

Perception of Residual Value Risk in Public Private Partnership Projects: Critical Review

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Abstract: 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 widely adopted and have significantly contributed to the development of new infrastructure built throughout the world. However, because 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 yet been thoroughly studied. Residual value risk (RVR) is a critical concern 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 to present a precise definition and meaning of RVR in PPP projects. The survey results indicate that RVR is viewed as an important concern by professionals and academics. The definition of RVR can be phrased as the risk that on expiry or earlier termination of the service contract, the asset (tangible or intangible) is not in accordance with the value originally estimated by the government at which point the private party agreed to transfer it to the government; as a result, public sectors may suffer the loss of the residual value, and the private sector partner may also suffer the loss of compensation from the government owing to a different residual value. Six critical risk factors leading to RVR are identified in this paper: (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 to facilitate the development of PPP projects from the perspectives of regulatory and financial planning. DOI: 10.1061/(ASCE)ME.1943-5479.0000256. © 2014 American Society of Civil Engineers.

Author keywords: Public private partnerships; Residual value risk; Risk identification; Cumulative effects of risk categories; Key risk indicators.

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 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. To achieve VFM, efforts should be made by both the public and private sectors toward the aspects of project planning and design, construction management, maintenance, facility management, staff training, and technology progress (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, whereas the governance of projects has been reported as weak and ineffective in many cases because of the limited control and monitoring by the public sector (Yuan et al. 2010a; Wibowo and Kochendoerfer 2011; Zhang 2006). Furthermore, residual value risk (RVR) may 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 U.K. 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 service contract, the asset does not have the value originally estimated by the government when the private party agreed to transfer it to the government. RVR is a structured risk system that may occur at any time before the transfer of PPP projects to the public sector; consequently, the residual value (RV) to the government cannot fulfill the specifications. Suitable management of RVR is tremendously valuable for better maintenance, easier transfer of the PPP projects, improvement of ongoing management, and sustainable development of the infrastructure (Hall 1998). Otherwise, many problems may occur, such as high

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Note. This manuscript was submitted on October 3, 2012; approved on September 4, 2013; published online on September 6, 2013. Discussion period open until September 9, 2014; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Management in Engineering*, © ASCE, ISSN 0742-597X/04014041(15)/\$25.00.

maintenance costs, low quality service, and functional problems of the facilities (Algarni et al. 2007).

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

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 2010), the risks at the stage of transfer have not been studied systematically because most PPP projects have a long concession period and few projects have been transferred at present. As presented by Infrastructure Australia (2008), the calculation of RV depends on the nature of the asset, historic RV estimates, the expected market for the assets, and the expected monetary benefit (or cost) to the government. Therefore, this study attempts to provide an overview of 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 life cycle of PPP projects.

This paper is organized as follows. The next section describes the methodology used in the paper. The third 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 was used to derive the definitions and contents of RVR in PPPs and to explore the conceptual indicator system of RVR to measure and manage effectively RVR in PPPs the whole research flow for this paper is shown in Fig. 1.

First, an extensive review of relevant research papers was conducted. Because RV primarily encompasses 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 RVR provide a clear picture of the history and current perception of RV and RVR in different fields. In addition, recently published official and political documents provide authoritative evidence of the attitudes of governments toward RVR in PPPs (Partnerships Victoria 2001; Efficiency Unit of Hong Kong 2003; European Commission 2003; HM Treasury of U.K. 2007; Infrastructure Australia 2008, 2013; Comptroller and Auditor General of India 2009). Second, the initially proposed definition of RVR was discussed with 46 PPP experts and professionals to clarify the definition and contents of RVR in PPP projects. The web-based interview method was used in the empirical survey. Data analysis was 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 determine ways to reduce

