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Preliminary Evaluation Methodology for Payback Infrastructure Projects in Private-Public Partnership

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ABSTRACT

The authors of the article present the results of scientific and practical research on the development of methods of primary assessment of the efficiency of payback infrastructure projects public-private partnerships achieved through the monitoring and analysis of the state company's investment activities and project portfolio management. The purpose of this study is to develop methodology for preliminary evaluation of payback infrastructure projects, that is able to be used to evaluate efficiency of capital investment at the stage of initial project appraisal and planning and to range perspective projects in accordance with their efficiency. The subject of the article: efficiency of payback investment projects in the infrastructure industry. The relevance of the study is determined by absence of a generally accepted methodology for initial evaluation of investment projects, that allows for into consideration the legal and economic specifics of federal projects approval and implementation in the regions of Russia. The methodology formed on the basis of an interdisciplinary approach implemented in the course of approval and evaluation practice of investment projects appraisal within the framework of the activities of a state-owned company. The instrumentation reviewed in this paper is based on data from financial modeling of infrastructure projects, with preliminary geographical modeling of traffic flow intensity. It includes the following modified indicators based on discounted cash flows: consolidated coverage ratio, ratio of operating income to capital investment, share of extrabudgetary funding in the life cycle of a project, internal rate of return. These indicators are unified into a single integral indicator, which allows to rank and manage future projects in a company's portfolio. The applicability of the proposed methodology has been verified by the results of implementation of the public-private partnership projects. Based on the results of the study a financial model for initial assessment of project efficiency has been prepared, which can be used as the initial stage of project justification.

Keywords: investment; project finance; spatial modelling; project management; corporate finance; public-private partnership; Russian regions; infrastructure; performance indicators; subsidy; budgeting

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INTRODUCTION

The market of public-private partnership projects (further — PPP) in Russia has achieved a trajectory of qualitative progress over the past 15 years: new unique federal, regional and municipal investment projects are formed, requiring significant capital investment, careful monitoring and effective application of advanced technologies (including: high-speed highway of M-11 "Moscow — St. Petersburg", construction of aviation infrastructure of Sheremetyevo airfield and other projects). From 2012 to 2020, the cost of projects and the number of concluded PPP agreements doubled: about 200 contracts with a cost over 1 bln rubles were signed [1]. The extensive experience of collaboration between state and private companies serves as the foundation for optimal methodological, managerial, and organizational approaches to project management, even for unprecedented federal projects.

At the same time, generally recognized and effective approaches to evaluation of PPP investment projects in relation to Russian implementation experience have not been fully presented in the scientific literature and are not currently the subject of intensive discussion by the scientific and business communities, and the existing legal framework for qualitative and quantitative criteria for determining the efficiency of such projects does not yet have a consistent experience of application [1–4]. Many Russian methodological approaches to financial analysis of PPP projects are based on foreign research and experience, as such a methodology for evaluating the performance of projects based on direct experience of conclusion, implementation and closure of PPP infrastructure projects in Russia, has not been developed. There is also a lack of agreement within the international community on best practices for project pre-assessment, since multiple criteria and models are recognized as optimal for estimation of cost-effectiveness of PPP [5]. The scientific literature identifies two groups of criteria to evaluate capital efficiency: investment efficiency criteria (net present value, internal rate of return and others) and budgetary efficiency criteria (revealed comparative advantage index, net present value of budget investments). At the same time, research criteria for preliminary, initial evaluation of PPP-projects are not sufficiently represented in scientific research. This fact supports the scientific relevance of the methodology developed in this article for the initial assessment of infrastructure projects, which can be used for practical application-oriented investment planning, and is based on first-hand experience of large federal concessions and long-term infrastructure investment agreements.

The purpose of the study — is to develop a methodology for the initial assessment of the payback of infrastructure projects, that will allow to assessment the effectiveness of investment at the preliminary project preparation stage and the ranking of prospective projects on efficiency. The paper is organized as follows: the first section provides a literary review of current approaches to evaluation of PPP infrastructure projects, and the second section develops methodologies to evaluate the cost-effectiveness of PPP projects.

