

Research Article

Identifying Critical Bankability Criteria for PPP Projects: The Case of China

Lei Zhu ¹ and David Kim Huat Chua²

¹Lecturer, Department of Construction and Real Estate, Southeast University, Nanjing 211189, China

²Professor, Department of Civil and Environmental Engineering, National University of Singapore, Singapore 117576,

Correspondence should be addressed to Lei Zhu; seuzhulei@seu.edu.cn

Received 19 April 2018; Accepted 24 September 2018; Published 17 October 2018

Guest Editor: Dujian Yang

Copyright © 2018 Lei Zhu and David Kim Huat Chua. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Public-private partnership (PPP) projects employ a high leverage in terms of debt finance needed by the private consortium. Debt finance providers need to know the bankability-related issues of PPP projects to make the timely arrangement of debt financing and avoid funding problems. However, there is still a lack of a systematic research on the bankability of PPP projects despite the worsening debt arrangement situation for PPP projects after the credit crisis and economic recession from 2008. To bridge this knowledge gap and enhance the practical debt arrangement of PPP projects, this study aims to identify and prioritize the critical bankability criteria of PPP projects. To achieve the objectives, 41 bankability-related criteria were first identified from a comprehensive literature. A structured questionnaire survey was then conducted with 31 industry experts in China who worked in financial institutes and had experienced PPP projects to investigate the relative importance of each criterion. To handle the uncertainty and vagueness of the subjective evaluation from surveys, this study analyzed the relative importance weight of each criterion using a proposed fuzzy analytical hierarchy process-based approach. The results showed that political environment, economic environment, shareholders' credibility, financial market, legal system, public sector's reliability, financial structure, and regulatory framework were ranked as the top eight critical bankability criteria. The findings of this study first contributed to the project finance body of knowledge for the bankability of PPP projects. Moreover, the outputs of this study would provide valuable information to the private and public sectors for formulating strategies on improving the bankability of PPP projects.

1. Introduction

As an efficient procurement method of the public infrastructure projects or services, the public-private partnership (PPP) approach has been widely adopted in many countries [1]. For instance, China has initiated 13,554 PPP projects costing 2,612 billion dollars until the end of June 2017 [2–4]. Through the PPP approach, the public sector can alleviate the shortage of the infrastructure investment and increase the efficiency of infrastructure provision [5]. As for the private sector, they can broaden their investment channel without severely endangering their corporate assets because of the off-balance sheet finance arrangement [6]. The main or sole source to meet financial obligations is the cash flows of a PPP project. In addition, the banks have no recourse or limited recourse to the private sector's corporate assets [6, 7].

Projects developed using PPP approach (PPP projects) are well known for the high leverage ranging from 50% to 90%, relying extensively on the debt capital provided by the debt holders such as banks and other financial institutions [8]. Therefore, raising sufficient funds via the debt channel is a key task for PPP sponsors and project companies [9]. However, international capital markets have experienced high levels of instability and adversely affected the funding arrangements for social and economic infrastructure projects since 2008, leading to limited availability of equity and debt capital and a higher cost of capital [10, 11]. Moreover, the market access has been difficult for both the public sector and the private sector, leading to banks becoming the main source of funds for PPP projects [10, 12]. Furthermore, banks were unwilling to commit to lending terms for anything other than a short period in some countries [12].

Because of the adverse situation of the financial market, several projects failed to be procured through the PPP approach because of unsuccessful debt arrangements [13–15]. Moreover, many researchers identified that the debt arrangements of PPP projects greatly hindered the eventual progress to the construction stage. Thomas [16] identified that delays in debt arrangements constitute a critical risk in the development phase of BOT projects in India. Cheng et al. [17] indicated that prolonged negotiations between borrowers and financiers abort the commencement of PPP projects. Moreover, Merna and Khu [18] pointed out that PPP promoters were sometimes unable to raise funds even if they had obtained the franchise from the government because of their lack of project financing techniques and the understanding of associated risks. In addition, funding is a major problem for PFI projects especially launched by small- or medium-sized companies [17]. The difficulty in raising the finance, the high cost of financing, and even being unable to close financing within the time frame stipulated in the concession agreement all could lead to the failure of financial close [7, 19].

Considering the significance of the debt for PPP projects and the difficulties in securing loans for a successful financial close, it is an important requisite for project stakeholders, especially project sponsors and the relevant public sector, to consider the bankability-related issues from the outset of a PPP project. A PPP project is considered bankable if lenders are willing to finance it [20]. Moreover, establishing enhanced bankability for a PPP project is because ultimately the financial market will judge the project on its own merits without the traditional government repayment guarantees [19]. Readily bankable PPP projects are prioritized over more-needed infrastructure projects by banks [10]. Bankable, generating enough cash flow, and reflecting project and financing term were identified as the top three most important expectations from stakeholders of PPP projects [7]. Furthermore, the lessons from the subprime mortgage led to banks enhancing their own internal credit rating systems instead of completely relying on the credit risk assessment of external credit rating agencies. Therefore, the research on the bankability assessment of PPP projects is important for paving the way towards the successful and sustainable development of PPP projects [21].

Up until now, the research on the bankability assessment of PPP projects is still lacking. Considering that the bankability implies a set of criteria that investors consider in approving project finance, this study aimed to identify and prioritize the critical bankability evaluation criteria (hereafter referred to as bankability criteria) for PPP projects from the bank's perspective. The findings of this study can enrich the project finance body of knowledge in the bankability assessment of PPP projects. Moreover, outcomes of this study can help PPP project stakeholders, especially the public and private sectors, make rational decisions to form bankable PPP projects, paving the way to the successful and sustainable development of PPP projects.

2. Background

2.1. Rational of Bankability Evaluation. Up until now, there is no uniform definition of the bankability of a project. Commonly, a PPP project is bankable if lenders are willing to finance it or the sponsor can convince the lenders to support it [9, 20]. From the assessment perspective, a bankable project involves a solid financial, economic, and technical plan, with a risk allocation scheme appropriate for the nature of the project, the risks involved, and the interests of the lenders, implying an acceptable credit risk [8, 22]. Moreover, the bankability of PPP projects consists of the key common bankability dimensions in general and a common set of bankability criteria against which the key dimensions are evaluated [8, 23]. Considering the quantitative loan analysis, the lenders believe that a project is bankable if the project company has the ability to service the principal and interest payment. In addition, the exposure of the lenders to default by the borrowers is acceptable [9, 22].

