

Based on the Application of VFM and PSC Integration in Infrastructure PPP Project Feasibility Assessment

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Abstract. The main objective of this study is to investigate a superior method of evaluation, to accurately assess the investment value of infrastructure PPP projects, and to compile literature for the development of infrastructure PPP projects. To accomplish this, we propose a comprehensive approach that involves calculating the PSC value and PPP value for a thorough analysis. This analysis aims to determine whether the PPP model should replace the government's traditional investment and operational approach. Secondly, an analysis of VFM and PSC is conducted at the beginning of the project, and thirdly, a continuous dynamic evaluation of VFM + PSC is implemented throughout the project lifecycle. The results indicate that developing more targeted project implementation strategies in the planning stage and conducting continuous dynamic evaluation throughout the life cycle, the integration and application of VFM and PSC in infrastructure PPP projects can improve the accuracy and objectivity of evaluation, reduce project risks, enhance cooperation between the government and enterprises, provide stronger support for the implementation of projects, promote the development of the PPP model, and enhance the efficiency of public resource utilization. This approach is expected to be increasingly valued and applied in PPP projects in the future.

1. Introduction

The PPP model is becoming more and more widely used in the field of infrastructure construction, but it also faces many challenges, such as the instability of partnerships, the unfairness of risk sharing, and the uncertainty of project benefits. These challenges make the feasibility assessment of PPP projects more complex and difficult. However, in recent years, PPP (Public-Private Partnership) infrastructure projects have been met with many scepticisms. This is mainly due to some problems in the actual operation of some PPP projects, such as:

- (1) unreasonable risk sharing, resulting in huge risks and losses faced by private enterprises in the process of project implementation.
- (2) Inadequate supervision cannot ensure the smooth progress of the project and the protection of public interests.
- (3) The terms of the contract are not clear and cannot stipulate the rights and responsibilities of all parties, resulting in the inability to effectively implement and manage the project.
- (4) PPP projects require a large amount of funds and have not been effectively addressed, resulting in slow progress or failure of the project.

Therefore, how to choose a suitable party to evaluate the PPP model will be very important and continue to explore. In the process of evaluating the feasibility of a

PPP project, the factors that need to be considered include the time value of funds, the particularity of the project, the benefits of different models and the fluctuation of costs, risks and other factors will affect the progress of the project, and how to design a sustainable development of the PPP project that can be monitored is the key. Through this approach, the feasibility of PPP projects can be monitored more comprehensively, the performance and efficiency of PPP projects can be improved, and the management efficiency of the public sector can be improved, and the loss of control can be prevented.

2. VFM+PSC Integration in the Feasibility Assessment Literature

The integration of VFM and PSC is an important part of evaluating the efficiency of PPP (Public-Private Partnership) projects. The history of the simultaneous use of VFM and PSC in countries around the world can be traced back to the 80s of the 20th centuries, when the UK explored the PFI model in the privatization process and took the lead in introducing the VFM evaluation method in PFI. Subsequently, other countries such as Canada, Australia, New Zealand, etc., have also introduced evaluation methods similar to VFM+PSC to more comprehensively assess the feasibility and efficiency of public projects and PPP projects.

2.1 The VFM+PSC model can solve the PPP feasibility assessment literature.

In recent years, it has been discussed that the VFM+PSC model can solve the shortcomings of PPP feasibility assessment to a certain extent. Through the integrated application of VFM+PSC, it is possible to comprehensively evaluate the ROI of PPP projects, cost-benefit comparison, and project implementation risks, so as to better understand the feasibility and efficiency of the project.

In addition, the VFM+PSC integration model can also provide guidance and suggestions for the design, construction and operation of PPP projects, thereby improving the efficiency and effectiveness of project management. At the same time, this model can also promote cooperation and communication between the government and enterprises and improve the level of trust and cooperation between the two parties.

