risks of public–private partnerships for infrastructure projects." *International Journal of Project Management*, 20 (2), 107–118.

Grimsey, D., Lewis, M.K. (2005). "Are Public Private Partnerships value for money? Evaluating alternative approaches and comparing academic and practitioner views." *Accounting Forum*, 29, 345–378.

Hall, J. (1998). "Private Opportunity, Public Benefit." *Fiscal Studies*, 19(2), 121-140.

Heald, D. (2003). "Value for money tests and accounting treatment in PFI schemes." *Accounting, Auditing &Accountability Journal*, 16(3), 342-371.

HM Treasury of UK. (2007). "Standardisation of PFI Contracts: Version 4." available at http://www.hm-treasury.gov.uk/d/pfi_sopc4pu101_210307.pdf (accessed 19 March 2012).

Hodge, G. A. (2004). "Risks in Public-Private Partnerships: Shifting, Sharing or Shirking?" *The Asia Pacific Journal of Public Administration*, 26(2), 155-179.

Hodge, G. A., Greve, C. (2007). "Public–Private Partnerships: An International Performance Review." *Public Administration Review*, 67(3), 545-558.

Infrastructure Australia. (2008a). "National PPP Guidelines Volume 4: Public Sector Comparator Guidance." available at http://www.infrastructureaustralia.gov.au/public_private/files/National_PPP_Guidelines-Vol

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

_4_PSC_Guidance_Dec_08.pdf (accessed 19 March 2012).

Infrastructure Australia. (2008b). "National PPP Guidelines Volume 5: Discount Rate Methodology Guidance." available at http://www.infrastructureaustralia.gov.au/public_private/files/National_PPP_Guidelines_Vol _5Discount_Rate_Methodology_Guidance_Jan_09.pdf (accessed 19 March 2012).

Iyer, K. C., and Sagheer, M. (2010). "Hierarchical Structuring of PPP Risks Using Interpretative Structural Modeling." *Journal of Construction Engineering and Management*, 136(2), 151-159.

Javed, A. A., Lam, P. T. I., Zou, P. X. W. (2013). "Output-based specifications for PPP projects: lessons for facilities management from Australia." *Journal of Facilities Management*, 11(1), 5 – 30.

Jin, X. (2010). "Determinants of Efficient Risk Allocation in Privately Financed Public Infrastructure Projects in Australia." *Journal of Construction Engineering and Management*, 136(2), 138-150.

Jooste, S. F., Levitt, R., and Scott, D. (2011) "Beyond 'one size fits all': how local conditions shape PPP-enabling field development." *Engineering Project Organization Journal*, 1(1), 11-25.

Ke, Y., Wang, S. Q., Chan, A. P. C., and Cheung, E. (2009). "Research Trend of Public-Private Partnership in Construction Journals." *Journal of Construction Engineering and Management*, 135(10), 1076-1086.

Ke, Y., Wang, S. Q., and Chan, A. P. C. (2010). "Risk Allocation in PPP infrastructure Projects: Comparative Study." *Journal of Infrastructure Systems*, 16(4), 343-351.

Keane, P., Sertyesilisik, B., and Ross, A. D. (2010). "Variations and Change Orders on Construction Projects." *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 2(2), 89-96.

Kheni, N. A., Gibb, A. G. F., and Dainty, A. R. J. (2010). "Health and Safety Management within Small- and Medium-Sized Enterprises (SMEs) in Developing Countries: Study of Contextual Influences." *Journal of Construction Engineering and Management*, 136(10), 104-115.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

KPMG Company (2009). "Financing Australian PPP Projects in the Global Financial Crisis." available at http://www.google.com.hk/search?client=aff-cs-360se&ie=UTF-8&q=Financing+Australian+PPP+Projects+in+the+Global+Financial+Crisis (accessed 19 March 2012).