The lessons from the subprime mortgage led to banks not completely relying on the credit risk assessment of external credit rating agencies [24]. Each bank has or starts to enhance its internal credit rating system to evaluate the credit of a PPP project [22]. Generally, the banks' internal credit rating systems are not revealed to outsiders as they are carried out by the banks' personnel. Only the banks' staffs who work with these bankability evaluation models, such as the bank directors and debt evaluators, know the rating system. Moreover, there is no common internal credit rating system for all banks. Comparing with statistical models developed by external credit rating agencies, the banks generally believe that a properly managed judgmental rating system delivers more accurate estimates of risk [24].

2.2. Identified Bankability Criteria. To identify the critical bankability criteria, this study adopted the analytic hierarchy process (AHP) approach. As a well-known structured technique for dealing with the complex decision, the decision problem is first decomposed into a hierarchy of more easily and independently analyzed subproblems. Experts' opinions and evaluation scores are then integrated into the simple elementary hierarchy system [25]. AHP approach has been widely used to deal with PPP-related issues [26, 27].

Through a comprehensive literature review and case studies, this study identified 41 bankability criteria that determine the bankability of a project or are of primary importance to the lenders in assessing a loan application. This study further classified them into six dimensions: (1) economic and political environment; (2) legal and regulatory environment; (3) project specificity; (4) project financial structure; (5) third party risk allocation; and (6) contract arrangement. The bankability dimensions and criteria under each dimension are summarized in Table 1.

2.2.1. Economic and Political Environment. Laishram and Kalidindi [29] identified that social-economic characteristics and economic strength were two extremely important criteria in assessing the desirability of a PPP project from a debt

TABLE 1: Identified bankability criteria for PPP projects.

S/N	Bankability criterion	References									
		1	2	3	4	5	6	7	8	9	10
D1	Economic and political environment										
D1.1	Economic environment		√	√							√
D1.2	Competition condition				√						√
D1.3	Financial market									√	
D1.4	Political environment			√							
D1.5	Public opinion						√				
D1.6	Tax policies			√							
D1.7	Currency issues			√					√		
D2	Legal and regulatory environment										
D2.1	Legal system			√	√			√			
D2.2	Regulatory framework			√							
D2.3	Enforceability			√	√						
D2.4	Nationalization and expropriation			√				√			
D2.5	Procurement process								√		
D2.6	Intervention right			√							
D3	Project specificity										
D3.1	Project definition		√	√				√			
D3.2	Feasibility studies		√	√							
D3.3	Capacity of the technology			√	√						
D3.4	Site acquisition and access			√							
D3.5	License, permits, and authorizations		√	√				√			
D3.6	Infrastructure issues			√							
D3.7	Environmental standards		√	√			√				
D3.8	Labor force			√							
D3.9	Size of the project		√	√			√				
D4	Project financial structure										
D4.1	Shareholders' credibility	√		√	√	√			√		√
D4.2	Public sector's reliability				√			√			
D4.3	EPC contractor's credibility				√						
D4.4	Financial structure		√	√		√			√		√
D4.5	Financial flexibility		√	√		√					√
D5	Third party risk allocation										
D5.1	Insurance arrangement			√		√				√	√
D5.2	Environmental and other legal/regulatory issues			√							
D6	Contract arrangement										
D6.1	Concession agreement			√		√					√
D6.2	Concession period			√		√					√
D6.3	Support agreement/guarantee					√			√		√
D6.4	Termination provisions			√							√
D6.5	Construction contract		√	√							√
D6.6	Operation and maintenance agreement		√	√							√
D6.7	Offtake purchase agreement			√							√
D6.8	Input supplier agreement			√							√
D6.9	Guarantee from multilateral investment agency				√			√		√	
D6.10	Direct agreement				√						
D6.11	Catastrophic risk			√				√			
D6.12	Arbitration						√				

References: (1) Lopes and Teixeira Caetano [28]; (2) Laishram and Kalidindi [29]; (3) Delmon [8]; (4) Gatti [30]; (5) Zhang [23]; (6) Davis [31]; (7) Wang et al: [32]; (8) Wang et al: [19]; (9) Regan et al: [11]; (10) Zhang [33].

financing perspective. Moreover, considering the practical requirements of the lenders when reviewing a project, Delmon [8] found that the economic and political viability and currency issues were important bankability issues. Furthermore, the tax regime applicable to PPP projects must be sufficiently stable because the lenders need to forecast the exposure to tax liability and plug into the financial model [8]. In addition, Gatti [30] and Zhang [33] emphasized the

importance of the competition condition in the economic environment to the bankability of a PPP project. Through many real case studies, Davis [31] revealed the importance of public opinion to the success of PPP projects.

2.2.2. Legal and Regulatory Environment. Contract enforceability depends on a series of factors such as a country's

judicial tradition as well as the degree of economic development in a country. Gatti [30] indicated that lenders felt less protection in nations where civil law is in force than in nations where the common law is in force. Moreover, Delmon [8] explained that lenders would want to consider the legal system applicable to a project in view of a long-term commercial agreement. The availability of justice, enforceability, and nationalization and expropriation were important criteria from the lenders' perspective. Change in law and expropriation were identified two of the six most critical risks affecting the finance of China's BOT projects [32]. In addition, among the procurement procedure, seeking a realistic target date for financial close is highly critical [19].

2.2.3. Project Specificity. After assessing the desirability of a PPP road project from a debt financing perspective, Laishram and Kalidindi [29] found that (1) the feasibility study was one of the extremely important criteria to a debt financing and (2) the permits and site clearances were two of the fairly important criteria to a debt financing. Practically, lenders prefer to ensure that protections are provided to the project company to avoid any cost increase and time delay because of the changes in the required permits and licenses [8, 32]. Moreover, in terms of the practical requirements of the lenders when reviewing a project, Delmon [8] explained that lenders usually attach great importance to the capacity of the technology to be used and its appropriateness for the site and the region. International financing organizations conventionally prefer to have a separate review of the capacity of the technology performed by an independent expert [8, 30]. Furthermore, the sufficient local infrastructures, including transportation systems, roadways, electricity, water, and other utilities, and local services were greatly important to the bankability of a PPP project [8].