Therefore, the VFM+PSC model is helpful to solve the shortcomings of PPP feasibility assessment and improve the practical effect and social benefits of PPP projects. Among them, Li et al. (2016) studied a value evaluation model for PPP projects based on the PSC evaluation method [9]. Liu and Yang (2015) conducted a similar study to explore the VFM evaluation index system of PPP based on the PSC assessment method [10]. Zhang and Cheng (2017) studied the VFM evaluation index system of PPP based on the PSC evaluation method [13].

2.2 Case study of VFM and PSC Integration application in PPP projects

The literature collected in this study highlights the role of PPP in the field of infrastructure and public services, pointing out the challenges and problems that exist. It is important for policymakers and practitioners to understand and address these issues in order to achieve a successful case for PPP projects.

The following is a summary of the case studies on the integration of VFM+PSC in PPP projects internationally.

Akintoye and Adewole (2013) studied the application of PPP in infrastructure development in Nigeria. They pointed out that although PPP has achieved some success in Nigeria, it still faces challenges such as insufficient government regulation and conflicts of interest between partners [1]. Arsanjani and Razmi (2014) conducted a comparative study of the application of PPP models in providing public goods in Iran and Malaysia. They found that although there were differences in the objectives and implementation methods of PPP projects in Iran and Malaysia, both achieved positive results, indicating that PPP can effectively provide public goods [2]. Björkman and Winands (2007) explored the impact of PPP on transport infrastructure projects. Case studies of transport PPP projects in Sweden and the Netherlands showed that the success of these projects was often influenced by the quality of the relationship between the partners [3]. Chan and Wong (2008) evaluated the value

of the Hong Kong Airport Express as a public-private partnership. The evaluation results showed that the project was successful in terms of economic benefits, service quality, and social benefits [4].

El-Hinnawi and Larrinaga (2016) reviewed the application of the PPP model in developing countries. The article points out that despite the many advantages of the PPP model, there are still many challenges when applied in developing countries, such as imperfect legal systems and lack of expertise and experience [5]. Hodge, Harrison, and Murdoch (2006) explore the public-private partnership issues faced by local governments in the UK. It is pointed out that although the public-private partnership model can improve efficiency and service quality, it may also bring some problems, such as difficulties in contract management and conflicts of interest [7]. Lee and Lim (2017) evaluated the public-private partnership model for a highway project in South Korea. The results of the assessment showed that although the project had achieved some economic results, there were problems in terms of environmental and social impacts [8]. Makaya, M. E. (2016) discusses the value of PPP in infrastructure development in Kenya. The authors emphasize the importance of value in the decision-making process, especially in PPP projects. Through a case study of a PPP project in Kenya, the authors find that valuation is critical to the success of the project. It can help decision-makers determine the economic viability of a project and choose the best PPP model [11]. Mohanty, S. K. (2018) conducted a systematic review and analysis of the application of PPP in the medical field in India and China. It is pointed out that although PPP has achieved some success in the medical field in the two countries, there are still some problems, such as insufficient funding and poor management. Some policy recommendations are put forward to improve the application of PPP in the medical field, such as strengthening government supervision and increasing capital investment [12]. The European Commission (2019) assesses the value and risks of public-private partnership projects within the EU. The study found that while these projects bring many benefits, there are also risks and challenges that need to be addressed, such as project delays, cost overruns, etc. [6]

3. Comprehensive comparison of the differences between VFM and PSC methods

VFM and PSC have significant differences in theoretical basis and application steps in terms of basic application. With the continuous improvement of data and models, the application of VFM+PSC integration will be more accurate and extensive. The differences in the theoretical basis and application steps are compared as (Table 1) and the advantages and disadvantages of the evaluation application (Table 2).

The differences between VFM and PSC are as follows:

(1) VFM mainly uses quantitative analysis methods to simulate the economic benefits and risk allocation of

PPP projects by establishing mathematical models. VFM is more efficient and effective in risk prevention because it can more accurately assess the economic benefits and risk allocation of PPP projects.

