

Efficiency improvement of the investment and innovation activities in the transport facility construction field with public-private partnership involvement

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Abstract. Growing demand to increase the investment volume in modernization and development projects for transport infrastructure define the urgency of the current study. The amount of private sector investments in the field is insufficient to implement the projects for road construction due to their significant capital intensity and long payoff period. The implementation of social significant infrastructure projects on the principles of public-private partnership is one of the key strategic directions of growth for transport facilities. The authors come up with a concept and methodology for modeling the investment and innovation activity in the transport facility construction. Furthermore, there is developed a model to find the balance between public and private sector investments in implementing construction projects for transport infrastructure with involvement of PPP (further – public-private partnership). The suggested concepts aim to improve the efficiency rate of the investment and innovation activity in the field of transport facility construction on the basis of public and private sectors collaboration.

1. Introduction

Road industry of the Russian Federation is an essential part of the integrated transport system of the country. The huge territory of Russia determines the importance of an effective transportation to preserve its territorial integrity. The state of the road sector and transport infrastructure should fully meet the needs of the country's economy [1, 2].

To date, there is a backlog in the construction and development of transport infrastructure facilities, a reduction in transport and operational characteristics of road facilities, an increase in the number of accidents due to inconsistencies in the financing of the road industry and the increase in motor vehicles. The current situation has led to the failure of transport infrastructure facilities to fully meet the needs of the country's economic development. In the absence of modernized road facilities, the territory of the Russian Federation may find itself in economic isolation. It is necessary to carry into effect the geographic location of the country as the link between two major centers - Asia and Europe, to maximize international traffic flows and, accordingly, the financial resources that accompany them. In order to do this, it is necessary to bring the road infrastructure facilities in line with the requirements of international standards, what will allow integration into the European and Asian road network.

In developed countries, the correspondence of the road network to the needs of the economy and the population is a part of the strategic priorities of economic policy. The implementation of programs to increase the length and improve the quality characteristics of transport infrastructure provides a multiplier effect and allows to achieve significant results, both in the economy and in the social sphere.



Due to the significant payoff period for the implementation of projects for the transport facilities construction, there is a need for government support for private investors, that are involved in implementing major socially significant infrastructure projects. It can be carried out in various ways: in the form of the transfer of existing transport infrastructure to the commercial operation, provided that they are to be reconstructed. It is also possible to provide land, state guarantees for loans or tax exemption [3].

2. Theory and experimental approaches

In order to increase the efficiency of investments in the construction of road facilities on the principles of PPP, a concept and methodology have been developed to model investment and innovation activities in the road sector in a PPP environment. The main modeling objectives of investment and innovation activities are: modernization and increase of accessibility of transport infrastructure facilities; improvement of the road construction work quality. As a consequence, it will increase the contribution of the road industry to the boost of the Russian economy.

The methodology of the system approach was used to develop the concept (Fig. 1).

1) At the first stage, investment and innovation activities in the road sector are analyzed, goals and objectives are set;

2) At the second stage, the development of PPP principles in the road sector should be developed, which will allow to define the form of PPP implementation in the construction of transport facilities;

3) At the third stage, the optimal mechanism of public and private investment in the construction of transport facilities is formed;

4) At the fourth stage, an appraisal is made about the income of investments in road facilities under PPP conditions and the directions to improve their efficiency are set;

5) At the fifth stage, the principles for optimizing the pricing system are determined, as well as the possibility and conditions for the use of the rotational work in transport facilities construction. It allows to increase the efficiency of investment and innovation activities in the road industry;

6) At the sixth stage, the volume of investments in road facilities is modelled;

7) At the seventh stage, conditions and requirements for the investment projects for the construction of transport facilities are figured out.

Modelling investment and innovation activities in the road industry in the context of PPP is all about to develop and implement solutions and efficiently use innovation and investment resources [4]. The concept of increasing the efficiency of investment and innovation activity in the road industry, unlike the current approaches, allows to set the directions of the increase of investment volume in transport facilities operating on a fee basis under PPP conditions. It also appraises their change for a long-term prospect within the concession agreement term, and increases the efficiency of innovation projects [5, 6].