2.2.4. Project Financial Structure. Lenders believe that the special purpose vehicle (SPV) shareholders which have the high creditworthiness and reliability would make a strong commitment to a project [8, 30]. Based on an empirical study to identify the determining characteristics of a firm to be engaged in a PPP project, Lopes and Teixeira Caetano [28] disclosed that larger and more leveraged firms had a higher probability of being engaged in a PPP project. The strong financial capability, sufficient commercial experience, and technical expertise of the concessionaire were an important prerequisite to the successful development of a PPP project [8, 23]. Compared with the private sector, the public sector's reliability and creditworthiness are often viewed as the critical risk for PPP projects [30, 32]. Factors, such as corruption and rent-seeking behavior, often turn a decision of a PPP project against lenders [30]. As one of the main shareholders, the EPC contractor's credibility, which is often examined through a due diligence investigation, directly determines the completion risk of a PPP project and affects the lenders' interest [30].

Moreover, the results of Laishram and Kalidindi [29]'s empirical study showed that some elements of a financial structure, such as debt service cover ratio, debt-equity ratio,

and debt service reserve, and the financial flexibility of a PPP project was extremely important to a debt financing. Essentially, the health of the project structure, the commercial plan, and the forecast revenue stream convince the lenders to provide financing to a PPP project [8]. Furthermore, the findings from a survey on 35 identified financial criteria showed that the price and adjustment mechanism, the attractiveness of main loan agreement, sound financial analysis, and minimal financial risks to the clients were the top four most significant financial criteria [23, 33].

2.2.5. Third Party Risk Allocation. The sufficient insurance coverage of a PPP project would further protect the lenders from risks and is viewed as the critical financial criteria measuring the financial capability of a PPP project [11, 23, 33]. A PPP project must have in place a comprehensive insurance scheme, avoiding gaps or overlapping coverage [8]. Moreover, lenders would prefer that the project company is isolated from sanctions for the breach of environmental regulations and compensation for environmental damage [8].

2.2.6. Contract Agreement. To ascertain that all risks are appropriately allocated to various players, lenders would closely look at the network of contracts with the SPV [30]. The relevant contracts include the concession agreement, EPC contract or construction contract, operation and maintenance (O&M) agreement, offtake purchase agreement, input supply agreement, termination provisions, and direct agreement [8, 29, 30, 33]. Moreover, the government's guarantees/support/comfort letters would enhance the bankability of a PPP project and, to some extent, reduce the relevant political risks [19, 33]. Furthermore, in terms of international financing, obtaining the guarantee from multilateral investment agency is regarded as the most effective measure in mitigating expropriation risk and obtaining the support of the project developer's home government [32]. In addition, the force majeure and relevant arbitration when a dispute occurs were also identified as critical risks in PPP development [31, 32].

3. Methodology and Data Presentation

3.1. Data Collection and Presentation. As a systematic method of collecting data, the questionnaire survey technique has been widely used to collect professional views [7, 34, 35]. This study conducted a questionnaire survey to investigate the relative importance weights of the bankability criteria. To develop the questionnaire, a comprehensive literature review of the bankability criteria was first carried out. Afterward, a two-step process was adopted to test the validity and relevance of the questionnaire. The questionnaire was first reviewed by an expert on question construction, ensuring that the survey did not contain common errors such as leading, confusing, or double-barreled questions. Then, a presurvey was conducted with three PPP industry professionals from the bank, who had several

years' experience in PPP projects. Their feedback was taken into consideration to finalize the questionnaire.

The finalized questionnaire first included the questions meant to profile the respondents. Furthermore, the 41 bankability criteria were presented in the questionnaire. Moreover, the brief description of each bankability criterion was provided to ensure consistency throughout the survey. Subsequently, the respondents were asked to conduct the pair-wise comparison of the importance of these bankability criteria using the five linguistic terms: equal importance, weak importance, moderate importance, strong importance, and extreme importance. The questionnaire was designed in a bottom-up manner. The questions relating to the criteria under different dimensions were presented in front, while those relating to dimensions were presented at behind. This bottom-up approach can enhance the respondents' understanding of the criteria and their contribution to each corresponding dimension. In addition, postsurvey interviews were conducted with three industry experts who possess the relevant experience in PPP financing. Their views helped us to validate the findings of the survey questionnaire and to provide a better understanding of the findings.

The population of this study consisted of all PPP professionals who had PPP financial experience in China, especially experts from banks. A total of 130 sets of survey questionnaires were randomly sent out through email to gather responses from the banks or financial institutions. Finally, 31 complete sets were received, representing a response rate of 23.8%. Although the sample size was not large, statistically analysis could still be performed because the central limit theorem holds true even when the sample size is no less than 30 according to the generally accepted rule [36, 37].

Among the 31 respondents, 30 respondents were from the banks and one respondent from a trust company that acted as a debt finance provider. Moreover, the respondents from the banks were from eight different commercial banks that provided a large portion of the loan for PPP projects in China such as China Construction Bank and Bank of Communications. Considering the business confidentiality, this study did not disclose the names of the involved banks. In addition, the respondents from the banks were holding the positions of bank director, loan evaluator, and marketing manager. The relatively small sample size was mainly caused by two reasons. First, only those with good PPP finance-related experiences and were willing to perform the survey would be approached to send the survey form. This has significantly reduced the pool size of the potential respondents. Second, some of the experienced practitioners contacted were reluctant to share their opinions because of business confidentiality. Although the size of the sample was relatively small, the knowledge and judgments of the respondents were reasonable considering the experience of the respondents. Considering the area of the respondents, this study was a location-based study.

3.2. Fuzzy AHP for Ranking of Bankability Criteria. This study adopted the fuzzy set theory to handle the uncertainty and vagueness of the subjective evaluation of the importance

of the identified bankability criteria. Zadeh [38] developed the fuzzy set theory to handle such kind of impreciseness of human subjective judgment. Buckley [39] later extended the hierarchical analysis to the case where experts were allowed to use fuzzy ratios in place of exact ratios. Fuzzy analytic hierarchy process (Fuzzy AHP) methodology has been used in research on various issues of PPP projects [26, 40].

Instead of using a precise number to assess the priority of a criterion, a triangle fuzzy number $\tilde{r} = (a, m, b)$ was used to express fuzzy ratios. The geometric mean technique was adopted to determine the fuzzy weights of criteria [39].

