Review of Studies on Risk Early Warning of Public-Private Partnership Projects in Characteristic Town

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Abstract. Under the new normal background of China’s economy, the construction of characteristic towns is of great significance for promoting the supply-side reform and also the sustainable development of regional economy. In recent years, the construction of characteristic towns is in full swing, and the PPP financing model has been introduced to various places due to the difficulty of financing. However, the projects combining a characteristic town with a PPP model are more likely to create risks. Based on literature analysis, this paper summarized the current status of risk identification, risk assessment and risk early warning research of PPP infrastructure projects, in order to draw on the existing research results, construct a theoretical framework for risk analysis and early warning of PPP projects in characteristic towns, which might benefit the future research.

1. Introduction
As a bond between large and medium-sized cities and rural areas, the characteristic towns play an important role in promoting rural revitalization and urban-rural integration. With the establishment of various policies, the construction of characteristic towns is in full swing, and the PPP financing model has been actively introduced to various places due to the difficulty of financing. According to statistics, 52% of the first batch 127 characteristic towns announced by the Ministry of Housing and Urban-Rural Development have launched PPP projects, and 73% of the characteristic towns’ local governments have purchased market-oriented services[1]. However, the problems caused by the “hot” of the characteristic towns and the “hot” of the PPP model also arise. The diversification of the functions of the characteristic towns will cause diversification of risks, in addition to its emerging features, and the insufficient experience for PPP model risk management, which make it more prone to risk. Therefore, it is urgent to carry out the whole process risk identification and risk warning for the characteristic town PPP financing model.

2. Identification of risk factors in characteristic town PPP projects
There are few risk studies on the characteristic town PPP model. Only five research papers were found after searching keywords ‘characteristic town’, ‘PPP’, and ‘risk identification’ in the China National Knowledge Infrastructure (CNKI).

Xu Youquan et al. (2017) combined the case analysis and expert questionnaire to identify the risk of the characteristic town PPP project. According to the source of risk factors, except for the common risks of the PPP project, the specific risks of screening the characteristic town PPP project include industrial risk and concept risk [2]. After that, Shao Guihua et al. (2017) drew on the risk screening results and used the risk breakdown structure (RBS) to identify the specific risks of sports and leisure...
industry risks and concept risks in the sports and leisure characteristic town PPP project[3]. Lai Yifei et al. (2018) had expanded the characteristic risks of the characteristic town PPP project: multi-regulation risk, production city integration/industrial positioning risk, unique culture risk, project innovation risk, long-term profit risk and land development risk. And then, they classified these risks according to government, market and project level risks [4]. In a word, the above studies not only consider the common risks of PPP projects, but also highlight the specific risks of the characteristic towns.

3. Infrastructure PPP project risk identification

The ways to identify risk factors in infrastructure PPP projects is multiple. Domestic and foreign scholars mainly use qualitative methods, literature analysis, case studies, questionnaires, expert interviews and other methods to identify risks. According to the literature, it is found that the current research results of risk identification can be summarized into four aspects:

3.1. Based on risk sources

By explaining the HHM framework of infrastructure PPP projects, Yang Zu et al. (2018) identified the risks of urban infrastructure projects using PPP mode from three aspects: economic subsystem, social subsystem and environmental subsystem[5]. From a financing perspective, Schaufelberger et al. (2003) believed that the three main risks affecting the selection of project financing strategies were market, financial, and political risks[6]. From the perspective of financing risk identification, Hu Li et al. (2011) also summarized three types of risks involved in PPP projects: force majeure risk, country risk and specific project risk[7].

3.2. Based on the level of risk

Hastak & Shaked (2000) suggested that risks could be categorized in three levels: country risk, market risk, and project risk[8], which are widely used by later scholars. For example, Fu Jincun (2016) obtained 15 risk factors through a cross-case study method that aggregated multiple classic cases, and used Hastak & Shaked's method to divide it into government risk, market risk and project risk [9]. Based on the PPP/PFI project, Li Bing et al. (2005) divided the risks into three categories: macro-level risks, meso-level risks, and micro-level risks[10], which had a relatively high recognition in the academic world. For example, when Li Yan et al. (2015) identified the risk list of PPP projects, they also classified the risks under the three levels of macro, meso and micro[11].