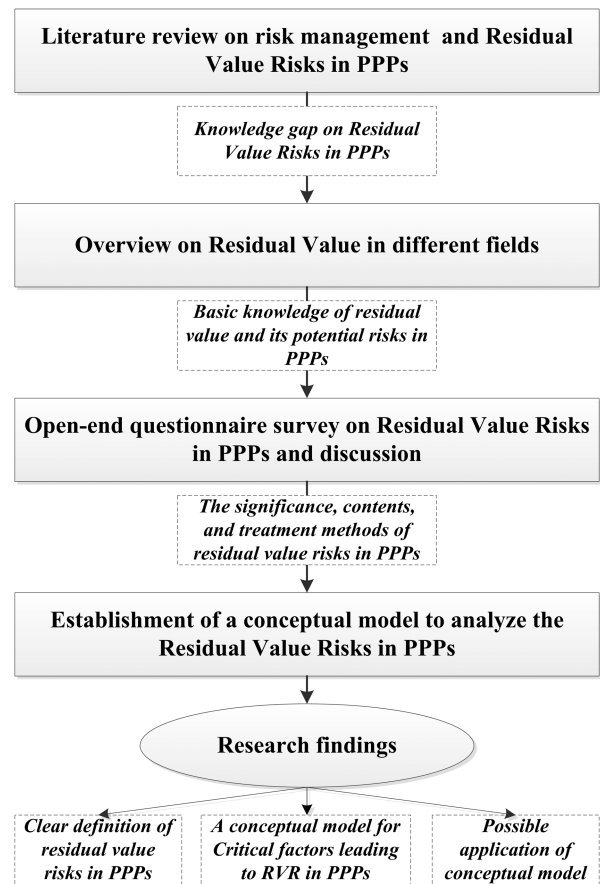


Fig. 1. Research flow in the paper

RVR. Additionally, the potential use of conceptual models was discussed, aiming to not just detect and explain, but to improve the present state of RVR management in real PPP projects and to be helpful for developing risk management in PPPs in the future.

Literature Review

Risk Management and Related Studies in PPPs

In the last two decades, PPPs have become a popular method of procuring major infrastructure projects (Tiong 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 because of long term and sophisticated contract conditions in PPPs (Zhang 2005). Based on the findings of Ke et al. (2009), the top five frequently cited papers in the field of PPP all focus on risk-related research. Tang et al. (2010) also indicate that risks are always an active research topic for PPP projects.

Prior works on risk management of PPPs 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, U.S., or U.K.) and specific project type (e.g., transportation, water treatment, power plant, or education). A 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, both in developed and developing 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 public and private sectors, considering risk management capabilities and certain internal and external conditions. Therefore, risk allocation is considered to be an effective risk treatment method in many 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 et al. 2010). Meanwhile, the establishment of a risk management framework is dependent on effective risk evaluation (Akintoye and Chinyio 2005). A series of qualitative risk evaluation frameworks has 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, previous studies have strengthened the perceptions of industry and academics regarding PPP risks and can be helpful to explore the appropriate ways for managing important risks.

Residual Value Risk in PPPs

Generally, RVR in PPPs can be described as the uncertainty that the RV may be lower than the estimated or anticipated value determined in the PPP contract when transferred, which means that the RV suffered losses during the life cycle of the PPP project under the impact of different factors. However, previous studies have illustrated many different perceptions of RVR in PPP projects.

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) demonstrated that the assets created under PPP deals typically have an expected useful life beyond the formal contract period and that risks associated with the worth of the assets when a PPP project is transferred to public sectors is very important. Algarni et al. (2007) asserted that facility assets that have been suffering from years of neglect, overuse, deferred maintenance, and delayed repair will finally result in RVR that would harm the sustainable development of the infrastructure. Additionally, 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 studies. 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 factor in China (Xu et al. 2010).

The different opinions on RVR reflect the perceptions of different stakeholders based on their own opinions. 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 2008, 2013; Comptroller and Auditor General of India 2009). In the survey conducted by Xu et al. (2010), data also show that opinions on RVR are different for academics and industrial practitioners (most from the private sector) in China. The academics perceived that the problem of RV is more severe than believed by industrial practitioners, based on the viewpoints of the public sector and the general public. Emphasizing and safeguarding the public benefits are the motivations to discuss RVR. On the contrary, the private sector focuses on short-term return on investment (Koppenjan and Enserink 2009), which hinders recognition of the significance of RVR. Second, the RVR problem may 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 not be what was previously required: "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 accurately 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 previously mentioned statement.

Froud (2003) deliberated that RVR can be addressed by completely writing off the asset over the life of the contract and should be transferred to the public when contract ends. On the contrary, Arndt (1998) suggested that RVR should be transferred to the private sector. Li et al. (2005) conducted a survey on risk allocation preference in the U.K. The results indicated different opinions among the respondents (22% of respondents thought that RVR should be transferred to the public sector, sharing the RVR was proposed by 23% respondents, and transferring to the private sectors was 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 among these methods to treat RVR reflect that the perception of RVR is still unclear. RV would suffer loss owing to many factors during the concession period of PPP projects. Public and private sectors should both be responsible for the management of RVR. Therefore, methods to keep RV at a high level should be further explored.

Knowledge Gap

Although prior works have mentioned RVR in PPPs, as presented earlier, few works have focused on RVR in PPP projects. The significance of RVR in PPPs has not been fully recognized by either the public or private sectors. Xu et al. (2010) explained that RVR has been viewed as a potential threat to the successful implementation of PPP projects. Prior research has indicated that RVR should be allocated to the public sectors because they are the asset owners upon 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 investors' overuse of resources like equipment or other technical instruments, which creates insufficient materials and equipment with depreciation at the end of the concession period. Consequently, RVR affects the continuous operation of these projects. Before RVR occurs, the infrastructure itself may have already massively deteriorated. In light of important impacts on society and economy, it is too late to address RVR only when the project is transferred.