3.2.1. Comparing the Dimensions and Criteria via Linguistic Terms. As stated above, the pairwise comparisons of both the dimensions and criteria were performed using a set of linguistic terms which were adapted from Saaty [41] and Saaty [42], namely, "equal importance," "weak importance," "moderate importance," "strong importance," and "extreme importance." The triangular fuzzy number was employed in this study first because it expresses most closely the meaning of "about x ," which is a common fuzzy thinking pattern of human beings [26]. Second, the triangular fuzzy number can be utilized in the situations when the comparisons in pair and judgments are uncertain or fuzzy [43].

The linguistic terms were then transformed into triangular fuzzy numbers in order to facilitate subsequent fuzzy arithmetic operations. The linguistic values and triangular membership functions are shown in Table 2 with the middle value denoting the most likely or typical value and the lower and upper bounds denoting the lower and upper membership values, respectively. In addition, the spread reflects the fuzziness of the term.

If a fuzzy number $\tilde{r} = (a, m, b)$ represents the importance of comparison of criterion C1 to criterion C2, then $\tilde{r}^{-1} = ((1/b), (1/m), (1/a))$ represents the inverse comparison of criterion C2 to criterion C1. The pair-wise criteria comparison matrix \tilde{A}_j^k was given by the following equation, where \tilde{r}_{jil}^k denotes the k^{th} expert's preference of criterion i over criterion l under dimension j , via fuzzy triangular numbers:

$$\tilde{A}_j^k = \begin{bmatrix} \tilde{r}_{j11}^k & \tilde{r}_{j12}^k & \cdots & \tilde{r}_{j1l}^k \\ \tilde{r}_{j21}^k & \tilde{r}_{j22}^k & \cdots & \tilde{r}_{j2l}^k \\ \cdots & \cdots & \cdots & \cdots \\ \tilde{r}_{jil}^k & \tilde{r}_{ji2}^k & \cdots & \tilde{r}_{jil}^k \end{bmatrix}. \quad (1)$$

The evaluation of the importance of the criteria was based on the survey results. Each expert gave his/her judgment of the importance of the criteria using linguistic terms.

3.2.2. Computing Average Preference. The average fuzzy preference was given by the geometric mean of the preferences of all experts as shown in Equation (2). The revised pairwise comparison matrix was depicted in Equation (3). In

TABLE 2: The linguistic terms and the corresponding triangular fuzzy numbers.

Scale of importance	Linguistic term	Triangular fuzzy numbers
1	Equal importance (EqI)	(1, 1, 1)
3	Weak importance (WI)	(1, 3, 5)
5	Moderate importance (MI)	(3, 5, 7)
7	Strong importance (SI)	(5, 7, 9)
9	Extreme importance (ExI)	(7, 9, 9)

the following equations, r_{jil} denotes the average preference of criterion i over criterion l under dimension j :

$$r_{jil} = \left[\prod_{k=1}^K (\tilde{r}_{jil}^k) \right]^{1/K}, \quad (2)$$

$$\tilde{A}_j^k = \begin{bmatrix} \tilde{r}_{j11}^k & \tilde{r}_{j12}^k & \cdots & \tilde{r}_{j1l}^k \\ \cdots & \cdots & \cdots & \cdots \\ \tilde{r}_{ji1}^k & \tilde{r}_{ji2}^k & \cdots & \tilde{r}_{jil}^k \end{bmatrix}. \quad (3)$$

3.2.3. Computing Weight of the Fuzzy Matrices. The following basic fuzzy operations shown from Equations (4)–(7) are required for computing the importance weights of the criteria. Given fuzzy number $\tilde{X} = (a_1, m_1, b_1)$ and $\tilde{Y} = (a_2, m_2, b_2)$, then

$$\tilde{X} \oplus \tilde{Y} = (a_1 + a_2, m_1 + m_2, b_1 + b_2), \quad (4)$$

$$\tilde{X} \otimes \tilde{Y} = (a_1 \cdot a_2, m_1 \cdot m_2, b_1 \cdot b_2), \quad (5)$$

$$\tilde{Y}^{-1} = \left(\frac{1}{b_2}, \frac{1}{m_2}, \frac{1}{a_2} \right), \quad (6)$$

$$\frac{\tilde{X}}{\tilde{Y}} = \left(\frac{a_1}{b_2}, \frac{m_1}{m_2}, \frac{b_1}{a_2} \right). \quad (7)$$

The weightings of criterion \tilde{W}_{ji} are geometric mean as follows:

$$\tilde{W}_{ji} = \left(\prod_{l=1}^n r_{jil} \right)^{1/n} \otimes \left[\sum_{i=1}^n \left(\prod_{l=1}^n r_{jil} \right)^{1/n} \right]^{-1}, \quad (8)$$

$$i, l = 1, 2, 3, \dots, n; \quad j = 1, \dots, 6,$$

$$= (a_{ji}, m_{ji}, b_{ji}).$$

3.2.4. Defuzzification of the Fuzzy Weights. Since the triangular fuzzy number was adopted in this research, the level rank method using the concept of α -cut was employed to defuzzify the fuzzy weights \tilde{W}_{ji} [44]. An α -cut of a fuzzy set embraces all elements of the fuzzy set whose degrees of membership to this fuzzy set are at least equal to α [45]. The membership scale of the fuzzy variable \tilde{W}_{ji} is cut with the aid of r randomly chosen α levels. For example, the defuzzification value M_{ji}^t of the fuzzy variable \tilde{W}_{ji} at the t^{th} α -cut level is determined as the arithmetic mean of the lower and

upper bounds of the membership interval at the t^{th} α -cut level. This concept was presented by Equation (9) and depicted in Figure 1. The advantage of this method is that the shape of the membership function is considered:

$$M_{ji} = \frac{1}{r} \cdot \sum_{t=1}^r M_{ji}^t = \frac{1}{r} \cdot \sum_{t=1}^r \frac{a_{ji}^t + b_{ji}^t}{2}. \quad (9)$$