3.3. Based on the project phase

Ghorbani et al. (2014) divided risk into: development phase, operational phase and full life phase [12]. However, this division failed to break down the risks of the development phase. From the perspective of the full life cycle, Li Li et al. (2016) re-divided the risks of PPP projects in the infrastructure sector according to the decision-making phase, financing phase, construction phase, operation phase from the perspective of life cycle[13]. Zhao Hui et al. (2017) focused on the “dynamic” of risk and the “phased” risk of the whole life cycle. According to the different phases of the environmental protection PPP project, the risk was identified and divided into five phases: decision phase and contracting phase, financing phase, construction phase, and operation phase [14].

3.4. Based on the project category

Guo Jiyue et al. (2016) focused on the social risks of transportation PPP projects. Based on the case analysis method and the questionnaire survey method, the social risk influencing factors of transportation PPP projects were divided into three categories: economy and people's livelihood, environment and humanities, management and operation. And more detailed influencing factors were proposed under each category [15]. In the PPP project of the integrated pipe gallery, Zhao Jia et al. (2018) used the HHM method to identify the eight major risk factors of financing: political risk, legal risk, financial risk, construction and operation risk, market risk, force majeure risk, and green environmental risk [16].
In addition, some scholars conducted research based on cases or surveys. Zayed et al. (2002) obtained financial risks, market risks, political risks, development risks and operational risks for PPP projects through the questionnaire [17]. Qi Xia et al. (2009) selected 16 failed cases implemented in China since the 1980s to identify 13 major risk factors [18].

In summary, the key to risk identification is to scientifically and rationally classify risk factors. Domestic and foreign scholars identified the risk factors of infrastructure PPP projects from different levels and perspectives. At present, scholars generally use Li Bing's three-level risk classification method and risk classification method from the perspective of life cycle, however, the more authoritative scientific and concise division system has not yet been established.

4. Infrastructure PPP projects risk assessment
Risk assessment is based on risk identification, establish a risk assessment model, comprehensively evaluate each risk factor in combination with qualitative and quantitative, understand the level of risk, identify the relationship between the factors, and finally determine the level of risk. Common risk assessment methods fall into three categories: qualitative methods, quantitative methods, and integrated methods.

4.1. Qualitative methods
Expert evaluation is a common qualitative research method used in early risk research. To this end, Lyons et al. (2004) conducted a survey study, and the results showed that the risk qualitative analysis method based on expert experience judgment and subjective evaluation was a commonly used risk assessment method in engineering projects [19]. However, because the expert evaluation method is too subjective, the risk factors of the PPP project are more complicated, and the results cannot be accurately and fairly evaluated. It needs to be combined with other methods.

4.2. Quantitative methods
Su Haihong et al. (2018) used the Analytic Hierarchy Process (AHP) to determine the weight of key risk indicators for PPP projects, and thus evaluate risk indicators at all levels [20]. The risk assessment model established by the analytic hierarchy process presented a three-tier structure of the target layer, the criterion layer and the index layer. The indicators at each level were independent of each other, and the information of mutual influence and interaction between the indicators could not be obtained. This was contrary to the complexity and interrelated complexity of risk factors in PPP projects. Therefore, Zhang Wei et al. (2012) further used the Analytic Network Process (ANP) for risk assessment [21]. The risk assessment model established by ANP had three layers of hierarchical and internal loop network layers, which fully considered the cross-linkage of risk factors, making the PPP project risk evaluation results more reliable.

Chen Jingwu et al. (2006) et al applied the fuzzy comprehensive evaluation method to the risk assessment of PPP projects [22].

The analytic hierarchy process (or ANP) and the fuzzy comprehensive evaluation method are classic traditional risk assessment methods, which are widely used by scholars. However, in view of the fact that both need to rely on expert scoring to evaluate risk factors, relying on the experience of experts to make subjectivity is strong, so a single evaluation method cannot make the results of the analysis more scientific, reasonable and accurate.