EVALUATION METHODS FOR PPP PROJECTS

The scientific and business communities' interest in developing public-private partnerships has increased significantly during the last 30 years [5]. The main research topics of PPP projects are: efficiency, financial closure, project risks, value for money and institutional factors. Both qualitative and quantitative research approaches are being developed. Quantitative methods are used to assess the effectiveness of projects, determine the agency relations between the parties in the framework of game theory, assess the net present value of projects and risks, and model interactions within PPP projects using fuzzy

set theories, analytical hierarchy processes and dynamic systems.

In English-language PPP studies the most commonly used model for financial efficiency estimation of a project is the model of real options. Real option theory is used to determine the duration of agreements and the cost of capital investment [6] and to form adaptive investment scenarios based on project indicators [7]. Another widespread approach to the effectiveness of PPP projects — simulation models. Y. Zhang et al. [8] uses a dynamic system experimental model, in which long-term implications of different decisions under financial project planning are examined by causal relations between PPP participants for choosing the optimal investment strategy.

The most commonly used approach to estimation of comparative advantages of PPP is value for money (VfM), which can be detected in early [9] and recent studies [10]. VfM method is suitable for preliminary and retrospective analyses: this method is used for economic justification of public-private partnerships, for evaluation of projects in relation to key indicators, and for analysis of efficiency of already completed PPP-cases [11].

The paper of F. Kurniawan et al. [12] suggests another method of evaluation — a step-by-step review of cost-effectiveness of a project: at the senior debt-raising stage and at the operational stage to define the sensitivity of the project indicators to market changes, as well as to guarantee an effective operational cash flow of the project at later stages, taking into account debt servicing. Another paper focuses more on the profits and losses of each party to the agreement and presents a method for efficiency estimation by use of a weighted criterion based on the parametric estimations obtained [17].

Empirical research in English-language sources is mainly based on case studies, and is consequently limited by the availability of data, which often constitutes commercially confidential information and is not publicly disclosed. Theoretical English-language papers, however, rarely implement hypothesis testing through multiple case comparison. Based on this, it can be concluded that in many foreign papers a weak body of evidence can be observed regarding independent practice of PPP implementation. In addition, the possibilities of comprehensive modeling in the course of direct project management may be limited by the uncertainty of key preconditions, which underlines relevance of an integrated approach to preliminary assessment of PPP projects based on financial metrics.

In the Russian-language papers, descriptive and comparative approaches to the theoretical side of the question [14] are thoroughly studied — a general theory is developed, that explains the emergence of PPP as a form of market relations and studies the structure and distinctive properties of PPP projects, as well as their risks. However, a relatively small number of papers are focused on project assessment methodologies with respect to the infrastructure sector. The paper of E.I. Gabdullina [15] develops a step-by-step general approach to project evaluation, which includes the definition of an information base, evaluation of project indicators, and financial and economic justification. This approach is subsequently developed on the basis of the structural and logical system for evaluation of project efficiency by other authors [16]. Research by L.S. Shakhovskaya et al. [17] proposed a methodology for evaluating the investment effectiveness of PPP projects, that is entirely based on classical financial performance indicators within the method of discounted flows (profitability index, net present value, internal rate of return and others), as well as defining a primary risk assessment matrix. A complex methodology of assessment on the basis of risks is applied in general to capital investment and, in particular, to the oil and gas industry: it is developed on the rule of formation of cash flows [18] and with the help of PEST-analysis [19], and consideration of existing project

management tools applied to this industry is carried out in the paper of M.V. Gracheva and M.V. Stepanova [20].

Thus, there is a need to develop a methodology for *primary* assessment of infrastructure projects in Russia, which cannot be ensured by existing Russian and English-language scientific papers, as well as national normative legal acts. The English-language papers consider a large number of methods, which differ in complexity, but there is no unified approach to the primary integrated assessment, which could take into account the Russian specifics of investment in capital infrastructure. In Russian-language studies, assessment approaches need more theoretical formulation in relation to the industry practice of implementing of PPP projects.