3.2.5. Normalization. Finally, to conform with traditional AHP, the importance weights of the criteria and the dimensions were normalized by ensuring that they sum to 1, as given by the following equation:

$$w_{ji} = \frac{M_{ji}}{\sum_{i=1}^n M_{ji}}. \quad (10)$$

The importance weights of bankability dimensions were similarly derived using Equations (1)–(10). Using w_j to represent the normalized importance weight of dimension j , the overall importance weight of criterion i is the product of the importance weight of criterion i under dimension j and the importance weight of dimension j , as computed by Equation (11). The calculation of overall importance weight ensures that each bankability criterion is ranked at the same level. Because the fuzzy AHP calculation is very complex, this study developed a program written in Microsoft C# to process the survey data:

$$w_i = w_j \cdot w_{ji}. \quad (11)$$

4. Results and Discussion

4.1. Consistency of Evaluation Results. Before analyzing the pertinent finding of this study, this study carried out the Pearson chi-square test (χ^2) to reveal the evaluation consistency of the samples within each set [36]. The hypothesis of this test was that each respondent's evaluation was the same or consistent with the geometric mean evaluation. The calculated χ^2 value for the sample sets of the bank was 45.70. Because the relevant critical value for χ^2 at 95% confident level is 55.76, the hypothesis cannot be rejected. Therefore, it is legitimate to use the geometric mean of the evaluations from the respondents to reflect the relative importance weights of the bankability criteria.

4.2. Importance Weights of Bankability Dimensions. Because the banks' perception is crucial to the establishment of a loan, this study first analyzed the importance weights of the bankability dimensions from the banks' perspective

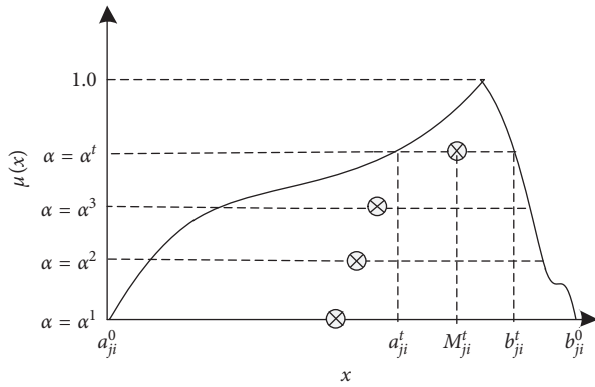


FIGURE 1: The level rank method of defuzzification.

using the fuzzy AHP-based method explained above. The relative importance weights of the bankability dimensions from the banks' perspective are presented in Table 3. The results showed that project specificity (D3), project financial structure (D4), and economic and political environment (D1) were ranked as the top three important dimensions from the banks' point of view, making up 64.81% of the total weight.

Because the revenue cash flows of a PPP project are the main or sole source to meet the financial obligation, the banks must first ensure that the project is financially well structured and profitable [6]. The bankable consideration was of great importance to the stakeholders of PPP projects [7]. Moreover, the project specificity and project financial structure represent the competitiveness of a PPP project in the market, indicating that the above results were reasonable/believable [3, 33]. Furthermore, PPP projects are usually mega projects or infrastructure projects with a vast amount of capital investment. The economic and political environment will easily affect the investment decision of a PPP project from the banks' point of view [31]. In addition, the findings revealed that the banks do have an emphasis on some of the bankability dimensions.

4.3. Importance Weights of Bankability Criteria. Using the above-explained fuzzy AHP method, this study analyzed the relative importance weights of the bankability criteria in China from the banks' perspective. For the sake of succinct presentation, this study listed the top twenty criteria whose importance weights were above the average, as shown in Table 4. Moreover, the importance weights of the top twenty criteria made up 71.33% of the total weight, indicating that the top twenty criteria generally covering the major bankability concerns from the bank's perspective.

Among the identified 41 criteria, the top ten criteria, which were within the first quartile of all criteria, that affect the bankability of a PPP project were political environment (D1.4), economic environment (D1.1), shareholders' credibility (D4.1), financial market (D1.3), legal system (D2.1), public sector's reliability (D4.2), financial structure (D4.4), regulatory framework (D2.2), EPC contractor's credibility

(D4.3), and financial flexibility (D4.5). This study briefly discussed these criteria as follows.

Political environment (D1.4) (importance weight = 6.94%), legal system (D2.1) (importance weight = 4.95%), and regulatory framework (D2.2) (importance weight = 3.74%) were ranked first, fifth, and eighth, respectively. It is well known that PPP projects are mostly infrastructure projects or public-related projects, involving a vast amount of investment. From the bank's perspective, the desirability of a PPP project is easily affected by the macroenvironment of a country [29, 46]. Moreover, the success of PPP projects would be greatly affected by the cooperation relationship between the public and private sectors. Once there is any divergence between the two parties, the legal system determines the contract enforceability and is the baseline for setting the dispute [8]. Any change in law would be critical risks for PPP projects, especially in countries using the civil law [32].

Economic environment (D1.1) (importance weight = 6.49%) and financial market (D4.1) (importance weight = 5.42%) received the second position and fourth position, respectively. In a sound and stable economic environment, the willingness of the consumer to pay for the use of infrastructure is high, ensuring the cash flow of a proposed project [8]. Furthermore, the condition of the financial market greatly affects the availability of the lending for PPP projects. The difficulties in the debt arrangements for PPP projects after the credit crisis and economic recession will prove this [12, 47]. In a nutshell, the ecosystem that consists of the political environment and economic environment should be sound enough [48].

Shareholders' credibility (D4.1) was ranked third (importance weight = 5.60%). The shareholder is the party who commit to developing and operating a PPP project in a long concession period. The experts in the postinterviews pointed out that the strong financial capability of the shareholders was an important prerequisite for a successful debt approval. The bank usually assumes that a PPP project developed by shareholders with a high credibility is more bankable even if the bank has limited recourse or nonrecourse to the shareholders' assets outside the project [23]. The bank wants to ensure that the shareholders have sufficient commercial experience, financial standing, technical capability, and operation ability to implement the project, thereby protecting the lenders' interests [3, 8, 23, 49]. This may be the reason that larger and more leveraged firms had a higher probability of being engaged in a PPP service concession agreement and receiving the loan from the banks [28]. Moreover, the operation ability of the shareholder draws great attention recently because many projects step into the operation stage. The operation stage is usually less capital intensive but determines the fulfillment of the revenue of a PPP project [3, 49]. Furthermore, the credible shareholder implies credible equity financing which is critical to the success of a PPP project and often influences the ability of a company to secure the further debt financing from the banks' perspective [8, 19].