3. Results

The methodology for modeling investment and innovation activities in the road industry under PPP conditions (Figure 2) is a set of interdependent tools, procedures, approaches, models and algorithms that form the basis for decision-making aimed to improve the efficiency of investment and innovation activities in the construction of transport facilities.



Figure 1. Conceptual framework for modeling of the innovation and investment activity in road industry in the context of PPP.

Implementing investment projects for the transport facility construction in the context of PPP, it is necessary to determine the optimal ratio of private and public capital, that will ensure the most efficient implementation of projects, both for the private and state investor. The main objective of the state in the implementation of projects in the context of PPP is to create conducive environment for the development of full-fledged partnerships with the private investor, including mechanisms for the reliable implementation of financial, legal and administrative guarantees to carry out the joint projects. And the main objective of private investor is to present to the state investment projects that implement innovations and have undergone marketing analysis. The project focuses on the joint implementation of socially significant problems. Moreover, private investor is responsible for the efficient management of such projects and for the achievement of a successful result. [7]

Using a mixed funding, the main objective of the project implementation is to optimize the source structure of the attracted resources. Let us consider the definition of the optimal ratio of public and

private capital with the use of the game theory.

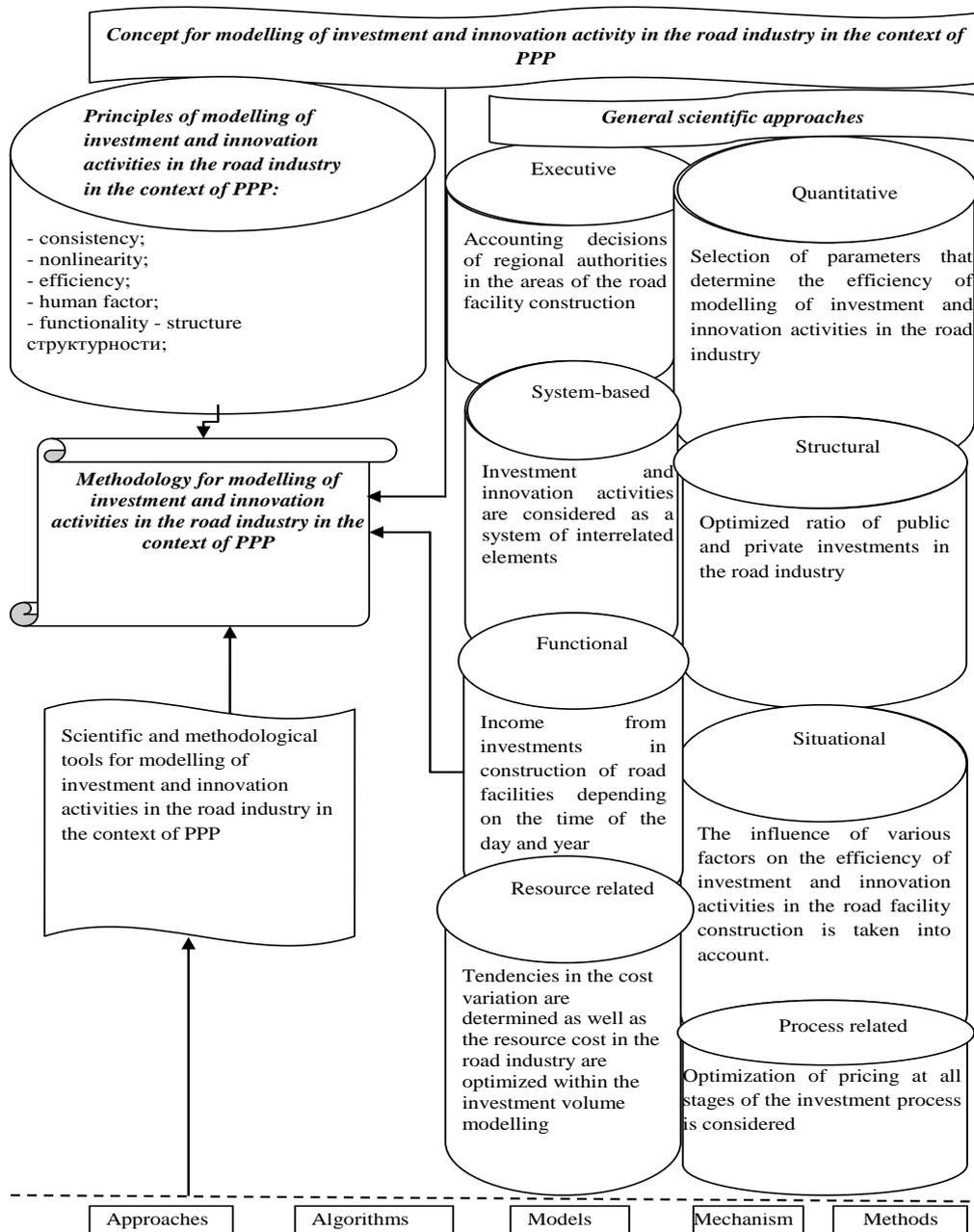


Figure 2. Methodology for modeling of investment and innovation activity in the road industry in the context of PPP

The process for the structure optimization of public and private investments in the construction of transport facilities under PPP conditions implies the following stages:

- 1) target effect obtained from the implementation of investment and innovation projects is defined;
- 2) strategies for the behavior of the state are formed;
- 3) strategies for private investor behavior are considered;
- 4) game matrix is compiled;
- 5) game is represented in a geometric interpretation.

1) target effect is expressed in the volume of the obtained effect from the implementation of investment and innovation projects.

