ISSN: 2710-0170

Research on Optimization of Quantitative Evaluation Model of Value for Money for PPP Projects

Chaoyang Xing

Anhui University of Finance and Economics School of Management Science and Engineering, Bengbu, China

Abstract

With the continuous development of China construction industry, in recent years, government departments are actively cooperating with social capital in the PPP model to solve public infrastructure construction problems. This study explores the interaction between the driving factors that affect value for money in the PPP model and their respective importance proportions. It combines the literature analysis method and the Delphi method to construct an index system, uses the analytic hierarchy process to calculate the weight of the driving factors, and adopts decision-making The laboratory method was used to construct a comprehensive influence matrix and calculate centrality. The results show that the comprehensive impact of reasonable risk sharing, recognition of stakeholders, organizational and operational capabilities, long-term contract, full life cycle costs, and government control of prices is relatively high. Government factors are easily affected by other types of factors, while society and the environment have a higher degree of impact on other factors.

Keywords

PPP model; quantitative evaluation; expert interviews; indicator system.

1. Introduction

The government promotes the construction of public infrastructure and optimizes the efficiency of public services by introducing proprietary technologies and funds from social capital, which greatly relieves the financial pressure on government departments. In recent years, the government-private partnership (PPP) model has experienced tremendous development in its application fields due to its advantages of complementary advantages, risk sharing, and win-win cooperation. Value for money evaluation (VFM) is the basis for judging whether a project adopts the PPP model. Under the goal of ensuring the supply of public infrastructure and services and the profitability of social capital, government departments must consider whether the project achieves VFM to achieve a win-win situation. At the same time, scholars have also conducted many studies on the driving factors of VFM in PPP projects. Ismail et al. [1] found that innovation investment, cost reduction and efficiency increase, on-time delivery and public satisfaction during the project construction cycle are key factors. Some driving factors simultaneously promote VFM and influence other factors. For example, unclear risk sharing mechanism greatly affects the optimization of full life cycle cost and thus reduces project effectiveness. This article takes the VFM driving factors of PPP projects of infrastructure and services as the research object, identifies the main driving factors through literature analysis, and analyzes the interrelationship and influence degree of each VFM driving factor by using the AHP-DEMATEL method.

ISSN: 2710-0170

2. Determination of VFM driving factors in PPP mode

The driver of value for money is the key to realizing VFM in PPP projects. Based on the assumptions and verification of relevant research, the determined price, payment mechanism, on-time delivery, project quality and operation management capabilities promote the realization of VFM. Chen et al. [2] conducted a comparative study of 15 driving factors of PPP projects and identified four key success factors: reducing government department management costs, reducing public fund investment, solving public sector budget constraints, and providing comprehensive solutions. Ismail unearthed 20 causes and concluded that perfect policies and regulations, risk sharing, technological innovation, business competitiveness, standardized production, project management capabilities, etc. are related to the success or failure of PPP project VFM. Regarding the research on the correlation of VFM driving factors, Ameyaw et al. [3] divided the 25 driving factors into the project decision-making stage, project procurement stage, project construction stage and project operation and maintenance stage according to the project cycle. In summary, the above research on VFM driving factors has laid a theoretical foundation for this article, but most of them are inductive classifications, and there are few studies that deeply analyze the internal relationships and respective influence levels of each VFM driving factor.

Based on literature review, 25 VFM driving factors were identified. In order to offset the distortion of results caused by experts' subjective judgments, driving factors recognized by two experts or more were selected. After screening, 16 VFM driving factors were obtained, as shown in Table 1.

Table 1 VFM driver hierarchy

Target layer	Middle layer	Indicator layer
VFM drivers	Government side	Government control over prices
		performance payment mechanism
		Reasonable risk sharing
		The long-term nature of the contract
	social capital side	Social capital innovation ability
		Technology and management of social capital
		Stakeholder recognition
		Organizational and operational capabilities
	user needs	Public sector experience
		Output standardization
		Timely delivery of public infrastructure
		Public infrastructure satisfaction
	society and environment	Stable macroeconomic environment
		Legal and policy support
		Project sustainability
		life cycle cost

3. Hierarchical structure model construction

The expert interview method and Delphi method were used to stratify the 16 VFM driving factors. The relevant participants all have three years or more of PPP project research or work experience, and their academic qualifications are no less than a master's degree. The target layer is VFM driving factors, and 16 driving factors constitute the indicator layer. After interviews with experts, the classification of the middle layer was determined as social capital

ISSN: 2710-0170

capabilities, economy and benefits, cooperation environment, and public satisfaction. The second round of Delphi method investigation was conducted on the nine indicators deleted in the first round. Finally, the indicators were classified through the two-stage Delphi method, the middle layer was clarified, and a hierarchical structure model was formed, as shown in Table 2.