EVALUATION METHODOLOGY

The article presents a summary of the practical investigations of the authors — the methodology for selecting infrastructure projects for the construction or reconstruction of roadways [parts of motorways and (or) artificial road structures, inseparable improvements without accounting for repair and capital repair], to be operated on a paid basis. This methodology has been tested by the results of implementation of PPP-projects and direct management of projects and investment commitments within the framework of the company, which for more than 12 years has held the primacy of industry leader.

The authors developed on the basis of the discounted cash flow approach, an integrated form of assessment for financial indicators, which were modified in accordance with the industry specifics of repayable infrastructure projects. The paper examines a universal approach to definition, calculation and accounting of integrated assessments of infrastructure projects for construction or reconstruction of roads, on the basis of which the primary assessment is carried out of project financial feasibility. Distinctive features of infrastructural investment projects are long planning period (from 15 to 30 years) and increased risks throughout the operational phase. These risks include both the risks of not reaching the forecasted traffic intensity and the financial risks associated with increased debt liabilities of project participants if determined on the basis of floating rates (consumer price index, key interest rate of the Central Bank of the Russian Federation or investment in fixed assets). In particular, the scientific significance of the paper is achieved through the proposed comparable values of indicators that characterize infrastructure projects throughout their life cycle. This is especially relevant for infrastructure payback projects, which are characterized by a significant increase in maintenance costs associated with carrying out repairs.

The methodology is based on quantitative criteria for the selection of investment projects, including cost-effectiveness indicators, which are unified into a single weighted sum of the values of each criterion, taking into account weighting factors. This evaluation is performed as part of the initial stage of project justification, which is then supported via technical, financial, and administrative expertise, including the calculation of the expected cost of implementation, financial model, and risk matrix.

QUANTITATIVE-INDICATORS

Quantitative indicators — key parameters of a PPP infrastructure project, on the basis of which it is possible to calculate the quantitative feasibility assessment of the project. Quantitative parameters according to the developed methodology include:

1. consolidated coverage ratio;
2. operation income/capital expenditure ratio;
3. project cost;
4. non-budget share;
5. internal rate of return;

6. intensity of road traffic.

The approach for determining key quantitative indicators to measure the efficiency of infrastructure projects is described below.

1. Consolidated Coverage Ratio (CCR)

PPP infrastructure projects are characterized by a large disproportion in the durations of the investment and operational phases and a rather high sensitivity of the financial indicators to changes in key factors throughout the life of the project. At the operational stage, the financial sustainability of the project is quite dependent on both changes in the revenue component and the servicing of debt financing attracted at the investment stage. Even in the final stages of the project, the need to maintain a positive cash balance after accounting for historical accumulations remains, as additional maintenance costs for repairs (after 12 years) and major repairs (after 24 years) are required in accordance with Decree of the Government of the Russian Federation No. 658. Therefore, a key measure of the financial sustainability of the projects is the consolidated coverage ratio. This indicator is calculated as the ratio of discounted values of all future project revenue and income to all project operating costs and debt service payments at the operational stage under the following formula:

$$CCR = \sum_{t=1}^{T} \frac{TC_t + STB_t}{(1+r)^t} \Big/ \sum_{t=1}^{T} \frac{OP_t + IP_t + CBP_t}{(1+r)^t}, \quad (1)$$

where t — financial model period counter (usually year); T — year corresponding to the end of the project (the last year of the PPP agreement and the last year of the project financial model); TC_t — income from tolls collection (*TC*) for the transportation of vehicles on the paid section of the road in the period t of this project; STB_t — short-term borrowings (*STB*) attracted in a year t to cover the cash gap during implementation of the project (balancing bond loans — up to 5 years); r — required return based on project implementation risks, most often used rate on STB_t; OP_t — operating payments (*OP*) in the year t в in favor of the project contractor (usually include the cost of maintenance toll systems (further — *TS*), operations, maintenance of the Traffic Management System (further — *TMS*) and services of emergency commissioners, as well as the maintenance, repair and overhaul of the road within the project); IP_t — investment payments (*IP*) in the year t in favor of the project executor (principal repayment and interest on the investment of the contractor); CBP_t — coupons and bond payments (*CBP*) in the year t (include repayment of both investment and short-term loans — STB_t).