According to the review of previous studies, the knowledge gaps can be identified. The differing 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 can be various because stakeholders 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 advance ownership-based risk. What is RVR in PPPs? What are the assets in PPP projects and how will they vary in the life cycle of a PPP project? (2) Most PPP projects are at the stages of planning, negotiation, construction, or operation. As a matter of course, more attention is given to current issues or possibly important issues in the near future. However, long-term vision on the PPP projects is essential for pursuing public benefits.

To realize these public benefits, the RV of PPP projects should be kept at a high level, and government should identify the factors leading to RVR and the indicators that 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 can 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 the first question. The second and third knowledge gaps will be partially involved.

Residual Value and Potential Risks in PPPs

RV 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 discussed by Lucko and Vorster (2003), terminology that is used to describe the concept of RV varies widely in the literature, including market value, salvage value, resale value, and trade-in value. In accounting, the RV can be defined as the estimated amount that an entity can obtain when disposing of an asset after its useful life has ended (Pirotea and Vaessen 2008). When doing this, the estimated costs of disposing the asset should be deducted. Therefore, the residual value of equipment can be the price 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 is 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 U.K. 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 that can be used or sold to pay debts. In essence, an asset can 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 primarily contains two parts: tangible assets and intangible assets.

- Tangible assets are those that have a physical substance and can be touched, including current assets and fixed assets. Current assets include inventory, whereas fixed assets include facilities, technical files, tolls, equipment, and instruments.
- Intangible assets are nonphysical resources and rights that have value to a company because they provide some kind of advantage in the marketplace. Examples of intangible assets are organization, intellectual property, reputation, 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 public sector should focus more on the performance of the private sector in delivering the services according to the stipulated service levels to ensure that the asset can revert back in a reasonable (but not new) condition at the time of transfer, when the assets should still have a 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 given conditions, in which the value of PPP projects can be classified as the value of tangible and intangible assets. Both tangible assets and intangible assets should ensure that the infrastructure facility can be operated

with perfect function and performance, favorable capital status, and complete organizational structure and human resources to continue delivering high quality service after PPP projects are transferring back to public sectors or other service providers. This means that the given conditions include not only financial conditions such as equipment market price or historical leasing data for a building, but also nonfinancial conditions (e.g., physical condition of facilities and historical risk events) that would strongly influence the RV of PPP projects. As a result, the implication of RV in PPPs has surpassed the scope of the traditional definition of RV in the accounting or leasing industries. Intangible assets play very important roles in the change.

In prior studies, the RV of a PPP project has a close relationship with depreciation (Heald 2003). Lucko and Vorster (2003) indicated 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 and the declining balance models, 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 the projects are transferred. For example, the RV of a toll road can be influenced by the level and frequency of maintenance, the private sector's capability of facility management, the change in traffic flow, and the market shares at the time of transferring. In some PPP guidelines (Infrastructure Australia 2013), the value is assumed as 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 marketplace. From this perspective, the confusion about depreciation and RV clearly demonstrates why RVR have not been paid enough attention. In fact, the possible loss of value in PPP projects can result from multiple factors. For example, government-related and financial risks are the most important risks in PPPs as mentioned previously. These risks can finally impact RV and consequently lead to RVR. Therefore, further research on RVR in PPP projects should be conducted to help the public sector better understand how RVR occurs and how to manage and measure the RVR.

Research Survey on RVR

Introduction of Survey

Because the definition and content of RVR are not clear, a research survey was conducted to gain the expert knowledge of PPP practitioners and professionals. Because of the exploratory characteristic of the research, the 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 have used 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 was presented based on a literature review from the perspective of the public sector. 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 consisted

of two parts (Fig. 2). Part A consisted of six questions aimed at gathering data on the respondents' backgrounds. The first question in Part B helped to improve the definition of RVR. The second question in Part B collected useful information from respondents about the contents of RVR and helped to identify the most common elements. The third question in Part B asked about the magnitude of RVR. The fourth question in Part B was another open-ended question to identify respondents' perceptions about how to treat RVR by using PPP contracts. The last question gathered 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 were 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 about respondents was obtained from Part A. Fifteen respondents were from mainland China, eight respondents were from Hong Kong, seven respondents were from United States, five respondents were from Singapore, five respondents were from Australia, and the others were from Europe



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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: _____

(a)

Fig. 2. Questionnaire used in the survey: (a) page 1; (b) page 2



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 following.

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 have not been 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 cumulative impact. 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. 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 renegotiation be involved? And can the contract be modified?
5. Do you have any other suggestions for our research?

(b)

Fig. 2. (Continued.)