2) private investor (player A - a possible concessionaire) has 2 possible options to obtain the target effect (2 pure strategies):

Option 1 - invest 25% of the total project cost; Option 2 - invest 40% of the total project cost.

3) The state (player B) has 2 possible options to obtain the target effect (two pure strategies): 1 - if the concession term is reduced (25 years); 2 - if the concession term remains as high as possible (30 years) [8].

4) The game matrix will be as follows (Table 1):

Table1. Game matrix

Strategy of a private investor	Strategy of the state	
	1	2
1	₹15,291 million	₹17,126 million
2	₹19,402 million	₹16,932 million

5) The solution of this game in geometric interpretation is represented in Fig. 3. On the horizontal axis, the mathematical expression of state strategies is intercepted. It is represented by the probability of applying the strategy in the range from 0 to 1 and is denoted by the y-axis. At the same time, the probability of applying the first strategy of the state will be 1.

If the government decides to agree on the expected duration of the concession, then the investor's profit will be denoted by a_{11} , and by a_{12} - if there is a reduction in the maximum possible concession period. When the government selects the first strategy, the potential investor's profit will be ₹16,932 million and if the investor applies the second strategy - ₹17,126 million. In case the state uses the second strategy, the investor's profit will amount to ₹19,402 million if he applied the strategy No1 and ₹15,291 million - in the application of the investor strategy No2.

$$(15,290.93-19,401.92) \times x_1 + 19,401.92 = -4,110.99 \times x_1 + 19,401.92$$

$$(17,125.84-16,932.46) \times x_1 + 16,932.46 = 193.38 \times x_1 + 16,932.46$$

The solution of the game can be found from the equation system

$$\begin{cases} -4,110.99 \times x_1 + 19,401.92 \\ 193.38 \times x_1 + 16,932.46 \end{cases}$$

$x_1 = 0.57$, $y = ₹17,043.40$ million. For the second player:

$$(15,290.93-17,125.84) \times y_1 + 17,125.84 = -1,834.91 \times y_1 + 17,125.84$$

$$(19,401.92-16,932.46) \times y_1 + 16,932.46 = 2,469.46 \times y_1 + 16,932.46$$

$$\begin{cases} -1,834.91 \times y_1 + 17,125.84 \\ 2,469.46 \times y_1 + 16,932.46 \end{cases}$$

$y_1 = 0.0449$, and $x = ₹17,043.404$ million.

Value of the game will be ₹17,043.404 million when the potential investor applies the optimal strategy of $x_{opt} = (0.5737; 0.4263)$. At the same time, the most profitable strategy for the State will be the strategy $y_{opt} = (0.0449; 0.9551)$, when value of the game will be ₹17,043.404 million [9].