4.3. Integrated methods
Later scholars preferred to combine multiple methods for risk assessment. Based on the Delphi method and expert survey method, Li Yan et al. (2015) designed the risk evaluation index system of PPP project, and combined with the analytic hierarchy process and fuzzy mathematics method, established an optimized F-AHP method to construct the risk assessment model of the infrastructure [11].
A combination of fuzzy comprehensive evaluation method and other methods is most widely used. Based on fuzzy comprehensive evaluation method and neural network model, Cai Xiaoyan et al. (2016) proposed an intelligent risk assessment model for traffic infrastructure PPP projects. Liu Hongyong et al. (2017) constructed a risk sharing model based on the risk of construction waste resource treatment project under PPP mode, using entropy weight method and fuzzy comprehensive evaluation method. The above method is more flexible and simple, can further improve the calculation efficiency, and also ensures the objectivity of the evaluation results.

In addition, as a new evaluation method, neural network technology has also been combined with principal component analysis for risk assessment. Lu Xiaoqin et al. (2017) established an adaptive radial basis function neural network (RBF) intelligent risk assessment model by reducing the principal component analysis (PCA) technique and combining fuzzy comprehensive evaluation results.

In summary, the analytic hierarchy process and the fuzzy comprehensive evaluation method are the current mainstream risk assessment methods. However, since it is difficult to guarantee the objectivity and accuracy of the evaluation results by a single evaluation method, they need to be combined with other methods. In addition, when applying the new risk assessment model, the accuracy of the model should be considered, and the evaluation model should be further improved due to the dynamic changes of risk factors.

5. Infrastructure PPP projects risk early warning

Through empirical research, Xianhai Meng (2014) found that early warning had a significant impact on problem solving and project performance in terms of time, cost and quality in construction projects. However, there are still relatively few risk warning studies on PPP infrastructure projects, and the research results are mostly concentrated on financial and real estate research.

Using the neuro-fuzzy modeling method, Chin-Shien Lin et al. (2008) proposed a mixed causal warning model for predicting the occurrence of currency crisis. The empirical results showed that the proposed neuro-fuzzy model had a good predictive effect on the crisis. Altman (1968) created a multi-variable judgment model-Z-score model. Wang Yi (2012) conducted a statistical analysis of the financial data of 40 real estate listed companies in China, and judged the effectiveness of the Z-score model on the financial risk warning of real estate listed companies in China. L.Y.Ding et al. (2013) used a hybrid data fusion model based on multi-source information (monitoring measurement, computational prediction), and visually inspects human experts to automatically conduct subway safety risk assessment and early warning. The system had been successfully applied to several subway construction projects and achieved good results. Xinran Tian et al. (2014) used fuzzy theory to establish an early warning model for real estate enterprises through factor clustering and weight clustering.

In the risk early warning research of infrastructure PPP projects, the mainstream methods currently used are matter-element models and cloud models. Wang Wenxiong et al. (2008) used fuzzy group decision theory and matter-element theory to construct a private-sector risk early warning model for infrastructure projects under PPP mode. Pan Yan et al. (2018) designed a risk early warning model based on variable weight extension material and evidence theory. Finally, a PPP project of a toll road in F Province was taken as an example to carry out risk warning, and the rationality and effectiveness of the model were verified. Li Juanfang et al. (2017) constructed a PPP environmental protection project risk early warning model based on fuzzy-rough set theory and cloud model theory. Finally, the Wuhan Xinzhou District project was taken as an example to verify the practicality of the model.

In summary, the application of the matter-element model is relatively mature, especially the private-sector risk warning model for infrastructure construction under the PPP model proposed by Wang Wenxiong. The calculation is simple, scientific and reasonable, but the appropriate early-warning model should be selected according to the characteristics of the project.
6. Summary
As the research conclusions of the infrastructure PPP project which can not be fully applied to the characteristic town PPP project, the identification of risk factors for the characteristic town PPP project needs further research, focusing on the “feature” of the characteristic town and the complexity of the PPP model, and conducting the systematic comprehensive risk factor identification. Secondly, in the aspect of risk assessment, it is necessary to select an appropriate evaluation method combining qualitative analysis and quantitative analysis. Finally, risk warning with empirical case test and the establishment of a sound preventing and coping mechanism will also be the focus of future research.

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