Table 1. Detailed Information about Sent and Returned Questionnaires in Survey

| | Sent questionnaires | | Returned questionnaire | | | |
|-----------------|---------------------|-------------------------------|------------------------|-----------------------------------|-----------------------------------|-------------------------|
| | <i>n</i> | Total sent questionnaires (%) | <i>n</i> | Effective returned questionnaires | Total returned questionnaires (%) | Effective returned rate |
| All respondents | | | | | | |
| Private sector | 37 | 30.58 | 11 | 13 | 28.26 | 35.14 |
| Public sector | 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. Types of PPP Projects with Which Survey Respondents Have Been Involved

| Types of PPP projects | Hospital | Transportation | Water, sanitation, and water treatment | Power and energy | Public housing | Police and prison | School education | Sports |
|-------------------------------------|----------|----------------|--|------------------|----------------|-------------------|------------------|--------|
| Number of participated PPP projects | 11 | 21 | 13 | 10 | 8 | 3 | 3 | 1 |
| % | 15.71 | 30.00 | 18.57 | 14.29 | 11.43 | 4.29 | 4.29 | 1.43 |

(U.K. and the Netherlands). 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 is 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 (2012). Demographic details about the experts and the background information of the respondents in the survey are provided in Tables 2–4. These experts represent a wide spectrum of PPP

professionals and provide a balanced view for the survey. Of the respondents, 28.26% came from the private sector, 47.83% from the public sector, and the remaining primarily comprised researchers and academics. More than 75% of the respondents had at least five 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.

Table 3. Respondents' Experiences in Construction Industry

| Experiences | 1–5 years | 6–10 years | 11–15 years | 16–20 years | 21 years and above |
|-------------|-----------|------------|-------------|-------------|--------------------|
| Number | 11 | 19 | 7 | 6 | 3 |
| % | 23.91 | 41.30 | 15.22 | 13.04 | 6.52 |

Table 4. Respondents' Experiences in PPPs

| Experiences | None | 1–5 years | 6–10 years | 11–15 years | 16–20 years |
|-------------|-------|-----------|------------|-------------|-------------|
| Number | 12 | 15 | 17 | 1 | 1 |
| % | 26.09 | 32.61 | 36.96 | 2.17 | 2.17 |

Table 5. Respondents' Opinion on Significance of RVR

| Significance | Extremely important | Very important | Important | Possibly important | Not important |
|--------------|---------------------|----------------|-----------|--------------------|---------------|
| <i>N</i> | 27 | 12 | 5 | 2 | 0 |
| % | 58 | 25 | 12 | 5 | 0 |

Table 6. Respondents' Opinions on Definition of RVR

| Opinions | Agree with predefinition | Basically agree with predefinition | Do not agree with predefinition |
|----------|--------------------------|------------------------------------|---------------------------------|
| <i>N</i> | 36 | 10 | 0 |
| % | 78.25 | 21.75 | 0 |

Table 7. Respondents' Additional Opinions on 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 can not only suffer residual value loss, but acquire additional value | S1: Losses and benefits of RV change should be studied simultaneously to balance the relationship between public and private sectors (Brinkerhoff and Brinkerhoff 2011) |
| Opinion 2 | Private sectors should be involved in RVR definition so different stakeholders 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. Additionally, favorable communication between public and private sectors should be encouraged to produce trust among all stakeholders (Appuhami et al. 2011) |
| Opinion 3 | Specifications for returning projects back to public are very important | S3: Too detailed and explicit specifications are not practicable and can influence the flexibility of the agreement owing to long-term concession period. S4: RVR should be dynamically managed by using process-based method (Cliftona and Duffield 2006) |

Analysis of the Results

As shown in Tables 5–8, some information can be analyzed by using the descriptive statistics method to obtain research findings.

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 Questions 3 and 4 in Part B. The answers of Question 3 in Table 5 reflect the urgency of considering RVR in PPPs in real projects, which indicates that great urgency means great significance. In the answer of Question 3, whether the RVR has been considered in the contract in PPP projects also reflects the significance of RVR in PPPs. If the RVR is considered very urgent and has been included in the PPP contract for the same respondent, the significance of RVR for this respondent is extremely important. If the RVR is considered very urgent for the respondent and has not been included in

Table 8. Respondents' Opinions on Contents of RVR

| Asset 1 | Tangible assets | | | |
|---------|----------------------|-----------------------|------------------|-------------|
| Detail | Facilities | Technical documents | Equipment | Instruments |
| % | 100 | 95 | 87 | 65 |
| Asset 2 | Intangible assets | | | |
| Detail | Project organization | Intellectual property | Project goodwill | Market |
| % | 95 | 86 | 54 | 49 |

the PPP contract for the same respondent, the significance of RVR for this respondent is very important. If the RVR is considered urgent for the respondent and has been included in the PPP contract for the same respondent, the significance of RVR for this respondent is also very important (at this level, RVR was considered in the contract by five respondents, and was not considered in the contract by seven respondents). If the RVR is considered urgent and has not been included in the PPP contract for the same respondent, the significance of RVR for this respondent is important. If the RVR is considered possibly urgent and has not been included in the PPP contract for the same respondent, the significance of RVR for this respondent is possibly important. If the RVR is not considered urgent and has not been included in the PPP contract for the same respondent, the significance of RVR for this respondent is not important.