Koppenjan, J. F. M. and Enserink, B. (2009). "Public-Private Partnerships in Urban Infrastructures: Reconciling Private Sector Participation and Sustainability." *Public Administration Review*, 2009, 69(2): 284-296.

Krüger, N. A. (2012). "To kill a real option – Incomplete contracts, real options and PPP." Transportation Research Part A: Policy and Practice, 46(8), 1359-1371.

Lam, K. C., Chow, W. S. (1999). "The significance of financial risks in BOT procurement." *Building Research and Information*, 27 (2), 84–95.

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), 25–35.

Ling, F. Y. Y., Pham, V. M. C., and Hoang, T. P. (2009). "Strengths, Weaknesses, Opportunities, and Threats for Architectural, Engineering, and Construction Firms: Case Study of Vietnam." *Journal of Construction Engineering and Management*, 135(10), 105-113.

Lucko, G. (2003). "A Statistical Analysis and Model of the Residual Value of Different Types of Heavy Construction Equipment." A Dissertation submitted to the Faculty of Virginia Polytechnic Institute and State University, VA, US.

Lucko, G., and Vorster, M. C. (2003). "Predicting the residual value of heavy construction equipment." *Proc., 4th Joint Int. Symp. on Information Technology in Civil Engineering*, Nashville, Tenn., ASCE, Reston, Va.

Lucko, G., Vorster, M. C., and Anderson-Cook, C. M. (2007). "Unknown Element of Owning Costs—Impact of Residual Value." *Journal of Construction Engineering and Management*, 133(1), 3-9.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Marques, R. and Berg, S. (2011). "Risks, Contracts, and Private-Sector Participation in Infrastructure." J. Constr. Eng. Manage., 137(11), 925–932.

Medda, F. (2007). "A game theory approach for the allocation of risks in transport public private partnerships." *International Journal of Project Management*, 25(3), 213–218.

Mirza, s. (2006). "Durability and sustainability of infrastructure — a state-of-the-art report." *Canadian Journal of Civil Engineering*, 33: 639–649.

Ng, A., and Loosemore, M. (2007). "Risk allocation in the private provision of public infrastructure." *International Journal of Project Management*, 25(1), 66–76.

Ng, S. T., Wong, Y. M. W., and Wong, J. M. W. (2010). "A Structural Equation Model of Feasibility Evaluation and Project Success for Public–Private Partnerships in Hong Kong." IEEE Transaction on Engineering Management, 57(2), 310-322.

Nisar, T. M. (2006). "Risk Management in Public–Private Partnership Contracts." *Public Organization Review*, 7(1), 1-19.

Partnerships Victoria (2001). "Risk Allocation and Contractual Issues." http://www.partnerships.vic.gov.au/CA25708500035EB6/WebObj/RiskAllocationandContractualIssues1-Entire/$File/Risk%20Allocation%20and%20Contractual%20Issues1%20-%20Entire.pdf (accessed 19 March 2012).

Pirottea, H., Vaessen, C. (2008). "Residual value risk in the leasing industry: A European case." *The European Journal of Finance,* 14(2), 157-177.

Private Finance Panel (1996) "Risk and Reward in PFI Contracts: Practical Guidance on the Sharing of Risk and the Structuring of PFI Contracts." London.

Ravindran, TK. S. (2010). "Privatisation in reproductive health services in Pakistan: three case studies." *Reproductive*

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Health Matters, 18(36), 13-24.

Reeves, E. (2008). "The practice of contracting in Public Private Partnerships: Transaction consts and relational contracting in the Irish scholls sector." Public Administration, 86(4), 969–986.

Regan, M., Smith, J., and Love, P. (2011). "Impact of the Capital Market Collapse on Public-Private Partnership Infrastructure Projects." J. Constr. Eng. Manage., 137(1), 6–16.

Ruuskaa, I. and Teigland, R. (2009). "Ensuring project success through collective competence and creative conflict in public–privatepartnerships – A case study of Bygga Villa, a Swedish triple helix e-government initiative." *International Journal of Project Management*, 27, 323–33.