4. Data sorting and result analysis

4.1. Driver weight

Combined with the hierarchical structure model constructed above, the expert interview method and questionnaire survey method were used to conduct pairwise analysis of factors, and the 1-9 scaling method was used to establish a judgment matrix. Based on this, the weight of each driving factor and the random consistency ratio were obtained. The CRs are all less than 0.1, indicating that each judgment matrix has passed the consistency test. Finally, the comprehensive importance of each driving factor in the overall system is calculated to determine the overall ranking, and the weight matrix of each factor is obtained [4] (as shown in Table 2).

Table 2 Driver weight matrix

Middle layer	Weights	Indicator layer	Weights	W
D1	0.5	C1	0.344	0.09
		C2	0.156	0.018
		C3	0.417	0.27
D2	0.273	C4	0.083	0.122
		C5	0.161	0.044
		C6	0.214	0.058
		C7	0.307	0.084
		C8	0.318	0.087
D3	0.067	C9	0.260	0.019
		C10	0.223	0.016
		C11	0.223	0.016
		C12	0.223	0.016
D4	0.16	C13	0.297	0.026
		C14	0.540	0.064
		C15	0.163	0.006
		C16	0.540	0.064

4.2. Determine the comprehensive impact matrix

Using the principle of the DEMATEL method, first, use the expert survey method to analyze the relationship between the different influencing factors of each factor on each driving factor, score using a 0 to 4 scoring method, and average the expert scoring results to obtain a direct relationship matrix.

$$A = (a_{i,j})_{n\times n}, (a_{i,j} = 0,1,2,3,4) \tag{1}$$

$$C = A / \max_{1\le i\le n} \sum_{j=1}^{n} a_{i,j} \tag{2}$$

$$T = \frac{C}{I - C} \tag{3}$$

ISSN: 2710-0170

$a_{i,j}$ represents the degree of influence of driving factor C_i on C_j. Formula (2) normalizes the direct influence matrix, and formula (3) calculates the comprehensive influence matrix.

4.3. Calculation of comprehensive impact

$$F_i = \sum_{j=1}^{n} t_{i,j}, G_i = \sum_{j=1}^{n} t_{j,i} \quad (4)$$

$$H_i = F_i + G_i, R_i = F_i - G_i \quad (5)$$

In the above formula: $t_{i,j}$ represents the degree of influence of driving factor C_i on C_j in the comprehensive influence matrix, $i \in 1,2,\cdots n$. Calculate according to the above formula, and perform weighted calculations based on the weight of each factor in Table 3, and finally obtain the comprehensive influence of each driving factor.

4.4. Result analysis

Calculating the comprehensive influence of VFM driving factors (as shown in Table 3), it can be found that there is a certain interaction between various factors, and the VFM driving factors under PPP mode have interacted with each other before. Among them, C2, C7, C8, C9, C10, C11, C12, and C16 are result factors, and the others are cause factors. The results show that most of the factors come from "social capital" and "user needs", indicating that these two types of driving factors are greatly affected by other factors. Among all the result factors, "public sector experience" is the most vulnerable to interference from external factors, but its comprehensive impact is only 0.028, ranking 10th. Among the result factors, C7 is not susceptible to interference from external factors, but its comprehensive influence is high, ranking second, and plays a key role in the realization of VFM. This is because the realization of VFM in PPP projects usually requires the provision of public goods and services. This goal brings a very complicated process to project construction. Project risk sharing, the capabilities of project participants, macroeconomic and legal conditions, etc. will all affect to the output and optimal use of project public goods [5]. To judge whether a project's VFM has been achieved, economic indicators are mainly used, including cost and benefit factors. Although it can reasonably quantify the degree of VFM realization, it cannot take into account social benefit indicators such as public satisfaction and user demand realization of the project.

Table 3 Comprehensive influence of VFM driving factors

Serial	Fi	Gi	Hi	Ri	W	W*Hi	Comprehensive influence	Rank
C1	0.98	0.74	1.73	0.24	0.09	0.156	0.063	6
C2	1.16	1.18	2.34	-0.02	0.018	0.042	0.017	15
C3	1.93	1.15	3.08	0.78	0.27	0.832	0.337	1
C4	1.18	0.26	1.45	0.92	0.122	0.177	0.072	4
C5	1.26	0.87	2.13	0.39	0.044	0.094	0.038	9
C6	1.40	0.81	2.21	0.59	0.058	0.128	0.052	8
C7	0.20	2.63	2.83	-2.43	0.084	0.238	0.096	2
C8	1.11	1.44	2.55	-0.33	0.087	0.222	0.090	3
C9	0.85	2.79	3.65	-1.94	0.019	0.069	0.028	10
C10	0.86	1.84	2.71	-0.98	0.016	0.043	0.018	14
C11	0.84	2.10	2.94	-1.26	0.016	0.047	0.019	12
C12	0.68	2.09	2.77	-1.41	0.016	0.044	0.018	13
C13	2.23	0.08	2.31	2.15	0.026	0.060	0.024	11
C14	2.15	0.08	2.23	2.07	0.064	0.143	0.058	7