Public sector's reliability (D4.2) was ranked sixth (importance weight = 4.59%). Even if there is a concession

TABLE 3: Relative importance weights of bankability dimensions from the banks' perspective.

Bankability dimension	Importance weight of bankability dimension (%)
Economic and political environment (D1)	17.34
Legal and regulatory environment (D2)	12.68
Project specificity (D3)	25.08
Project financial structure (D4)	22.39
Third party risk allocation (D5)	9.82
Contract arrangement (D6)	12.68

TABLE 4: Relative importance weights of the twenty criteria from the banks' perspective.

Bankability criterion	Ranking	Importance weight (%)	Subtotal (%)
Political environment (D1.4)	1	6.94	
Economic environment (D1.1)	2	6.49	18.85
Financial market (D1.3)	4	5.42	
Legal system (D2.1)	5	4.95	
Regulatory framework (D2.2)	8	3.74	
Enforceability (D2.3)	11	2.92	
Intervention right (D2.6)	13	2.63	16.84
Nationalization and expropriation (D2.4)	14	2.60	
License, permits, and authorizations (D3.5)	18	2.36	
Shareholders' credibility (D4.1)	3	5.60	
Public sector's reliability (D4.2)	6	4.59	
Financial structure (D4.4)	7	3.77	20.82
EPC contractor's credibility (D4.3)	9	3.52	
Financial flexibility (D4.5)	10	3.34	
Insurance arrangement (D5.1)	12	2.81	
Environmental and legal issues (D5.2)	15	2.59	5.40
Concession agreement (D6.1)	16	2.56	
Support agreement/guarantee (D6.3)	17	2.46	
Termination provisions (D6.4)	19	2.25	9.42
Concession period (D6.2)	20	2.15	
		Total weight	71.33

agreement between the public and private sectors, the public sector who has a low reliability has a high probability to break the contract relationship when difficulties attend during the project development [32]. Moreover, the off-takers, most of whom have a public or government background, will easily default if the public sector's reliability is low. This is clearly reflected in many real projects such as Changchun Huijin waste water BOT project in China, Dabhol power project in India, and Samalayuca II in Mexico [1, 31].

Financial structure (D4.4) (importance weight = 3.77%) and financial flexibility (D4.5) (importance weight = 3.34%) were ranked seventh and tenth, respectively. For a PPP project, the main or sole source to meet financial obligations is the project cash flow [6, 47]. An optimal and operational financial structure that reflects the characteristics of project financing is extremely important for both the private sector and the bank because it synchronizes both profitability and repayment capacity [50, 51]. From the bank's perspective, only truly good projects with real, tangible service provision, and well structured should be considered to be implemented as PPP projects and be financed [48]. Financial terms calculated based on the financial structure, such as the debt service coverage ratio, sensitivity, debt service reserve and debt-equity ratio, were

extremely important to a debt financing, greatly influencing the desirability of a PPP project from a debt financing perspective [29]. Moreover, reasonable and flexible financial arrangements are also needed to deal with unforeseen risks or problems [47]. For instance, many transportation PPP projects exposed to the financial risk of low profitability due to the inaccurate forecast of traffic volume [52, 53]. In this condition, flexible financial arrangements should be considered to overcome the uncertainties.

EPC contractor's credibility (D4.3) (importance weight = 3.52%) was ranked ninth. The related experience, financial strength, and technical capability of the EPC contractor ensure the completion of a PPP project on time and within budget, partially securing the banks' interest in PPP projects. Moreover, many engineering contractors participate in PPP projects and become a major constituent of the private sector in PPP projects [3, 54]. Engineering contractors with a high credibility bring the added value to PPP projects because they have a strong construction and financing capabilities and can improve the development efficiency [3]. Through the due diligence reporting, a closer examination of the contractor's construction and financing capability could reduce EPC contractor-related risks [30].

5. Conclusion and Recommendations

For PPP projects, raising sufficient funds via the debt channel is a key task for all project stakeholders. Considering the lack of a systematic research on the bankability of PPP projects, this study proposed the fuzzy AHP-based approach to identify the critical bankability criteria of PPP projects from a debt financing perspective. A total of 41 bankability-related criteria were first identified from a comprehensive literature review and further classified into six dimensions. Afterward, a structured questionnaire survey was conducted with 31 industry experts from the bank in China to investigate the relative importance of each criterion. Finally, this study analyzed the relative importance weight of each criterion using the proposed fuzzy AHP-based approach that can handle the uncertainty and vagueness of the subjective evaluation from surveys. The results of this study first showed that project specificity, project financial structure, and economic and political environment were ranked as the top three important dimensions from the bank's point of view. Moreover, the top twenty criteria, the importance weights of which made up 71.33% of the total weight, represented the major bankability concerns from the bank's perspective. Furthermore, political environment, economic environment, shareholders' credibility, financial market, legal system, public sector's reliability, financial structure, regulatory framework, EPC contractor's credibility, and financial flexibility were identified as the top ten most critical bankability criteria of PPP projects. In addition, the importance weights of the top twenty criteria made up 71.33% of the total weight, representing the major bankability concerns from the bank's perspective.

With the aim of identifying the critical bankability criteria for successful PPP project finance, the empirical results of this study fill a gap in the project finance body of knowledge for the bankability of PPP projects. Moreover, the findings of this study would provide valuable information to the private and public sectors for formulating strategies on improving the bankability of PPP projects. Furthermore, the research methodology proposed in this study could be extended and customized to suit for different stakeholders of PPP projects and different countries implementing PPP projects.

Although the objectives have been achieved, this study still suffers from several limitations. First, the importance weights proposed in this study may be biased by the respondents' judgments and experience because they were subjective. Besides, the findings from this study were well interpreted in the context of China, which may be different from the context of other countries. Nonetheless, this study still provides an operational method to identify the bankability criteria for PPP projects which can be modified and customized to suit for the context of other countries. Moreover, this study provides an in-depth understanding of the critical bankability criteria because it is widely acknowledged that China government has been promoting PPP to facilitate the infrastructure development.

Future studies would use the developed fuzzy AHP-based method to investigate whether the private and

public sectors have the same perception on the importance weights of bankability criteria with the bank. If different parties have different perceptions on bankability criteria, there will be information asymmetry, hindering the financial close of PPP projects. Moreover, future studies would identify best practices to improve the bankability of PPP projects and increase the efficiency and success rate of financial arrangement for PPP projects.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

This work was cosupported by "the Fundamental Research Funds for the Central Universities" of China, the National Key Research and Development Program of China, and the National Natural Science Foundation of China (NSFC-71801038).