Of the respondents, 58, 25, and 12% considered RVR to be an extremely important, very important, and important issue, respectively, in formulating PPPs. Notwithstanding slightly different opinions on RVR in PPPs, the RVR can be viewed as a very significant issue with great urgency, based on the survey data. Because there are many maintenance problems in ongoing PPP projects, the occurrence of RVR in PPPs is highly possible, according to 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 unable to meet requirements when projects are transferred back to the public sector because the technological and economical lifespans are shorter than the physical lifespans of an infrastructure project (Javed et al 2013). The progress of technology and reasonable equipment renewal would greatly benefit reducing RVR in PPPs. Only 5% of respondents considered RVR to be an important issue, and no respondents think RVR is an unimportant issue. In the opinions of the respondents, which were obtained from their suggestions based on the answers of Question

5 in Part B, very detailed specifications for transferring PPP projects and strict contract conditions can help to avoid RVR in PPPs.

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.” This was proposed in the survey and respondents’ opinions were sought. The respondents’ opinions of Question 1 in Part B indicated a strong degree of agreement about the definition, according to Table 6. No respondents disagreed with the definition, 78.25% of respondents agreed with the definition, and 21.75% of respondents 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 9.

Based on the answers of Question 2 in Part B, as shown in Table 8, RVR in PPPs has relationships with facilities that were 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 can be varied; explanations and examples or references are shown in Table 10.

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 2007). 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 10, 14 respondents have not considered RVR in project contracts. Because 12 respondents have not been involved in any PPP projects according to Table 4, the RVR was not considered by only two respondents.

Table 9. Primary 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 | Contents of equipment in a specific PPP project depending on its type | In a healthcare center, equipment includes building services and fittings equipment, minor clinical equipment office and major clinical equipment, and relocated equipment supplied by hospital acquired condition |
| 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 documents include economic and financial, engineering, institutional, geographical, and some specific documents (Asian Development Bank 2008) |
| Intangible assets | | |
| Project organization | Workforce for projects, management system, and specifications in organization | Ruuskaa and Teigland (2009) |
| Intellectual property | Copyrights, trademarks, patents, design, drawings, and trade secrets in some jurisdictions | Brinkerhoff and Brinkerhoff (2011) |
| Project reputation and goodwill | 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 | Percentage of a market (defined in terms of either units or revenue) accounted for by a specific entity | Bloomfield (2006) |

Table 10. Respondents' Opinions on Treatments of RVR by Using Contractual Methods

| Opinions | Has RVR been considered in contract? | | No |
|----------|---|----|----|
| | Yes | | |
| | Can the contract be revised or renegotiated in the case of RVR? | | |
| | Yes | No | |
| <i>N</i> | 19 | 13 | 14 |
| % | 41 | 30 | 29 |

However, respondents have different opinions about the use of renegotiation to dynamically treat RVR in the project process. Nineteen respondents that agreed with renegotiation insisted that not all risks and 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, the 13 respondents that disagreed with renegotiation insisted that renegotiation was not reasonable because it may change PPP contracts, resulting in subsequent risks. For example, renegotiation was believed to lead to more disputes and arguments between the public and private sectors. Because of the strong background of public sectors, renegotiation may result in unfairness for the private sectors (Cruz and Marques 2013). Simultaneously, the termination payment to the 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 of RVR, some suggested using the stakeholder perspective to improve the definition. Accordingly, the definition of RVR in PPPs was revised to describe the risk that on expiry or earlier termination of the service contract, the asset (tangible or intangible) is not in accordance with the value originally estimated by the government when the private party agreed to transfer it to the government, such that public sectors may suffer the loss of the residual value and the private sector partner may also suffer a loss of compensation from the government owing to a different residual value.

An interpretation of RVR can be obtained from the description of respondents' opinions on the contents of RVR. As mentioned before, RV in PPP projects includes tangible and intangible assets. According to the different types of content, 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 can result in RVR. Because of the diversified representation form of RVR, the method to treat RVR can be complicated when reducing 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 may 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 first be identified.

Conceptual Framework of Critical Factors Leading to RVR

Identification of Critical Factors Leading to RVR

Although RVR has been redefined from stakeholder perspectives and the loss of compensation from government owing to excess RV also has been considered, this study still concentrates 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 associated risks, and the extent to which a risk factor exists within a particular area is negatively related to the likelihood of a successful outcome to the project (Chapman 2006). Hence, the critical factors leading to RVR should positively impact the final loss of RV in PPP projects.