(2) PSC relies more on qualitative analysis methods to determine the economic benefits of PPP projects

through a comprehensive assessment of their risks, technologies, and economics. PSC pays more attention to the comprehensive evaluation of PPP projects, including economic benefits, social benefits, technical feasibility and other aspects.

Table 1 Comparison of the theoretical basis and application steps of VFM and PSC

	VFM Method	PSC Method
Theoretical basis	The theoretical basis of the VFM approach includes the concept of resource optimization and efficiency improvement, and the pursuit of maximizing the common good between the government and the private sector.	The theoretical basis of the PSC method includes public goods theory, transaction cost theory and institutional economics.
Application steps	<ol style="list-style-type: none"> 1. Define project goals and scope: Clarify the project's objectives, scope of implementation, timeline, and budget. 2. Analyze risks and uncertainties: Identify risks and uncertainties in a project and assess their impact on the project. 3. Formulate a preliminary PPP plan: According to the project objectives and scope, formulate a preliminary PPP plan, including cooperation model, equity structure, income distribution, etc. 4. Conduct financial evaluation: Conduct financial evaluation of PPP proposals, including analysis of indicators such as return on investment, internal rate of return, net present value, etc. 5. Conduct efficiency evaluation: Evaluate the efficiency of the PPP program, including service quality, operational efficiency, technological innovation, etc. 6. Formulate a comprehensive evaluation report: Based on the results of the financial evaluation and efficiency evaluation, formulate a comprehensive evaluation report and make recommendations on the feasibility of the project. 	<ol style="list-style-type: none"> 1. Project identification: Determine the objectives and scope of the project, conduct a techno-economic assessment, and determine feasibility. 2. Partner selection: Select the appropriate private sector as a partner to jointly implement the project. 3. Contract signing: Determine the specific content and terms of cooperation and sign the contract. 4. Project implementation: Carry out the specific implementation of the project in accordance with the contract. 5. Project Evaluation and Monitoring: Evaluate and monitor the project to ensure that the project is on track as intended.

Table 2 Comparison of the advantages and disadvantages of VFM and PSC in the evaluation application

	VFM Method	PSC Method
advantage	<ol style="list-style-type: none"> 1. Focus on resource allocation and efficiency improvement: The VFM method maximizes the common interests of the government and the private sector by optimizing resource allocation and efficiency improvement, which helps to improve project feasibility and reduce the financial burden of the government. 2. Strong operability: The VFM method has clear application steps and evaluation indicators, and is highly operable, which can provide guidance for practical operation. 3. Rich experience: The VFM method has been widely used in PPP projects at home and abroad and has rich practical experience and case support. 	<ol style="list-style-type: none"> 1. Improve efficiency: The PSC model can introduce the efficiency and innovation advantages of the private sector to improve the efficiency of project implementation. 2. Cost reduction: The PSC model can reduce the construction and operating costs of the project through competition and cooperation. 3. Flexibility: The PSC mode can be adjusted and optimized according to the actual situation of the project, which has great flexibility.
disadvantage	<ol style="list-style-type: none"> 1. Reliance on subjective judgment: The evaluation results of VFM methods often rely on subjective judgment and analysis, which may affect the objectivity and accuracy of the results. 2. High data requirements: VFM methods require large amounts of data and information to be collected and analyzed, which can lead to high implementation costs. 3. Difficult to fully quantify the evaluation: The quantitative evaluation of the VFM method is difficult to perform, and some factors that are difficult to quantify may not be possible. 	<ol style="list-style-type: none"> 4. Uneven distribution of risk: In the PSC model, the private sector takes on more risk and responsibility, while the public sector is primarily responsible for oversight and management. This way of allocating risk may affect the effectiveness and quality of the project's implementation. 1. Difficult to cooperate: The implementation of the PSC model requires close cooperation between the public and private sectors. However, due to the different goals and interests of both parties, it is difficult to cooperate.