Salman, A. F. M., Skibniewski, M. J. and Basha, I. (2007). "BOT viability model for large-scale infrastructure projects. " *Journal of Construction Engineering and Management*, 133(1), 50–63.

Sharma, S. (2007). "Exploring best practices in public–private partnership (PPP) in e-Government through select Asian case studies." *The International Information & Library Review*, 39(3-4), 203-210.

Shen, L. Y., Platten, A., 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), 587–594.

Singh, L.B., Kalidindi, S.N. (2006). "Traffic revenue risk management through annuity model of PPP road projects in India." *International Journal of Project Management*, 24 (7), 605–613.

Sobhiyah, M.H., Bemanian, M.R., and Kashtiban, Y.Kh. "Increasing VFM in PPP power station projects – Case study:Rudeshur gas turbine power station."*International Journal of Project Management*, 27(7),512–521.

Tang, L. Y., Shen, Q. P., and Cheng, E. W. L. (2010). "A review of studies on Public–Private Partnership projects in the construction industry." *International Journal of Project Management*, 28, 683-694.

Thomas, A.V., Kalidindi, S.N., Ganesh, L.S. (2006). "Modelling and assessment of critical risks in BOT road projects."

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Construction Management and Economics, 24 (4), 407–424.

Unkovski, I., and Pienaar, E. (2009). "Public private partnerships in South Africa: Analysis and management of risks." *Proc., RICS Construction and Building Research Conf. (COBRA),* Royal Institution of Chartered Surveyors, London.

Wang, S. Q., Tiong, R. L. K., Ting, S. K., and Ashley, D. (1999). "Political risks: Analysis of key contract clauses in China's BOT project." *Journal of Construction Engineering and Management*, 125(3), 190–197.

Wang, S. Q., Tiong, R. L. K., Ting, S. K., and Ashley, D. (2000a). "Evaluation and management of political risks in China's BOT projects." *Journal of Construction Engineering and Management*, 126(3), 242–250.

Wang, S. Q., Tiong, R. L. K., Ting, S. K., and Ashley, D. (2000b). "Evaluation and management of foreign exchange and revenue risks in China's BOT projects." *Construction Management and Economics*, 18(2), 197–207.

Wibowo, A. and Kochendoerfer, B. (2011). "Selecting BOT/PPP Infrastructure Projects for Government Guarantee Portfolio under Conditions of Budget and Risk in the Indonesian Context." *Journal of Construction Engineering and Management*, 137(7), 512-522.

Wibowo, A. Permana, A., Kochendoerfer, B. (2011). "Modeling Contingent Liabilities Arising from Government Guarantees in Indonesian BOT/PPP Toll Roads." Journal of Construction Engineering and Management, 138(12), 1403-1410

World Commission on Environment and Development. (1987). *Our Common Future*. Oxford: Oxford University Press.

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

Xia, B. and Chan, A. P. C. (2012). "Investigation of barriers to entry into the design-build market in the People's Republic of China (PRC)." *Journal of Construction Engineering and Management*, 138(1), 120-127.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

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

Xu, Y. L., Sun, C., Skibniewski, M. J., Chan, A. P. C., Yeung, J. F. Y., Cheng, H. (2012). "System Dynamics (SD) -based concession pricing model for PPP highway projects." *International Journal of Project Management*, 30(2), 240-251.

Ye, S. D., and Tiong, R. L. K. (2000). "NPV-at-risk method in infrastructure project investment evaluation." *Journal of Construction Engineering and Management*, 126(3), 227–233.

Yuan, J. F., Skibniewski, M. J., Li, Q. M., and Shan, J. (2010a). "The driving factors of China's public-private partnership projects in Metropolitian transportation systems: public sector's viewpoint." *Journal of Civil Engineering and Management*, 16(1), 5-18.