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

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, because of their uncontrollable nature, there is a need for continual scanning and forecasting of these risks and for a project to be developed for responding to the effects of external forces. These external factors contain changes in the political, social, legal, and economic conditions of a 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 risk factors of PPP projects explored by Shen et al. (2006). Hence, this study focuses on internal factors leading to RVR. For PPPs, different PPP projects have different characteristics. Thus, the internal factors leading RVR are 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. 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, six critical factors are identified based on the requirements of the public sector, the general public, and the cause-and-effect relationship between the critical factors and RV.

The six critical factors include downfall of product or service performance, functional problems, decrease of profitability and low possibility of refinancing, deterioration of maintainability, decline of operability, and failure of sustainability. From the perspective of public goods or services provided by PPP projects, the need for public facilities means high project quality and 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 represent tangible assets of RV. At the same time, good financial management supports the development of PPP projects (Xenidis and Angelides 2005; Wibowo et al. 2011). Otherwise, RV is reduced if the financial conditions cannot be well kept. Therefore, another important factor influencing the RVR should arise from the financial and financing aspect, in which 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 is well organized (Sharma 2007; Chan et al. 2009), on the basis of which continuous improvement can be provided during the longstanding operation period of PPP projects. Moreover, the social, environmental, and financial sustainability in PPPs can provide a satisfactory basis for long-term realization, maintenance, and operation of public infrastructures (Koppenjan and Enserink 2009). Detailed justification and description of the six factors are presented in the following.

The first factor is the 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, superior safety, and comfortable travel. Therefore, congestion, traffic accidents, and low quality pavement indicate a decline in performance. When a PPP project cannot achieve the prescribed performance, the reputation of the project can be harmed, the market share decreases, and the project organization is questioned by general public (Efficiency Unit of Hong Kong 2003). Meanwhile, more vehicles also damage the facilities and equipment. Although the problem may be resolved in a short time, the influence can be long term and invisible. Hence, the decline of performance greatly influences the RV of PPPs. This kind of decline can result from unreasonable design, low construction quality, outdated technologies, unmanageable organization, and maintenance cost overruns.

The second factor is functional problems. Necessary function is traditionally 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 are used in PPP projects to meet the function requirements to ensure that high performance can be achieved. For instance, effective traffic control, strict traffic isolation by different subsidiary facilities, superior design standards for 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 contracts. Functional problems lead to dissatisfaction of users, further damage of related facilities, equipment, and instruments, negative impact on reputation and goodwill, and decreased market shares.

The third factor is the decrease of profitability and the low possibility of refinancing. 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 that 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. Several factors must be considered when prices are

established, including variable costs and fixed costs. Hence, prices and costs are the most important factors for profitability. Low profitability can lead to a lower possibility of refinancing when a PPP project is transferred. In this case, refinancing has changed from an attractive opportunity to a risk for RV. As concluded by Salman et al. (2007), financial ability is critical to the viability of a PPP project. Decrease of profitability and the low possibility of refinancing are very dangerous to a PPP project because of potentially small investments on tangible and intangible assets.

The fourth factor is the deterioration of maintainability. This is the ease with which a project can be maintained to isolate defects or their causes, correct defects or their causes, meet new requirements, simplify future maintenance, 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 to improve the ability to maintain systems or to improve the 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 the reliability and serviceability of infrastructure projects, thus reducing RVR.

The fifth factor is the 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. To maintain tangible assets, facilities, technical documents, equipment, and instruments should be kept at a high level. To maintain intangible assets, operability means that every ingredient of the whole project, including stakeholders, subsystems, and interfaces of different project phases or contracts, should be integrated by technology and efficient project organization, which is also called interoperability (Sharma 2007). Therefore, RV is also strongly influenced by operability.

The sixth factor is the failure of sustainability. 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 was 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 by poorer groups within society. Environmental sustainability refers to the impacts of PPP projects on the related population (health and wellbeing), environment (air and water quality), and the wider surroundings (ecological impacts and 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 utilizing 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, the long-term improvement of RV after a project is transferred is firmly affected by sustainability.

Establishment of Conceptual Model

Although the aforementioned six critical factors leading to RVR have been identified, the occurrence of RVR 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 can finally result in RVR owing to long-term cumulative impacts, which means many risk factors of a PPP project would impact 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 the following.

First, RV change originates not only from a single factor, but from interactions among multiple factors. These interactions must be considered in risk planning and monitoring to ensure that RV limits are not breached. Second, 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 predicted because of interactions between factors.

Hence, a conceptual framework of critical factors leading to the 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 Fig. 3.