Regardless of the optimized structure of public and private capital, the basic concession model of PPP is the BTO (build - transfer - operate), that is adapted to be implemented in the construction of transport facilities of Russia. The author suggests to create a United Russian Association in order to manage the system of toll roads

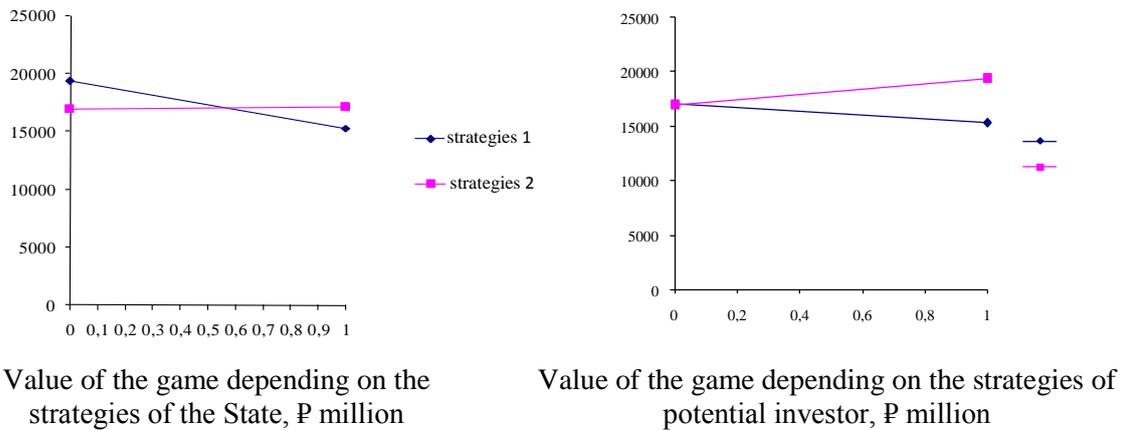


Figure 3. Geometric interpretation of players' strategies

4. Discussion

Modelling of innovative and investment activities in the road sector in the context of PPP plays a significant role in the efficiency improvement of the road industry as a whole. Based on the analysis, organizational and economic problems affecting the efficiency of innovative and investment activities in the road industry have been identified. It also makes it possible to justify the directions of its development, taking into account the modern requirements of innovative development, ensuring an increase of investments in the road industry and their efficiency improvement in the context of PPP as well as maximization of the contribution of the road industry to the growth acceleration of the Russian Federation economy [10].

The developed methodology for modelling of investment and innovation activity in the road industry in the context of PPP includes a set of methods, procedures and approaches aimed to improve the efficiency of investment activity in the road industry in the context of PPP, that will create a new space for development of various sectors of the economy, promote mobility, business and social activity in the society.

5. Conclusions

An approach to optimize the structure of public and private investments in the creation of transport infrastructure facilities with PPP involvement, taking into account the concession life of the facility by a private investor, is suggested. This approach allows not only to consider, but also to harmonize the interests of all project participants, and, consequently, to accelerate the implementation of socially significant infrastructure projects based on the principles and methodology of PPPs, which is one of the most important strategic priorities of the road industry at the present stage of its development.

References

- [1] Shibayeva M and Belykh Y 2011 *Materialy Mezhdunarodnoj nauchno-prakticheskoy konferencii (Kursk)* 310-312
- [2] Shul'gina L, Shibayeva M and Belykh Y 2011 *Finansy Ekonomika* **12** 30-34
- [3] Kankhva V, Uvarova S and Belyaeva S 2016 *Procedia Engineering* **165** 1046-1051
- [4] Strelets K and Vatin N 2015 *Rocznik Ochrona Srodowiska* **17(1)** 104-12
- [5] Uvarova S, Belyaeva S, Kankhva V and Vlasenko V 2016 *Procedia Engineering* **165** 1317-1322
- [6] Gasilov V and Shibayeva M 2009 *Predprinimatelstvo* **4** 141-144
- [7] Nazmeeva T V and Vatin N I 2016 *Magazine of Civil Engineering* **62(2)** 92-101
- [8] Rolima R, Santos E and Meirac L 2014 *Region. XI Congreso de Ingenieria del Transporte* 160 – 169