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METHODS FOR ASSESSING THE EFFECTIVENESS OF PUBLIC-PRIVATE PARTNERSHIP PROJECTS

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ABSTRACT

This article examines the main methods for assessing the effectiveness of public-private partnership (PPP) projects, which play a crucial role in developing infrastructure and providing social services. The study identifies key financial, economic, social, and environmental evaluation tools, including NPV, IRR, Payback Period, and Benefit-Cost Ratio (BCR). The author also highlights the importance of risk analysis and scenario modeling in ensuring the sustainability and feasibility of PPP initiatives. Using international and regional examples (Kazakhstan, Great Britain, Uzbekistan), the article demonstrates the practical significance of comprehensive effectiveness assessment for achieving successful and sustainable PPP outcomes.

KEYWORDS

Public-private partnership, effectiveness assessment, NPV, IRR, payback period, benefit-cost ratio, risk analysis, scenario modeling, infrastructure development, investment efficiency.

Introduction

Public-private partnership (PPP) projects are one of the most effective mechanisms for modernizing infrastructure, improving public services, and attracting private investments to socially significant sectors. Their effectiveness largely depends on comprehensive and scientifically grounded evaluation before, during, and after project implementation. Assessing the effectiveness of PPP projects allows the public and private sectors to determine the rationality of investments, forecast risks, and measure the social and environmental impacts of initiatives. Therefore, developing and applying reliable evaluation methods is crucial to ensure the long-term success and sustainability of PPP mechanisms.

Evaluating the effectiveness of public-private partnership projects is crucial for ensuring success before their implementation, as well as during the project and subsequent stages. Through such an assessment, the economic, social, financial, and environmental impact of the project is determined, and accurate and substantiated information is provided for the decision-making parties. First of all, through the assessment of effectiveness, the targeted and rational use of budget funds allocated by the state is achieved. For the private sector, such analyses provide reliable information about the stability of the investment climate and the profitability

of the project. This, in turn, will increase investor interest and stimulate the attraction of private capital.

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Evaluating effectiveness is also socially important. Through this process, such factors as the positive or negative impact of the project on the population, the creation of new jobs, and the improvement of the quality of public services are analyzed. At the same time, the impact on the environment is also assessed, which is necessary to ensure sustainable development. Another important aspect is that through the analysis of effectiveness, the risks that may arise in the project are identified in advance and measures to reduce them are determined. This makes the project more reliable and effective, ensuring its long-term sustainability. Therefore, evaluating the effectiveness of public-private partnership projects plays an important role in making decisions that are not only of financial or economic interest, but also of broad social, environmental, and strategic importance.

Correct assessment of the effectiveness of public-private partnership projects contributes to the adoption of investment decisions on a rational and strategic basis. It is especially necessary to conduct a comprehensive analysis before starting projects at socially significant infrastructure facilities - schools, hospitals, roads, and energy systems.

For example, the public and private sectors collaborated on the project to modernize the Almaty-Kapshagay highway in Kazakhstan. Before the implementation of the project, it was assessed based on such indicators as traffic flow, costs, environmental impact, and the level of convenience for the population. Analysis of the effectiveness showed that the reconstruction of this road made it possible to increase traffic flow by 40%, reduce time savings by 25%, and reduce carbon emissions by 18%. Such results clearly demonstrate how important the effectiveness analysis is for the project.

The project of hospitals built on the basis of the British Private Finance Initiative (PFI) is also noteworthy. In such projects, through performance analysis, it became possible to compare construction time, service quality, and costs. For example, 80% of more than 30 hospitals built by the private sector in the NHS (National Health Service) system projects were completed within the planned timeframe and without exceeding the established budget. Through these analyses, the state acquired high-quality infrastructure, while the risks associated with the project were transferred to the private sector.

The "Construction of a Children's Hospital for 540 Beds in Tashkent" project in Uzbekistan was also properly planned through such assessments. In the analysis of the project's social effectiveness, new jobs, coverage of medical services, and the impact on the population's potential were taken into account. As a result, after the launch of this hospital, children's health indicators in Tashkent improved significantly, and access to medical services increased by 27%.

As can be seen from the specific examples above, performance evaluation is necessary for the effective implementation of public-private partnership projects and risk management in advance**.** This will ensure not only financial benefits, but also social impact, improved service quality, and the creation of a sustainable infrastructure.

We consider it expedient to use a number of methods in assessing the effectiveness of financing public-private partnership projects.

These assessment methods can be grouped as a whole as follows:

Table 1 Methods for assessing the financial efficiency of financing public-private partnership projects

№	Method name	Brief description
1.	**NPV** **Net Present Value**	Calculates the difference between income and expenses from investments at present value. Positive NPV - the project is profitable.
2.	**IRR** **Internal Rate of Return**	Determines the level of internal profitability of the project. What is the percentage of the IRR, NPV = 0.
3.	**PP** **Payback Period**	The investment in the project shows how long it will pay off.
4.	**BCR** **Benefit-Cost Ratio**	Profit-costs ratio. If BCR > 1, the project is considered acceptable.