In Fig. 3, the proposed model cannot only help industry and academia to 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 the risk of an activity. Therefore, KRIs identified by six risk 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), one 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 may affect the achievement of those objectives. In the current research, the objective for RVR management includes the improvement of tangible and intangible assets that can be viewed as strategic initiatives in the management process.

The identified six 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 to pinpoint the most relevant information that may serve as an effective leading indicator of an emerging RVR. Therefore, KRIs can be identified from the project stage-based perspective, according to the previously 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 is created.

First, the model consists of six internal critical factors and one external risk factor group, as shown in Fig. 3. These factors, which can be measured by different KRIs in different stages, impact the RV of PPP projects during their life cycles. The identified six internal factors concurrently affect the RV during the whole concession period. However, these factors can change from one stage to the next. In different stages, critical factors leading to RVR impact RV and potentially result in losses of RV. These factors can still exist or be transformed to other factors in the next stage and continue influencing RV. Finally, RV will suffer great losses because of the aforementioned cumulative impacts through the implementation of the entire project.

Second, the proposed conceptual model is a project stage-based framework. The influence of identified factors varies in different stages. There are many leading indicators (KRIs) that can indicate how the risk factors influence the RV. Detailed KRIs are not provided in this paper because KRIs vary in different PPP projects. More case studies may be helpful for the identification of KRIs. On the other hand, the proposed model allows that KRIs can flexibly change when projects move from one stage to another. For example, the indicators in the stage of preconstruction may be related to the problems like the quality of planning, the selection of the concessionaire, the appropriateness of financing, the reasonableness of technologies, and the speed of land acquirement. Some of these problems may be resolved within the stage of preconstruction. Other unresolved problems can still impact subsequent stages of the project. Thus, the influence of factors identified during the