Yuan, J. F., Skibniewski, M. J., Li, Q. M., and Zheng, L. (2010b). "Performance Objectives Selection Model in Public-Private Partnership Projects Based on the Perspective of Stakeholders." *Journal of Management in Engineering*, 26(2), 89–104.

Zhang, X. Q. (2005) "Critical success factors for public-private partnerships in infrastructure development." *Journal of Construction Engineering and Management*, 131(1), 631–644.

Zhang, X. Q. (2006). "Public clients' best value perspectives of public private partnerships in infrastructure development." *Journal of Construction Engineering and Management*, 132(2), 107–114.

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Appendix 1: The questionnaire

东南大学建设与房地产研究所
The Research Institute of Construction Management & Real Estate (CMRE)
中国 南京 四牌楼二号 (邮编 210096) Tel: (025) 83792527 Fax: (025) 83793251

The Survey for Residual Value Risk of PPP/PFI/BOT

Dear Sir / Madam,

The CMRE of the Department of Construction and Real Estate at the Southeast University is currently carrying out research on "Dynamic Control and Prediction Method for Residual Value Risk (RVR) in Public Private Partnership Projects". In view of your research experience and expertise in PPP, we would like to invite you to do a survey about the research. The findings collected through this survey will help us to analyze the influence of RVR in PPPs. Furthermore, constructive suggestions are expected to be gained from this survey to improve integrated performance management in PPPs.

Attached to this letter is a MS Word-formatted version of the survey which we would like for you to complete. If at all possible, we also appreciate input from your colleagues. Alternatively, the questionnaire can also be completed on-line and it is available from this address: http://www.zoomerang.com/Survey/WEB22ALGPSB9GM

Our survey will be utilized for research purposes only. Your expert opinions are most valuable for the success of this study. We greatly appreciate your participation kindly request that the completed questionnaires be returned to us by e-mail at cmre@pub.seu.edu.cn by 30 May 2010.

Please feel free to contact Mr. Jingfeng Yuan by e-mail to cmre@pub.seu.edu.cn if you have any questions.

We will be most grateful for your contribution to this important effort.

Best wishes and regards,

Jingfeng Yuan, *Ph.D.*; Qi Ming Li, *Ph.D., Professor*
On behalf of the Research Team
Department of Construction and Real Estate, Southeast University, Nanjing, China.

A. About the Respondent

1. Name of your organization: _____
2. Your position in the organization:_____
3. Your Country: _____
4. Please indicate your primary role in your organization:

☐ Researcher ☐ Public sector (official or public agent) ☐ Designer/contractor/operator
☐ Financier (e.g. bank) ☐ Other, please specify: _____

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

东南大学建设与房地产研究所
The Research Institute of Construction Management & Real Estate (CMRE)
中国 南京 四牌楼二号 (邮编 210096) Tel: (025) 83792527 Fax: (025) 83793251

5. How many years of construction industrial-related experience do you have?

☐ 5 years or less ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ 21 years or more

6. How many years have you been involved in PPP projects?

☐ 5 years or less ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ 21 years or more

7. What type of PPP projects have you been involved with (you may select more than one answer)?

☐Hospital ☐Transportation ☐Water and Sanitation ☐Power and Energy

☐IT & Communication ☐Housing & Office ☐Defense & Naval ☐Police & Prison

☐School & Education ☐Others (please specify):_____

B. About the Residual Value Risk in PPPs

There is a brief introduction about the background of the research as followed.

