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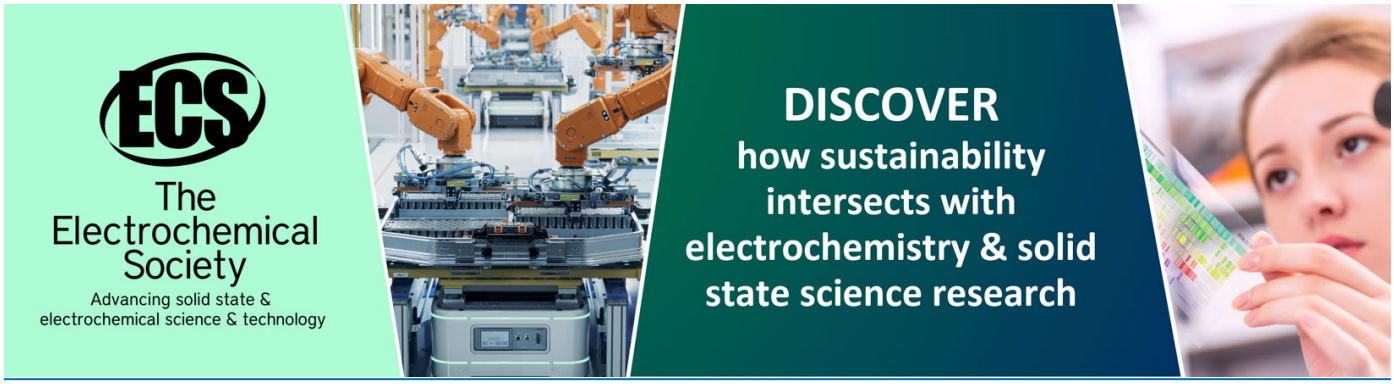

Assessing Infrastructure Projects Under Public-Private Partnerships

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Abstract. This paper discusses a methodological framework for assessing infrastructure projects on the base of public private partnership, which can help investors to take the decision of investment. The financing schemes associated with infrastructure projects have been considered and analyzed in this article and the **FUZZY – AHP** technique was applied to get the optimal financial scheme for financing infrastructure projects on the base of public private partnership. To get the optimal solution, the membership functions and the weights of the variables in every financial scheme in infrastructure projects on the base of private public partnership have been calculated. At the end, a case study was applied to demonstrate the application of analytical hierarchy process module. The results of the study can be used in theoretical and practical researches to develop the financial mechanism of infrastructure projects, as well as can help to predict new schemes to improve the infrastructure projects based on private public partnership.

1. Introduction

1.1. Research questions

In general, there are no effective methods and modules for assessing the financial schemes in infrastructure projects based on public-private partnerships. According to that, many problems appear when the infrastructure projects will be implemented. This will ultimately affect the productivity and effectiveness of financial mechanism in infrastructure projects. The problems of assessing the schemes of financing infrastructure projects were discussed in the works of: Zou W., Shash N.N., Borodin A.I., Gordienko M.S., Voskanyan R.O., Liu T., Wilkinson S., Shen L.Y, Platten A.X, Hardcastle C., Radziszewski P., Kowalski KJ, Król J.B, Sarnowski M., Piła T.J.

1.2. Research objectives

This article aims to select the optimal financial scheme for infrastructure projects based on public-private partnerships. Based on this aim, the following objectives have been identified:

1- Develop a module for assessing schemes of financing infrastructure projects based on PPP;
2- Choose the most optimal financing scheme for infrastructure projects based on PPP.

1.3. Significance of the research

Scientific novelty in this article included in the development of proposals for improving financing schemes in infrastructure projects based on public-private partnerships. The most significant results characterizing the scientific novelty:

1- A developed model for evaluating schemes of financing in infrastructure projects based on PPP;
2- Optimized financial scheme for infrastructure projects based on PPP.