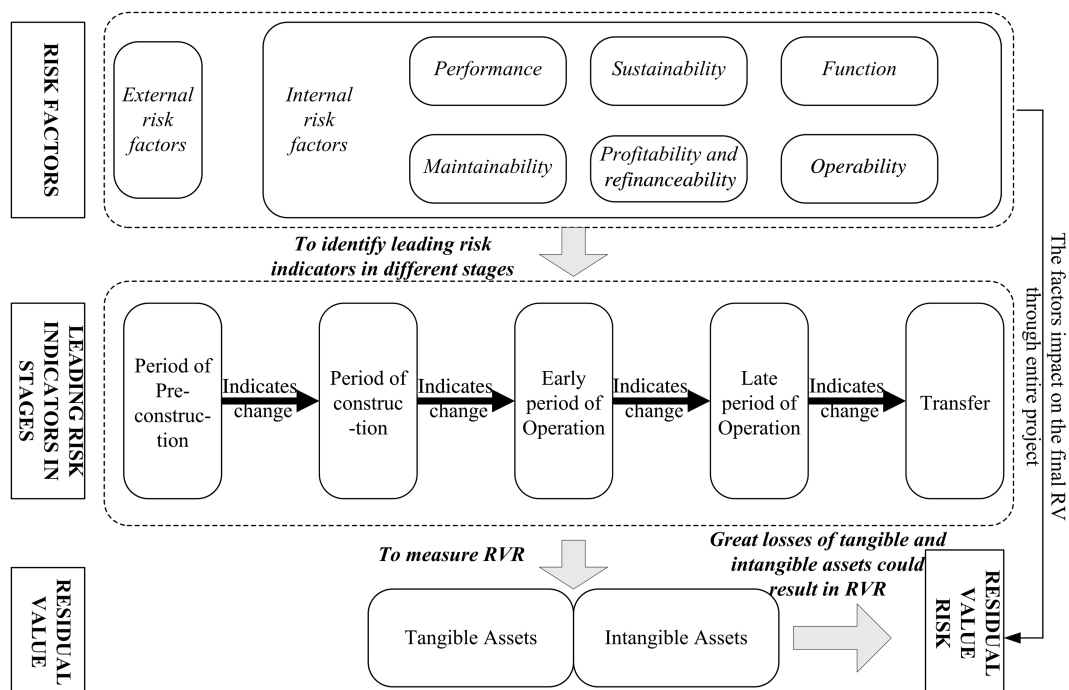


Fig. 3. Conceptual model of RVR in PPP projects

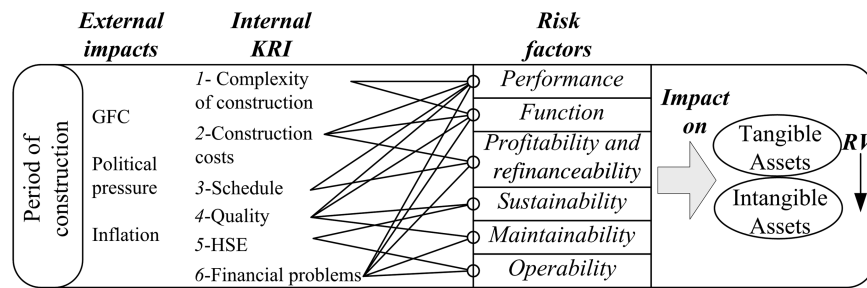


Fig. 4. KRIs in construction period for RVR management in tunnel PPP project

construction period may change. For example, design problems may be invisible in the preconstruction stage, which would result in quality problems in the construction and maintenance stages. Hence, the critical factors may change quantitatively and qualitatively (e.g., downfall of product or service performance may be enlarged or functional problems may change because of the deterioration of maintainability in different stages). In the construction stage, the identified factors will keep changing because of cost overruns, poor quality, delayed completion, and resource overuse. Unresolved problems in the construction stage influence project operation. The operation period is divided into the early stage of operation and the late stage of operation because of great differences between the early and late periods. In the early stage of operation, external factors may still be unchanged. The possible loss of RV at this stage can 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 can change because of the lengthy time since the concession agreement was signed. In this case, external factors should be reevaluated in the late stage of operation. At the same time, technologies used in PPP projects can become outdated or inappropriate at this stage, which is not necessarily considered in the early stage of operation. Furthermore, physical problems such as damage to structures, equipment, and labor are more critical during the late operation phase of the projects (Iyer and Sagheer 2010). Similarly, the market and environment will also be different. Hence, related factors should also be reconsidered.

Third, the six identified risk factors always exist in any stage of a PPP project, but the KRIs change in different stages. The six risk factors can finally impact the RV through the cumulative impacts of multiple project stages. The cumulative impacts on the changes of RV in PPP projects are very important reasons for causing the loss of tangible assets and intangible assets at any time within the concession period (Algarni et al. 2007). During the long-term process of planning, construction, operation, and transference, the public sector is the organizer that can greatly influence the success of a PPP project. However, the public sector may neglect the impact of RV change and the risk may be huge when the project is 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 satisfactory construction and operation by the private sector during the concession period (Ng et al. 2010; Chan et al. 2010). Although many PPP projects may have clear specifications (HM Treasury of U.K. 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 the proposed conceptual model.

Furthermore, the proposed model can be used to track and monitor the changes in RV during the concession period to improve the management of RVR. Fig. 3 clearly presents the relationships among RVR, six risk factors, and KRIs. The cause-and-effect relationship between KRIs and the six risk factors can be used to determine how the RVR occurs in a real PPP project. As shown in Fig. 4, six KRIs have been identified during the period of construction in a PPP tunnel project in Nanjing, China [detailed information is provided by Yuan et al. (2010a)]. The external impacts arose from the global financial crisis (GFC), the political pressure to facilitate the construction, and the inflation led by GFC, on the basis of which the six risk factors leading to RVR can be indicated by six KRIs [e.g., complexity, costs, schedule, quality, and health safety environment (HSE) of construction]. Additionally, the financing problem is also very important. Thus, the KRIs can be identified and used to track and monitor the changes in RV. In other stages, a similar method can be adopted by using six risk factors and corresponding KRIs in each stage, which can assist both the public and private sectors to track the changes in 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 entitled the performance evaluation strategy (PES) and the trust-based strategy (TBS) can be useful to enhance the management of RVR. In the proposed model, the goal of RVR management is to improve the tangible and intangible assets. To achieve this goal, efforts can be made on the basis of the conceptual model to minimize the effects of goal incongruence by the PES and to bring the partners to agreement by the TBS.

Conclusions

Given the increased need for public facilities and the lack of funds and skills for the life cycle management of existing facilities, PPPs have been used extensively and have contributed to the development of infrastructure in many countries. However, the problems related to the management of ongoing PPP projects when transferred to the public sector have not been thoroughly studied. RVR has been identified as an important risk to PPPs at the time of project transfer, but the perception and definition of RVR in PPP projects, the contents and changes of RV during the concession period, and the treatment methods of RVR are not clear; this 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, can be greatly influenced. Therefore, this study focuses 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 two aspects: tangible and intangible assets. By using an open-end questionnaire, the significance, the initial definition proposed by the authors, the contents, and the treatment methods of RVR were discussed with 46 PPP experts and professionals. Most of the respondents (95%) considered that RVR was an important or extremely important concern 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 service contract, the asset (tangible asset and intangible asset) is not in accord with the value originally estimated by the government at which point the private party agreed to transfer it to the government, such that public sectors may suffer loss of residual value and the private sector may also suffer loss of compensation from the government owing to excess residual value. The contents of RVR in PPPs are 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 for RVR. Although the contract was considered to be 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 refinancing; (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 between different risk factors on the RV changes, which can reflect a dynamic situation in a PPP project and help the public sectors to 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 influence the RVR.

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

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