Recommended target value of the indicator $CCR \geqslant 1{,}3$. *CCR* target value can decline to 1.1 with additional measures to manage the traffic intensity risk. The minimum $CR_t \geqslant 1.1$ value can be used to calculate coverage ratio for a specific period of the operational phase of the project. The minimum $CR \geqslant 1.2$ value is allowed for calculation of the current cover ratio for the repayment period of the principal involved in a loan financing project. Deviations from the recommended values are allowed if additional project structuring elements are applied to ensure the financial stability of the project in case of traffic risks. For repair and overhaul periods, the factor may take values less than 1, but the availability of accumulated liquidity in the form of available project cash must be guaranteed to achieve the optimum average value and the fall of the consolidated coverage ratio below the target level should not exceed three consecutive periods.

2. Operating Income/Capital Expenditure Ratio (OICR)

For comparative analysis of infrastructure project structure at investment and operational stages of implementation, it is

advisable to apply the operating-income/capital expenditure ratio. This metric is able to demonstrate the effectiveness of investment in a project in the long term, taking macroeconomic assumptions into account. The operating income/capital expenditure ratio is calculated as the ratio of the amount of the discounted income from the collection of the tolls, reduced by the value of operating payments, to the total amount of discounted capital investment according to the following formula:

$$OICR = \frac{\sum_{t=1}^{T} \frac{(TC_t - OP_t)}{(1+r)^t}}{\sum_{t=1}^{T} \frac{Capex_t}{d_t}}, \quad (2)$$

where $Capex_t$ — project capital expenditure (*Capex*) in the period t (from all sources of funding); d_t — discount factor for investment based on investment index in fixed assets (further — *IIFA*) adjusted by choice of degree for optimal discount periods.

This synthetic indicator measures how many times the income from the project exceeds the capital cost of establishing it without taking into account the sources of funding. There is no standard value. The value of $OICR \geq 1$ indicates a very high prospect of the project (and indirectly, excluding the value of the debt, indicates the possibility of recouping the capital investment during the period of the agreement).

3. Project Cost (PC)

For infrastructure projects, it is especially important to calculate the total cost of the project on the life cycle correctly, as often the project may require much more investment at the operational stage, which, if critical levels of return are not reached, will create an additional need for funding. As a result, in order to properly evaluate the project, the total cost of the project over the entire life cycle must be calculated, which is defined as the sum of the discounted costs for construction and maintenance of the infrastructure facility from all sources for the entire duration of the agreement (Project Cost) by the following formula:

$$PC = \sum_{t=1}^{T} \frac{Capex_t}{d_t} + \sum_{t=1}^{T} \frac{OP_t}{(1+r)^t}. \quad (3)$$

The total cost of the project over its life cycle shows the present value of the infrastructure facility, excluding the cost of paid maintenance and extrabudgetary financing. Attracting extrabudgetary funding and implementing the project on a paid basis will relieve some of the burden on the government budget for the facility's construction and upkeep throughout its life cycle.

4. Non-Budget Share (NBS)

Determining non-budget share is important for evaluation of a PPP-project. It should be noted, however, that non-budget funding is attracted not only during the project's investment stage, as the costs of the project's operating phase may not be covered by toll collection income (which is especially relevant in the first years of operation, when traffic intensity is not yet reaching full volumes due to addictive effects). As a result, the complete life cycle of a PPP-project should be taken into account in order to accurately assess the percentage of non-budget expenditure. Non-budget share (*NBS*) is calculated as the ratio of discounted costs for creation and maintenance of the facility from non-budget sources to the total amount of costs from all sources (see above) according to the following formula:

$$NBS = \frac{\sum_{t=1}^{T} \frac{NBInv_t}{d_t} + \sum_{t=1}^{T} \frac{OP_t^{tall}}{(1+r)^t}}{PC}, \quad (4)$$

where OP_t^{tall} — operating payments (*OP*) in the period t, which are financed from toll collection (non-budget sources).