4. VFM+PSC integration and application PPP project evaluation practice.

4.1 VFM+PSC integrates the functions of the application.

In PPP projects, although VFM+PSC has its own focus, it is essentially to improve the efficiency and effectiveness of the project. The integrated application of VFM+PSC can give full play to the advantages of both and improve the accuracy and comprehensiveness of the feasibility assessment of PPP projects. The integration of VFM+PSC can provide a clear assessment of the expected effect of the project at the beginning of the project, and at the same time, the evaluation results can be continuously revised according to the actual situation during the project implementation process to ensure that the final effect of the project meets expectations.

(1) When evaluating the feasibility of PPP projects, VFM+PSC provides important evaluation perspectives. Whether the use of public resources maximizes value provides a measure of performance and efficiency for PPP projects.

(2) The integrated application of VFM+PSC can effectively weigh the performance of PPP projects against the comparative advantages of the public sector, so as to provide a more comprehensive assessment of the feasibility of the project.

4.2 Evaluate the feasibility of the project to improve the benefits.

The integrated application of VFM+PSC has an important impact on the feasibility assessment of PPP projects, which can improve the accuracy and objectivity of the assessment, reduce the project risk, promote the cooperation between the government and enterprises, provide stronger support for the implementation of the project, promote the development of the PPP model and improve the efficiency of the use of public resources. The specific improvement benefits are as follows:

(1) model development and improve the efficiency of the use of public resources. The specific improvement benefits are as follows:

(2) Improve the accuracy and objectivity of assessments: Factors such as the return on investment, cost-benefit comparisons, and risks of project implementation are more comprehensively considered, resulting in more accurate and objective assessment results.

(3) Reduce project risk: Understand the overall risks and uncertainties of the project, so that you can better develop risk management and response measures to reduce project risk.

(4) Promote cooperation between the government and enterprises: It can strengthen the exchange of information and communication between the government and enterprises and promote cooperation and trust between the two sides.

(5) Provide stronger support for the implementation of the project: It can better understand the feasibility and efficiency of the project, help the government and enterprises better understand the implementation and problems of the project, take timely measures to solve the problem, and ensure the smooth implementation of the project.

(6) Promote the development of the PPP model: A better understanding of the advantages and risks of the PPP model can provide guidance and suggestions for the design, implementation and management of the PPP model, and promote the application and development of the PPP model in more fields.

(7) Improve the efficiency of the use of public resources: The right projects and partners can be better selected, and public resources can be better used to achieve the goals of the project. Provide guidance and suggestions for the configuration and scheduling of public resources to avoid waste of resources and duplicate investment.

5. Feasibility assessment of VFM+PSC integrated application PPP project

5.1 VFM+PSC integration application form and implementation steps

The integrated application of VFM+PSC can be practiced through the following periods: at the beginning of the project, VFM+PSC evaluation is carried out at the same time to ensure the effectiveness and efficiency of the project. During the implementation of the project, the evaluation results of the VFM are continuously revised according to the monitoring results of the PSC. At the end of the project, the results of the VFM+PSC evaluation were comprehensively analyzed to summarize the lessons learned. Specific implementation steps for VFM+PSC integration application:

First of all, you need to calculate the PSC value and PPP value. Among them, the PSC value is the present value of the total cost of public goods and services provided by the government in the traditional mode during the whole life cycle of the project, while the PPP value is a quantitative evaluation of the cost and benefit of public services provided by private enterprises.

Secondly, after calculating the values of the two, the result of subtracting the PPP value from the PSC value is the VFM value, which is the value for money. The VFM value can reflect the efficiency advantages of the PPP model compared with the traditional government procurement model, so as to provide a quantitative evaluation result for policymakers to judge whether the PPP model should be used to replace the government's traditional investment and operation mode.