Supplementary Materials

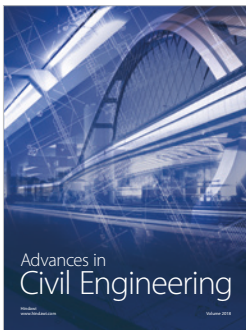
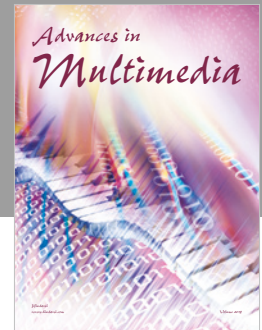
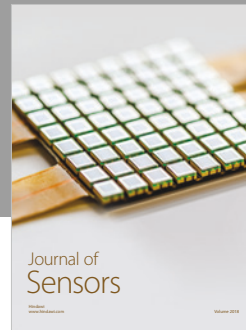
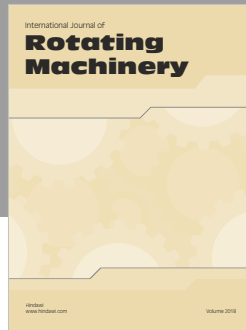
Table A1: qualitative bankability criteria and remarks, which briefly describe each bankability criterion to ensure consistency throughout the study. (*Supplementary Materials*)

References

- [1] L. Zhu, X. Zhao, and D. K. H. Chua, "Agent-based debt terms' bargaining model to improve negotiation inefficiency in PPP projects," *Journal of Computing in Civil Engineering*, vol. 30, no. 6, article 04016014, 2016.
- [2] China Public Private Partnership Center, *National PPP Integrated Information Platform Project Management Database*, China PPP Center, Hong Kong, China, 2018, <http://www.cpppc.org:8086/pppcentral/map/toPPPMap.do>.
- [3] J. Du, H. Wu, and L. Zhu, "Influencing factors on profit distribution of public-private partnership projects: private sector's perspective," *Advances in Civil Engineering*, vol. 2018, Article ID 2143173, 10 pages, 2018.
- [4] J. Du, H. Wu, and L. Zhu, "Research on the participation mode selection of construction enterprises in PPP projects," in *Proceedings of Construction Research Congress 2018*, New Orleans, LA, USA, April 2018.
- [5] J. Song, Y. Hu, and Z. Feng, "Factors influencing early termination of PPP projects in China," *Journal of Management in Engineering*, vol. 34, no. 1, article 05017008, 2018.
- [6] W. Tan, *Principles of project and infrastructure finance*, Routledge, 2007.
- [7] F. Kurniawan, S. Ogunlana, and I. Motawa, "Stakeholders' expectations in utilising financial models for public-private partnership projects," *Built Environment Project and Asset Management*, vol. 4, no. 1, pp. 4–21, 2014.
- [8] J. Delmon, *Project Finance, BOT Projects and Risk*, Kluwer Law International, The Hague, The Netherlands, 2005.