PPP model has been widely used in the past two decades all around the world; many researchers have investigated the risks in the execution of PPPs. However, most of the projects under this model have long concessionaire period and few projects have been transferred at present. So the risks at the stage of transfer can not be studied systematically. Furthermore, there is no precise definition about Residual Value Risk. Actually, the Residual Value Risk occurs frequently during the lifecycle of PPP projects, which is not a unique risk at the stage of transfer. During the process of project, the public sector neglects the impact of residual value change. As a result, the risk becomes very huge when the project being transferred because of the accumulated impacts. The potential influence is that the function and performance of PPP projects can not meet the needs of general public after being transferred. Our research aims to define the residual value risk through this survey and provide a basis for identifying the critical indicators of Residual Value Risk in future. Currently, the Residual Value Risk (RVR) can be defined as the risk that on expiry or earlier termination of the services contract the asset does not have the value originally estimated by government at which the private party agreed to transfer it to government (BASED ON THE PERSPECTIVE OF PUBLIC SECTORS). The residual value contains fixed asset, organization, intellectual property, technical files, patents, and function et al. We would like to ask for your suggestions about the definition and contents of RVR.

1. So our first question is that do you agree with this definition? If you don't agree, please give your opinion.
2. For the contents of RVR, except those mentioned above, are there any other elements should be involved?
3. How do you think Residual Value Risk is an urgent problem to be resolved at present?
4. Has the Residual Value Risk been considered in your project contract? If the Residual Value can not meet the expectation of public sector (e.g. low performance, low assets), can the negotiation be involved? And can the contract be modified?
5. Do you have any other suggestions for our research?

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Table lists

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Table 1 The detailed information about sent and returned questionnaire in survey

All respondents	***Sent questionnaires***		***Returned questionnaire***			***Effective returned rate***
	n	Percentage to total sent questionnaire	n	effective returned questionnaire	Percentage to total returned questionnaire	
Private Sectors	37	30.58	11	13	28.26	35.14
Public Sectors	45	37.19	24	22	47.83	48.89
Academia	39	32.23	13	11	23.91	28.21
Total	121	100.00	48	46	100.00	38.02

Table 2 The background information of respondents in survey

Type of PPP projects that the survey respondents have been involved with								
	Hospital	Transportation	Water, Sanitation, and Water treatment	Power and Energy	Public housing	Police & Prison	School & Education	Sports
Number of participated PPP projects	11	21	13	10	8	3	3	1
percentage	15.71	30.00	18.57	14.29	11.43	4.29	4.29	1.43

Respondents' experiences in construction industry					
	1-5 years	6-10 years	11-15 years	16-20 years	21 years and above
Number	11	19	7	6	3
percentage	23.91	41.30	15.22	13.04	6.52

Respondents' experiences in PPPs					
	None	1-5 years	6-10 years	11-15 years	16-20 years
Number	12	15	17	1	1
percentage	26.09	32.61	36.96	2.17	2.17

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Table 3 The survey results

1 Respondents' opinion on the significance of RVR

Significance	Extremely important	Very important	Important	Maybe important	Not important
N	27	12	5	2	0
Percentage	58	25	12	5	0

Detailed description of scale:

Extremely important- If the RVR has been considered very urgent and has been included in the contract of PPPs for the same respondent, the significance of RVR for this respondent is extremely important.

Very important- If the RVR has been considered very urgent for the respondent and has not been included in the contract of PPPs for the same respondent, the significance of RVR for this respondent is very important. **Or** If the RVR has been considered urgent for the respondent and has been included in the contract of PPPs for the same respondent, the significance of RVR for this respondent is very important. (In this level, RVR has considered in the contract by 5 respondents, and has not been considered in the contract by 7 respondents.)

Important- If the RVR has been considered urgent and has not been included in the contract of PPPs for the same respondent, the significance of RVR for this respondent is important.

Maybe Important- If the RVR has been considered maybe urgent and has not been included in the contract of PPPs for the same respondent, the significance of RVR for this respondent is maybe important.

Not important- If the RVR has been considered not urgent and has not been included in the contract of PPPs for the same respondent, the significance of RVR for this respondent is not important.