In recent years, with the development of financing methods in infrastructure project based on PPP, various financing schemes have been applied, such as: BOT, BLTM, BOOT, DBOOT, and each scheme had its own advantages and disadvantages. To choose the optimal scheme for financing infrastructure projects based on PPP, a FUZI- AHP module has been chosen [1]. According to this module, it is necessary to divide each financial scheme into three parts or indexes and also divide each index into sub-indexes [8], and calculate the weight of each part according to their impact on the financial decision. After that the optimal solution formula should be applied as follows [9]:

$$D = MAX\ FUZI - AHP \quad [10] \tag{1}$$

$$FUZI - AHP = (\mathrm{ds})^{1/2} \quad [11] \tag{2}$$

$$\mathbf{ds} = \sum_1^i \tilde{\omega} * \mathrm{dsi} \quad [18] \tag{3}$$

$$\mathrm{dsi} = \sum_1^i \mathrm{Q} * \mathrm{W} \quad [20] \tag{4}$$

Where ds: membership function level 3 of the financial scheme,
D: optimal financial scheme solution,
$\tilde{\omega}$: index weight,
dsi: membership function level 2 of the financial scheme,
W: sub index weight,
Q: is the membership function of level 1.

2. Discussion

The FUZI- AHP module has been applied on an infrastructure projects in Russia (Creation of an indoor sports complex with artificial iceland for 5,000 seats (Ulyanovsk region)) [2]. To calculate the membership function in the financial scheme in this project, it is necessary to construct a FUZI matrix for each sub index and obtain weights for all indexes [13] (table 1).

Table 1. The weight of every index in financial scheme BOOT (Creation of an indoor sports complex with artificial iceland for 5,000 seats (Ulyanovsk region)) [14].

	P11	P12	P13	P14	*W 1i*
P11	0.5	0.4	0.3	0.7	**25% = W 1,1**
P12	0.6	0.5	0.7	0.4	**28% = W 1,2**
P13	0.4	0.3	0.5	0.7	**25% = W 1,3**
P14	0.6	0.3	0.6	0.5	**26% = W1,4**

: $P = \frac{1}{n(n-1)(n-2)} \sum_{i=1}^{n} * \sum_{j=i\ j\neq 1}^{n} * \sum_{k=1,\ k\neq i,j}^{n} \left| rij - (rik + rkj - \frac{1}{2}) \right|, n > 2$ [15].... (5)

In the same way can also calculate W2, i and W 3, i.

Table 2. Weights W2, i and W 3, i (Creation of an indoor sports complex with artificial iceland for 5,000 seats (Ulyanovsk region)) [16].

W 2,i	**29%**	**31%**	**23%**	**21%**
W 3,i	**27%**	**26%**	**22%**	**29%**

After calculating the weight of each sub index in the system, the optimal solution can be calculated by the dsi (membership function level 2 of the financial scheme). Table 3. Illustrates the calculation of (dsi) for financial scheme BOOT [19].

Table 3. Weights and membership function level 2 in financial scheme BOOT.

Sub index 1,2,3.	Weight of each sub index	**Q**	**dsi**
1 orm of interaction between the public and private sectors	25%	(0.04, 0.11, 0.44, 0.41, 0.00)	= (0 .0385 , 0.1735 ,0.4796 , 0.3012 ,0.0072)
2 omplexity of the financing process	28%	(0.07, 0.41, 0.48, 0.04, 0.00)	
3 und	25%	(0.00, 0.11, 0.56, 0..30, 0.03)	
4 apital Structure	26%	(0.04, 0.04, 0.44, 0.48, 0.00)	
1 Financial expenses	29%	(0.00, 0.11, 0.41, 0.44, 0.04)	(0.0298,0.1124,0.3812,0.4444,0.0322)
2 ayback period	31%	(0.07, 0.04, 0.26, 0.56, 0.07)	
3 egree of off-balance sheet financing	23%	(0.04, 0.18, 0.52, 0.26, 0.00)	
4 everage Ratio	21%	(0.00, 0.15, 0.37, 0.48, 0.00)	
1.	27%	(0.04, 0.04, 0.30, 0.55,	(0.0204, 0.0335,