- [9] D. Kong, R. L. K. Tiong, C. Y. J. Cheah, A. Permana, and M. Ehrlich, "Assessment of credit risk in project finance," *Journal of Construction Engineering and Management*, vol. 134, no. 11, pp. 876–884, 2008.
- [10] R. Bain, *Review of Lessons from Completed PPP Projects Financed by the EIB*, European Investment Bank, Kirchberg, Luxembourg, 2009.
- [11] M. Regan, J. Smith, and P. E. D. Love, "Impact of the capital market collapse on public-private partnership infrastructure projects," *Journal of Construction Engineering and Management*, vol. 137, no. 1, pp. 6–16, 2011.
- [12] KPMG, *Financing Australian PPP Projects in the Global Financial Crisis*, KPMG, Australia, 2009.
- [13] A. Gunawansa, "Is there a need for public private partnership projects in Singapore," in *Proceedings of the Construction, Building and Real Estate Research Conference of the Royal Institution of Chartered Surveyors*, Paris, France, 2010.
- [14] D. Hall, *A crisis for Public-Private Partnerships (PPPs)?*, Public Services International Research Unit (PSIRU), London, UK, 2009.
- [15] National Audit Office, *Improving the PFI Tendering Process*, National Audit Office, London, UK, 2007.
- [16] A. Thomas, *Identification, assessment, and allocation of critical risks in Indian BOT road projects*, Ph.D. thesis, Indian Institute of Technology, Chennai, India, 2003.
- [17] E. W. L. Cheng, Y. H. Chiang, and B. S. Tang, "Alternative approach to credit scoring by DEA: evaluating borrowers with respect to PFI projects," *Building and Environment*, vol. 42, no. 4, pp. 1752–1760, 2007.
- [18] T. Merna and F. L. S. Khu, "The allocation of financial instruments to project activity risks," *Journal of Structured Finance*, vol. 8, no. 4, pp. 21–33, 2003.
- [19] S. Q. Wang, R. L. K. Tiong, S. K. Ting, and D. Ashley, "Evaluation and management of foreign exchange and revenue risks in China's BOT projects," *Construction Management and Economics*, vol. 18, no. 2, pp. 197–207, 2000.
- [20] European Investment Bank, *Assessment of the PPP Option*, EIB, Kirchberg, Luxembourg, 2015, <http://www.eib.org/epcc/g2g/i-project-identification/12/123/index.htm>.
- [21] J. Leloux, E. Lorenzo, B. García-Domingo, J. Aguilera, and C. A. Gueymard, "A bankable method of assessing the performance of a CPV plant," *Applied Energy*, vol. 118, pp. 1–11, 2014.
- [22] N. Hampl, F. Lüdeke-Freund, C. Flink, S. Olbert, and V. Ade, *The Myth of Bankability-Definition and Management in the Context of Photovoltaic Project Financing in Germany*, Geotzpartners Consulting Company, Munich, German, 2011.
- [23] X. Zhang, "Concessionaire's financial capability in developing build-operate-transfer type infrastructure projects," *Journal of Construction Engineering and Management*, vol. 131, no. 10, pp. 1054–1064, 2005.
- [24] W. F. Treacy and M. Carey, "Credit risk rating systems at large US banks," *Journal of Banking and Finance*, vol. 24, no. 1-2, pp. 167–201, 2000.
- [25] D. K. H. Chua, Y. C. Kog, and P. K. Loh, "Critical success factors for different project objectives," *Journal of Construction Engineering and Management*, vol. 125, no. 3, pp. 142–150, 1999.
- [26] J. Li and P. X. W. Zou, "Fuzzy AHP-based risk assessment methodology for PPP projects," *Journal of Construction Engineering and Management-Asce*, vol. 137, no. 12, pp. 1205–1209, 2011.
- [27] P. Raisbeck and L. C. M. Tang, "Identifying design development factors in Australian PPP projects using an AHP framework," *Construction Management and Economics*, vol. 31, no. 1, pp. 20–39, 2013.
- [28] A. I. Lopes and T. Teixeira Caetano, "Firm-level conditions to engage in public-private partnerships: what can we learn?," *Journal of Economics and Business*, vol. 79, pp. 82–99, 2015.
- [29] B. S. Laishram and S. N. Kalidindi, "Desirability rating analysis for debt financing of public-private partnership road projects," *Construction Management and Economics*, vol. 27, no. 9, pp. 823–837, 2009.
- [30] S. Gatti, *Project Finance in Theory and Practice*, Elsevier Inc., New York, NY, USA, 2008.
- [31] H. A. Davis, *Project Finance: Practical Case Studies*, Euro-money Books, London, UK, 2003.
- [32] S. Q. Wang, R. L. K. Tiong, S. K. Ting, and D. Ashley, "Evaluation and management of political risks in China's BOT projects," *Journal of Construction Engineering and Management*, vol. 126, no. 3, pp. 242–250, 2000.
- [33] X. Zhang, "Critical success factors for public-private partnerships in infrastructure development," *Journal of Construction Engineering and Management*, vol. 131, no. 1, pp. 3–14, 2005.
- [34] B. Hwang, X. Zhao, and M. J. S. Gay, "Public private partnership projects in Singapore: factors, critical risks and preferred risk allocation from the perspective of contractors," *International Journal of Project Management*, vol. 31, no. 3, pp. 424–433, 2013.
- [35] M. Shan, B. G. Hwang, and K. S. N. Wong, "A preliminary investigation of underground residential buildings: advantages, disadvantages, and critical risks," *Tunnelling and Underground Space Technology*, vol. 70, pp. 19–29, 2017.
- [36] R. L. Ott and M. Longnecker, *An Introduction to Statistical Methods and Data Analysis*, Cengage Learning, Brooks Cole, Belmont, CA, USA, 2010.
- [37] X. Zhao, B. G. Hwang, and H. N. Lee, "Identifying critical leadership styles of project managers for green building projects," *International Journal of Construction Management*, vol. 16, no. 2, pp. 150–160, 2016.
- [38] L. A. Zadeh, "Fuzzy sets," *Information and Control*, vol. 8, no. 3, pp. 338–353, 1965.
- [39] J. J. Buckley, "Fuzzy hierarchical analysis," *Fuzzy Sets and Systems*, vol. 17, no. 3, pp. 233–247, 1985.
- [40] Q. Wu and Y. Gao, "Selection model of concessionaire in PPP projects," *Applied Mechanics and Materials*, vol. 174–177, pp. 2906–2910, 2012.
- [41] T. L. Saaty, *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*, University of California, MxGraw-Hill, New York, NY, USA, 1980.
- [42] T. L. Saaty, "The modern science of multicriteria decision making and its practical applications: the AHP/ANP approach," *Operations Research*, vol. 61, no. 5, pp. 1101–1118, 2013.
- [43] L. P. J. M. Van and W. Pedrycz, "A fuzzy extension of Saaty's priority theory," *Fuzzy Sets and Systems*, vol. 11, no. 1–3, pp. 199–227, 1983.
- [44] B. Möller and M. Beer, *Fuzzy Randomness: Uncertainty in Civil Engineering and Computational Mechanics*, Springer Science and Business Media, Berlin, Germany, 2013.
- [45] W. Pedrycz, P. Ekel, and R. Parreiras, *Fuzzy Multicriteria Decision-Making: Models, Methods and Applications*, John Wiley and Sons, Hoboken, NJ, USA, 2011.
- [46] T. Chang, X. Deng, J. Zuo, and J. Yuan, "Political risks in central asian countries: factors and strategies," *Journal of Management in Engineering*, vol. 34, no. 2, article 04017059, 2017.

- [47] V. Khmel and S. Zhao, "Arrangement of financing for highway infrastructure projects under the conditions of Public-Private Partnership," *IATSS Research*, vol. 39, no. 2, pp. 138-145, 2016.
- [48] P. Leviäkangas, T. Kinnunen, and A. Aapaoja, "Infrastructure public-private partnership project ecosystem-financial and economic positioning of stakeholders," *European Journal of Finance*, vol. 22, no. 3, pp. 221-236, 2016.
- [49] J. Yuan, W. Li, X. Zheng, and M. J. Skibniewski, "Improving operation performance of public rental housing delivery by PPPs in China," *Journal of Management in Engineering*, vol. 34, no. 4, article 04018015, 2018.
- [50] B. Chen and F. M. Liou, "Optimal capital structure of power plant projects with various bargaining powers in project negotiations," *Journal of Energy Engineering*, vol. 143, no. 2, article 04016051, 2017.
- [51] X. Zhang, "Financial viability analysis and capital structure optimization in privatized public infrastructure projects," *Journal of Construction Engineering and Management*, vol. 131, no. 6, pp. 656-668, 2005.
- [52] B. Flyvbjerg, M. S. Holm, and S. Buhl, "Underestimating costs in public works projects: error or lie?," *Journal of the American Planning Association*, vol. 68, no. 3, pp. 279-295, 2002.
- [53] S. Yun, S. H. Han, H. Kim, and J. H. Ock, "Capital structure optimization for build-operate-transfer (BOT) projects using a stochastic and multi-objective approach," *Canadian Journal of Civil Engineering*, vol. 36, no. 5, pp. 777-790, 2009.
- [54] C. O. Cruz and R. C. Marques, "Risk-sharing in highway concessions: contractual diversity in Portugal," *Journal of Professional Issues in Engineering Education and Practice*, vol. 139, no. 2, pp. 99-108, 2012.



Hindawi

Submit your manuscripts at
www.hindawi.com