Notice: *The above-mentioned urgency scale from "very urgent" to "not urgent" is judged according to the answers of question 3 for different respondents.*

2 Respondents' opinion on the definition of RVR

Opinions	Agree authors' pre-definition	Basically agree authors' pre-definition	Do not agree authors' pre-definition
N	36	10	0
Percentage	78.25	21.75	0

3 Respondents' opinion on the contents of RVR

Assets 1	Tangible assets			
Detail	Facilities	Technical documents	Equipment	Instruments
Percentage	100	95	87	65
Assets 2	Intangible assets			
Detail	Project organization	Intellectual property	Project goodwill	Market
percentage	95	86	54	49

4 Respondents' opinion on the treatments of RVR by using contractual methods

Opinions	Has RVR been considered in contract?		
	YES		NO
	Can the contract be revised or renegotiated on the case of RVR?		
	YES	NO	
N	19	13	14
Percentage	41	30	29

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Table 4 The respondents' additional opinions on the definition of RVR in PPPs

Respondents	***Respondents' additional opinions on the definition of RVRs***	***Possible solutions***
Opinion 1	At the end of contract, public sectors not only could suffer residual value loss, but also could acquire additional value.	S1-Losses and benefits of RV change should be studied simultaneously in order to balance the relationship between public and private sectors. (Brinkerhoff and Brinkerhoff 2011)
Opinion 2	Private sectors should be involved in RVR definition for the reason that different stakeholders would have relationships with RVR.	S2-Private sectors have very strong relationship with RV. The role of private sectors should be carefully considered in the definition of RVR. Meanwhile, favorable communication between public and private sectors should be encouraged to produce the trust for all stakeholders (Appuhami et al. 2011).
Opinion 3	The specifications for returning projects back to public are very important.	S3-Too detailed and explicit specifications were believed by respondents not practicable and could influence the flexibility of agreement owning to long-term concession period S4-RVR should be dynamically managed by using process-based method (Cliftona and Duffield 2006).

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Table 5 Main contents of RV in PPPs

Main contents		**Explanation**	**References or examples**
Tangible assets	*Facilities*	immovable property (e.g. building, road, bridge, and related supporting facilities)	Koppenjan and Enserink 2009
	Equipment	the contents of equipment in a specific PPP project depend on its type.	In a healthcare center, equipment include building services and fittings equipment, minor clinical equipment office and major clinical equipment, and relocated equipment supplied by HAC, *etc.*
	Instruments	technical and scientific device for collecting data used in measurement and comparison	medical instruments, weather instruments, vehicle instruments
	Technical documents	all technical documents related to construction, maintenance, and operation	In a PPP project, technical document would include economic and financial, engineering, institutional, geographical, and , some specific documents (Asian Development Bank 2005)
Intangible assets	*Project organization*	covers wide contents including manpower of projects, management system and specification in organization	Ruuskaa and Teigland 2009
	Intellectual property	include copyrights, trademarks, pa tents, design, drawings and trade secrets in some jurisdictions	Brinkerhoff and Brinkerhoff 2011
	Project reputation and goodwill	reputation means the opinion (more technically, a social evaluation) of stakeholders toward PPP project and related organization and a group of people; goodwill was originally used in accounting to express the intangible but quantifiable "prudent value" of an ongoing business beyond its assets	Ruuskaa and Teigland 2009; Reeves 2008
	Market shares	the percentage of a market (defined in terms of either units or revenue) accounted for by a specific entity	Bloomfield 2006

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

Figure caption list

Figure 1 The research flow in the paper

Figure 2 The conceptual model of Residual Value Risk in PPP projects

Figure 3 The KRIs in construction period for RVR management in a tunnel PPP project