he level of the demand		0.07)	0.377,0.5113, 0.0578)
2.	26%	(0.04, 0.00, 0.44, 0.44,	
he level of risk		0.08)	
3.	22%	(0.00, 0.11, 0.26, 0.59,	
icroeconomic		0.04)	
atmosphere			
4.	29%	(0.00, 0.00, 0.48, 0.48,	
he structure of the		0.04)	
investment			

Table 4, illustrates the calculation of membership function level 3 and the overall FUSI – AHP index.
Where: ds BOT = $\sum_1^i \tilde{\omega} * \text{dsi}$
$\tilde{\omega}$ BOT = (Wc1, Wc2, Wc3).

Table 4. Weight and membership function level 3 of the financial scheme BOOT.

***C* BOOT**	$\tilde{\omega}$	dsi **BOOT**	ds	**BOOT**
C1: Characteristics of the financial method	Wc1=0.46	(0 .0385 , 0.1735 ,0.4796 , 0.3012 ,0.0072)	(0.032016, 0.125515,	
C2: The priorities of the investor	Wc2=0.35	(0.0298,0.1124,0.3812,0.4444,0.0322)	0.425666, 0.391239, 0.025564)	1.9
C3:Characteristics of the project	Wc3=0.19	(0.0204, 0.0335, 0.377,0.5113, 0.0578)		

$$\text{FUZI} - \text{AHP } \mathbf{BOOT} = ((\ 0.032016 * 1) + (0.125515 * 2) + (0.425666 * 3) + (0.391239 * 4) + (0.025564\ ))^{1/2} = 1.9$$

After calculating FUZI – AHP for **BOOT**, it is possible to use FUSI-AIP to calculate the optimal financial solutions for other schemes and determine the max FUSI-AIP (Tab. 5) [17].

$$\mathbf{FUZI\ BLTM} = ((\ 0.026064\ * 1) + (0.426066 * 2) + (\ 0.34239 * 3) + (0.124815 * 4) + (\ 0.031016 * 5))^{1/2} = 1.7$$

$$\mathbf{FUZI\ D}\text{BOOT} = ((\ 0.391239 * 1) + (0.025564 * 2) + (0.032016 * 3) + (0.125515 * 4) + (0.425666 * 5\ ))^{1/2} = 1.80$$

$$\mathbf{FUZI\ BOT} = ((0.125515\ * 1) + (\ 0.025564 * 2) + (0.032016 * 3) + (0.391239 * 4) + (0.425666 * 5\ ))^{1/2} = 2$$

3. Results

The analysis showed that the BOT financing scheme is the most optimal financing scheme (FUZI -AHP for = 2) (see table 5).

Table 5. Optimal financial solutions for infrastructure projects based on PPP.

	BOT	**BLTM**	**DBOOT**	**BOOT**
FUZI -AHP	2	1.7	1.8	1.9
D = max FUZI -AHP	1.99			

4. Conclusions

To implement infrastructure projects based on PPP we need to get the most effective financing schemes. The choice of financing scheme depends on many factors, such as: the characteristics of the financial method, the investor's priorities, and the characteristics of the project. The goal of the FUZI -AHP module is to choose the most optimal financial solution for the project and minimize the cost of capital. The analysis showed that in infrastructure projects based on PPP using FUZI -AHP module and in comparison with other schemes, BOT, (construction, operation / management, transfer) represents the optimal financial solution. Thus, in the project **(**Creation of an indoor sports complex with artificial iceland for 5,000 seats (Ulyanovsk region)) the BOT financing scheme is the most optimal scheme for financing infrastructure projects based on PPP and can be used for the application of infrastructure projects.

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