Thirdly, when calculating the VFM value, both the PSC value and the PPP value need to be measured in net present value (NPV). This is because the economic benefits of the project can only be more accurately reflected if the time value of the money is taken into account. In addition, since every PPP project has

5.2 VFM+PSC integration application case

In the case of an infrastructure PPP project, the cost of providing public goods under the traditional model of the government is 100 million yuan, while the cost of public services provided by private enterprises under the PPP model is 80 million yuan. Whether it is suitable for investment and operation in the PPP model, and the evaluation of the integration application with VFM + PSC, the steps are as follows.

(1) Calculate the PSC value

The PSC value is the present value of the total cost of the government to provide public goods and services using the traditional model. To simplify the calculation, it is assumed that the costs of the government are invested in a lump sum at the beginning of the project, while the costs of the private sector are invested annually during the project. The cost of the traditional government model is 100 million yuan, assuming a discount rate of 5%, and the formula for calculating the PSC value is:

$$PSC = 1 \text{ hundred million} / (1 + 0.05) = 0.9524 \text{ hundred million} \quad (1)$$

(2) Calculate the PPP value.

PPP value is a quantitative evaluation of the costs and benefits of public services provided by private enterprises. The cost of a private enterprise is 80 million yuan, assuming that its benefit is 120 million yuan, the discount rate is 5%, and the formula for calculating the PPP value is:

$$PPP = 1.2 \text{ hundred million} / (1 + 0.05) - 80000 \text{ thousand} = 0.7692 \text{ hundred million} \quad (2)$$

(3) Calculate the VFM value.

The VFM value is the result of the PSC value minus the PPP value:

$$VFM = 0.9524 \text{ hundred million} - 0.7692 \text{ hundred million} = 0.1832 \text{ hundred million} \quad (3)$$

(4) Results and Judgment

The VFM value of this PPP project is 18.32 million, which means that compared with the traditional model of the government, the PPP model can save about 0.1832 billion yuan. It can be used to calculate the efficiency benefits of PPP projects, and to determine whether the PPP model should be used to replace the government's traditional investment and operation methods.

In addition, the factors that need to be considered in practice will be more complex and diverse, such as the volatility of benefits and costs of different models, risks and other factors. Therefore, more detailed research and analysis are required for the actual calculations.

6. Conclusions

The integration of VFM+PSC has both significant enlightenment and challenges. Firstly, it offers a fresh perspective for evaluation, enabling a more comprehensive understanding of the feasibility of PPP projects. Secondly, it contributes to enhancing the performance and efficiency of PPP projects by conducting a comprehensive analysis of VFM+PSC at the beginning of the project, resulting in a more targeted implementation strategy. Thirdly, it helps to improve the management efficiency of the public sector by continuously evaluating VFM+PSCs, allowing for timely adjustments to implementation strategies.

However, there are also some challenges in the integrated application of VFM+PSC. Firstly, there are differences in evaluation methods and emphases between VFM and PSC, necessitating the coordination and improvement of the evaluation system to ensure accuracy and consistency of evaluation results. Secondly, integrating applications requires more data support and computational costs, which may increase evaluation time and costs. Finally, the integrated application requires a more comprehensive and scientific theoretical system as well as practical experience to ensure the credibility and practicability of evaluation results.

Based on the research findings, the following recommendations are proposed: (1) Conducting a comprehensive analysis of VFM+PSC at the outset of a PPP project is recommended. This will enable the public sector to develop a targeted implementation strategy during the planning stage through an in-depth assessment of VFM+PSC. (2) It is advisable to continuously evaluate VFM+PSC throughout the life cycle of a PPP project. By doing so, the public sector can make timely adjustments to its implementation strategy in response to changes in the external environment.

Acknowledgment

This paper is one of the phased achievements of the project "Intelligent Management Practice of Promoting Local Characteristic Industry Construction under PPP Mode in Taiwan Province" (FW202208) supported by Zhaoqing University Scientific Research Fund.

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