Table

Weight Coefficients for Integral Appraisal of Infrastructure Projects

No.	Coefficient	Score	Score 0.5	Score 1	Weight
1	Consolidated coverage ratio	< 1.0	1.0–1.29	>= 1.3	w_1
2	Operating income / investment	< 1.0	–	>= 1.0	w_2
3	Non-Budget Share	< 20%	20–60%	> 60%	w_3
4	IRR of the project	$< \min(r_{pr};7,0\%)$	$\epsilon[\min(r_{pr};7,0\%); \max(r_{pr};11\%)]$	$> \max(r_{pr};11\%)$	w_4
	Total				100%

Source: Compiled by the authors.

Operating payments account for a significant proportion of the total life cycle cost of the project, which in the case of PPP can be 100% financed from the income from trust activities (revenue from toll collection). Financing operating costs from collection revenue reduces the overall burden on the budget. In this case, the non-budget share in analysis of projects is significantly higher, which is important when justifying PPP-projects before the federal executive authorities for purposes of the project's inclusion in structural documents. Priority is given to projects, which may maximize financing requirements from non-budget sources, increasing infrastructure development while reducing budget costs.

5. Internal Rate of Return ($IRR_{project}$)

The value of the internal rate of return of an infrastructure project ($IRR_{project}$) is determined by the following formula:

$$0 = \sum_{t=0}^{T} \frac{FCF_t}{\left(1 + IRR_{project}\right)^t}, \quad (5)$$

where FCF_t — free cash flow (*FCF*) of the infrastructure project in the period t, rubles; (FCF — Free Cash Flow); $IRR_{project}$ — internal rate of return on the infrastructure project, %; t — period of time; T — final period of implementation of the infrastructure project.

The value of the free cash flow numerator in each period t (FCF_t) is determined by the following formula:

$$FCF_t = TC_t - OP_t - Capex_t, \quad (6)$$

where TC_t — revenues from the toll collection in the period t of this project; OP_t — operational payments in the year t to the project contractor (includes, as a rule, TS maintenance, TMS operations and emergency commissioners services, as well as

maintenance, repair and overhaul of the road under the Agreement); $Capex_t$ — project capital expenditure in the period t (from all sources of funding); t — period of time.

CALCULATION OF AN INFRASTRUCTURE PROJECT'S INTEGRAL APPRAISAL

Following the evaluation of the project indicators, the data is compiled into an overall integrated assessment, which simplifies project comparison and is required for the project's implementation decisions. To calculate the integral evaluation of an infrastructure project (Ef_{eff}) it is necessary to calculate the weighted average sum of the indicators on the basis of the calculation of points according to the selection criteria (in accordance with *Table*):

$$Ef_{eff} = \sum_{j=1}^{N} \alpha_j \beta_j, \qquad (7)$$

where α_j — weight coefficient defined for the selection j — criterion; β_j — score corresponding to the selection criterion j; N — total number of selection criteria.

To calculate the integral evaluation of an infrastructure project, the weights are determined as follows (see *Table*).

Integral assessment allows the company to rank prospective projects in accordance with the best investment efficiency, as well as quickly manage the project portfolio and build its investment policy. Weights are determined with small deviations from equal values within 100%. Projects with the largest integral assessment indicator have priority for implementation, as they achieve payback in the shortest possible time and create positive flows, which increase development opportunities for the company. However, inclusion of projects with a low integral rating could significantly impair the investment performance of the company's portfolio and reduce flexibility of the operational response.

CONCLUSION

The article describes a method for primary selection and assessment of PPP infrastructure projects based on an integral indicator of the major financial efficiency metrics. The suggested method is applicable to any infrastructure project, which includes mechanisms for return on investment and self-profitability. Applicability and effectiveness of the developed method were tested through a pre-project study on selected payback projects, as well as through actual practice of implementing PPP infrastructure projects throughout the life cycle as part of the core business of the market's largest company — the infrastructure PPP project initiator. In the future, methods of accelerated preliminary modeling of projects on the basis of the proposed methodology could be developed in order to more accurately budget the financial structure of a project and to determine the main flows of projects, as well as further refinement of the proposed methodology based on project risk assessment.

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