Fig. 1 The research flow in the paper

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

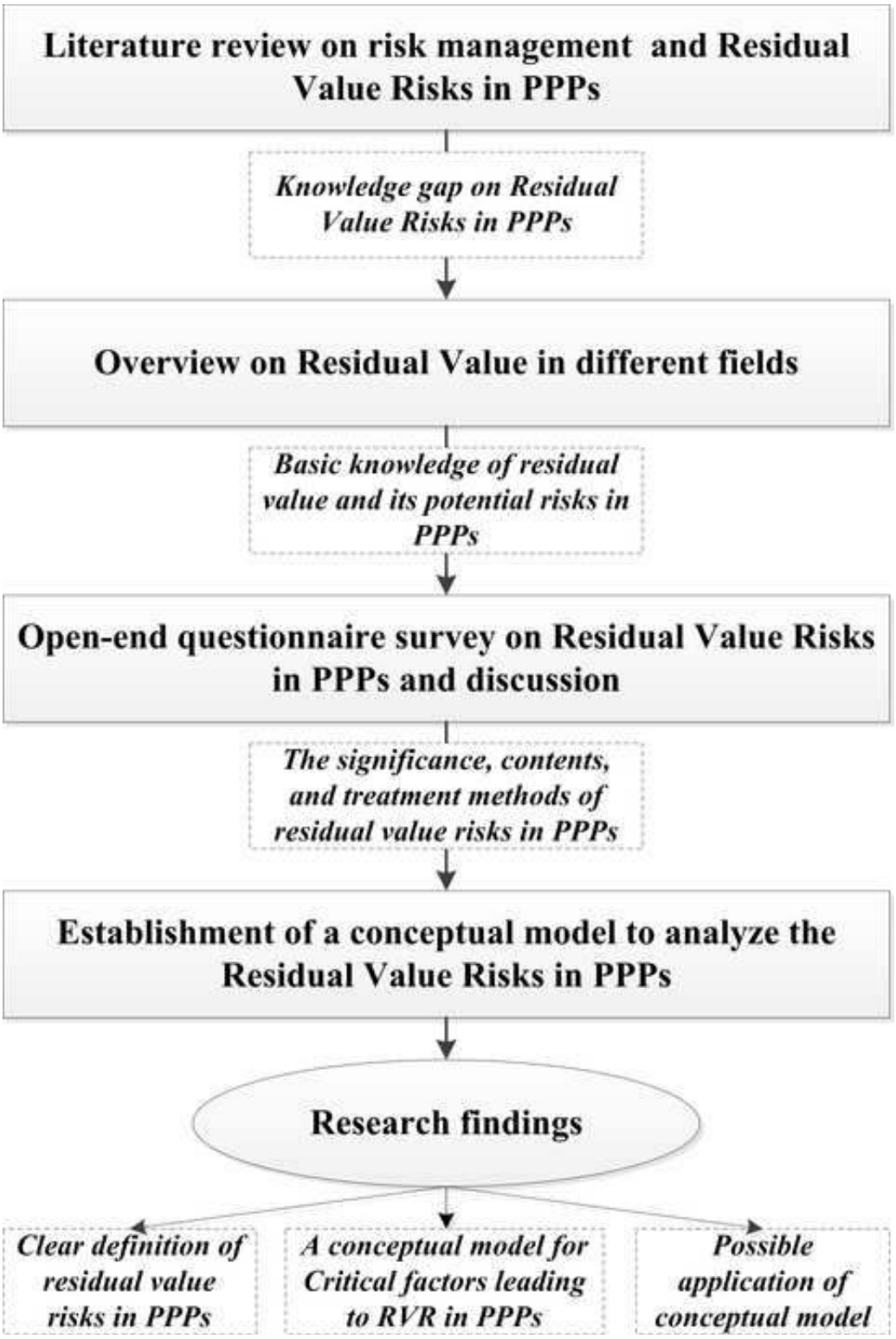

Fig. 2 The conceptual model of RVR in PPP projects

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256