ISSN: 2710-0170

C15	0.82	0.81	1.63	0.02	0.006	0.010	0.004	16
C16	0.54	2.06	2.60	-1.52	0.064	0.166	0.067	5

The government's control of prices (C1) and reasonable risk sharing (C3), the long-term nature of the contract (C4), the technology and management of the social capital (C6), the recognition of stakeholders (C7), organizational and operational capabilities The comprehensive impact of (C8), legal and policy support (C14) and life cycle cost (C16) are all above the average comprehensive impact, and have a greater impact on the realization of VFM and the realization of other driving factors. Among them, C3, C4 and C8 rank high in influence and cause, indicating that the above driving factors are closely related to other factors and have important influence [6].

In addition, according to the above classification results, C3 and C7 have the highest degree of influence, and the comprehensive influence of C5 (0.038) is only lower than the average comprehensive influence. These three factors jointly indicate that government departments and social capital are improving PPP projects. Value for money plays an important role. C2 and C16 both belong to result factors, and C1 has a relatively high degree of influence. Therefore, performance and cost driving factors are easily affected by other factors. This shows that due to the characteristics of the PPP project itself, effective government cooperation and low life-cycle costs can promote project progress and achieve value for money. Guzzmn et al. [7] studied the impact of user demand satisfaction on project input and output, that is, improving user satisfaction to a certain extent can increase the public value of PPP projects. Social and environmental factors have a greater impact on other factors, which shows that optimizing the cooperation environment can promote the construction of PPP projects, thus promoting efficient cooperation between the government and the private sector. Based on the above analysis, a good macroeconomic environment, mature legal system and cooperation mechanism can improve the output ratio of PPP projects, reduce the impact of various uncertain factors under the long construction cycle, and achieve VFM of PPP projects.

5. Conclusion

This article combines the literature review method and the Delphi method to construct a hierarchical analysis model of VFM driving factors under PPP mode, uses AHP-DEMATEL to calculate the comprehensive impact of driving factors, and ranks the data. Based on this, this article found that 16 driving factors, including the social capital's technology and management, legal and policy support, and full life cycle costs, play a role in achieving value for money in PPP projects. Among them, reasonable risk sharing, recognition of stakeholders, organizational and operational capabilities, long-term contract, full life cycle costs, and government control of prices have a high comprehensive impact. Based on the relationship and characteristics of each factor, the 16 driving factors are divided into government, social capital, user needs, and social and environmental categories. Social capital and user demand factors are easily affected by other types of factors, and society and the environment have a higher degree of influence on other factors.

Acknowledgements

Funded by the Innovation and Entrepreneurship Training Program for College Students of Anhui University of Finance and Economics(202210378306)

ISSN: 2710-0170

References

[1]Ismail, Kharizam, Roshana Takim and Abdul Hadi Nawawi. "The evaluation criteria of Value for Money (VFM) of Public Private Partnership (PPP) bids." (2011).

[2] Chuan Chen, Hemanta Doloi. BOT application in China: Driving and impeding factors [J]. International Journal of Project Management, 2008, 26(4): 388-398.

[3]Ameyaw C, AdjehkumiI T, Owusu-manu D G.Exploring value for money (VFM) assessment methods of public-private partnership projects in Ghana: A theoretical framework[J].Journal of Financial Management of Property and Construction,2015 ,20(3):268-285.

[4] Cui Caiyun. Research on VFM driving mechanism and governance performance improvement of infrastructure PPP projects [D]. China University of Mining and Technology, 2018.

[5] Cui Caiyun, Wang Jianping, Liu Yong, et al. Importance analysis of VFM driving factors of PPP projects using AHP-DEMATEL [J]. Journal of Huaqiao University (Natural Science Edition), 2018, 39(05): 682-688.

[6] Bao Yuhui. Research on the impact mechanism of government credit on government performance of PPP projects [D]. Zhejiang Sci-Tech University, 2021.

[7]Guzmán F, Sierra V.Public-private collaborations: branded public services?[J].European Journal of Marketing, 2013,46(7/8):994-1012.