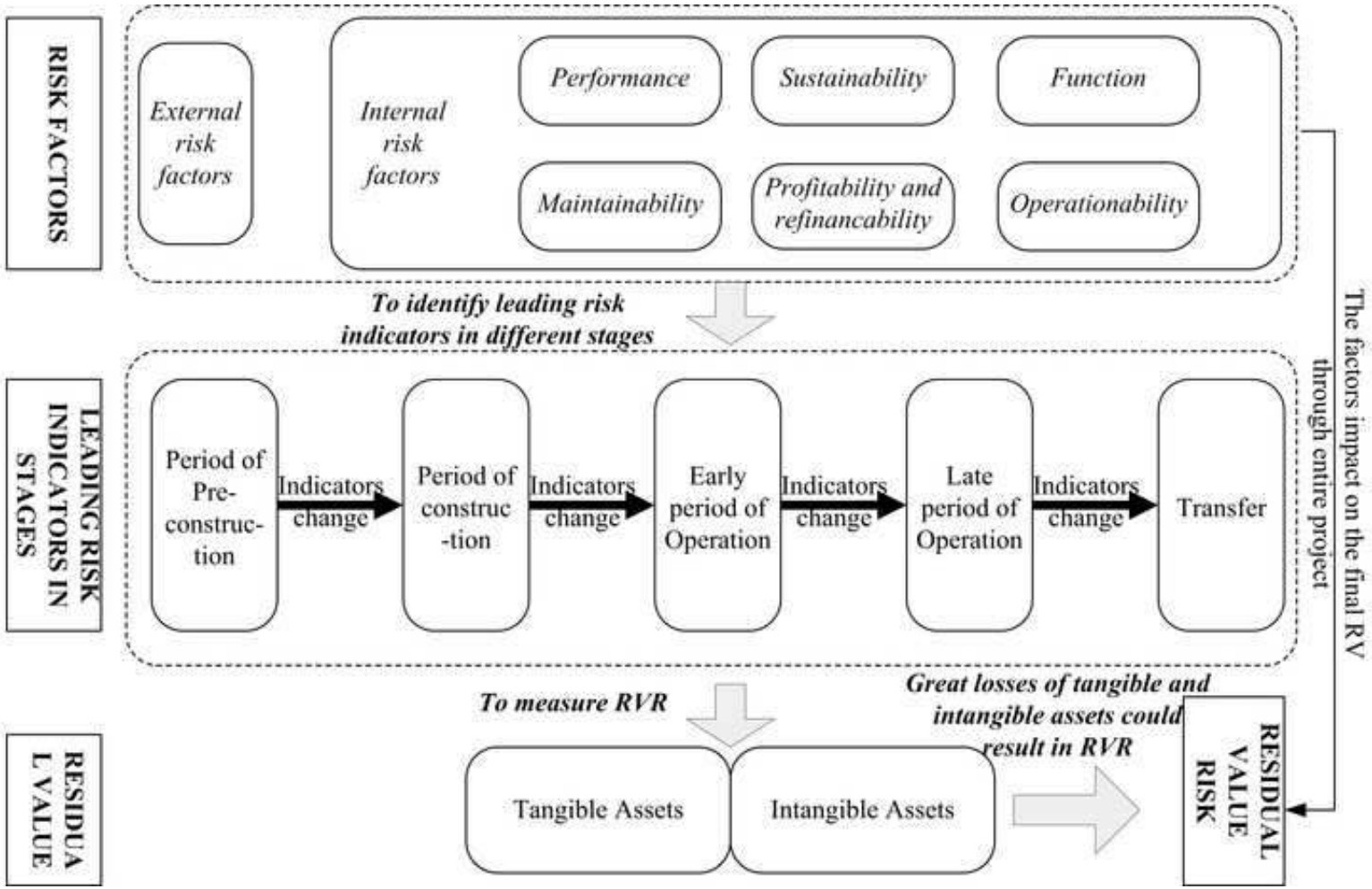

Fig. 3 The KRIs in construction period for RVR in a PPP project

Journal of Management in Engineering. Submitted October 3, 2012; September 4, 2013;
posted ahead of print September 6, 2013. doi:10.1061/(ASCE)ME.1943-5479.0000256