1) NPV (Net Present Value), that is, net discounted income - calculates the discounted value of all profits and costs of the project and helps to evaluate the result in a negative or positive form. If the NPV is positive, the project is financially profitable. This method allows you to take into account future investment returns, inflation, and other economic factors:

$$\text{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - C_0$$

in the formula:
C_t - cash flow received in year t (cash income);
C_0 - initial investment of the project;
r - discount rate (percentage of capital depreciation);
t - time (number of years), n - project duration (years).

Table 2 Interpretation of the NPV indicator of financial efficiency for financing public-private partnership projects

NPV result	Interpretation
NPV > 0	The project is profitable, it is advisable to invest.
NPV = 0	The project is neutral, ensures return on investment, but there is no profit.
NPV < 0	The project is unprofitable, investment is not recommended.

This method is one of the most reliable and widespread methods for determining the financial effectiveness of projects. With its help, the investor and the state can draw a reasoned conclusion that the project actually creates value.
2) IRR (Internal Rate of Return) is the discount rate at which the NPV of future income from an investment project is equal to zero. That is, the IRR is the interest rate at which project revenues and expenditures are equalized. The IRR helps to assess how profitable it is to invest in a project. This indicator is used by private investors or government agencies when making

investment decisions. The IRR is the value of r for which NPV is equal to 0 can be found using the following formula:

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+IRR)^t} - C_0 = 0$$

in formula:
Ct - cash flow in year t (cash receipts);
Co - initial investment;
IRR - internal rate of return;
t - time (years).
When assessing IRR, the following rules are followed, i.e., when IRR > discount rate (capital value), the project is profitable and acceptable. When IRR = discount rate, the project is neutral, profits and costs are the same, and when IRR < discount rate, the project is not economically feasible. For example, $100,000 was invested in a project implemented through a public-private partnership mechanism. Revenue in the next 3 years: $40,000, $50,000, and $60,000. If the IRR ≈ 18.7%, which makes NPV 0, this project is considered profitable if the expected discount rate is 12%. As advantages and disadvantages of the IRR method, the following should be considered:

Table 3 Advantages and disadvantages of the IRR method

Benefits	**Limitations**
A convenient concept for an investor in the form of interest	You may not always get a clear solution
Comparison of different projects	Multiple IRRs may appear when cash flow is large
Intuitive and graphically easy to understand	The selection should be considered in conjunction with NPV

The IRR is mainly defined as the interest rate that equates the present value of future cash flows to investment capital. Through this indicator, investors and government organizations can understand the effectiveness of investments. If the IRR exceeds the minimum requirement for investment capital (e.g., bank interest rate or expected rate of return), the project is considered financially sound. The R&D is especially important in coordinating the interests of the public and private sectors in public-private partnership projects. Because a clear indicator of the project's profitability serves as a reliable source for attracting a private investor and assessing investment risk. In addition, the IRR indicator allows you to compare the project with other options and choose which project is economically feasible. Also, since the IRR shows the profitability of the project as a percentage, it allows easy comparison of projects in different areas. Unlike other financial methods, through IRR, investors can directly see the difference between the current interest rate and project profitability.
3) Payback Period (PP) or project payback period is a financial indicator that shows how long it takes for funds spent on an investment project to fully return. Through this method, the investor or government organization assesses how many years it will take for the investment in the project to pay off. The payback period means the liquidity of the project, that is, the ability of the investment to quickly turn into money. Therefore, this indicator is very important for

investors, especially in conditions of high risk or rapid market volatility.
The PP calculation formula, if the cash flows are the same each year, is carried out as follows:

$$PP = \frac{C_0}{C_t}$$

formula:
C_0 - initial investment (fund contributed to the project);
Ct<3 - annual cash flow (direct revenue).
If cash flows differ annually - a cumulative calculation is applied through the sum of annual cash flows.

Table 4 Advantages and disadvantages of the PP method

Benefits	**Disadvantages**
Easy and understandable to calculate	Only calculates the return on investment, excluding subsequent profits
Evaluates project liquidity	Does not take into account risk and time factors (discounting is not allowed)
Quick Risk Assessment Tool	Only considers short-term benefits

This assessment method is an operational method for assessing the return on investment of public-private partnership projects and is important in determining the return period of funds spent on the project. This indicator is of great importance for the public and private sectors in terms of security and liquidity. However, for a full assessment of effectiveness, it is recommended to use in conjunction with in-depth analysis methods such as IRR and NPV. This method is aimed at determining when the project can recoup its costs. If the return time is powerful, the project is considered financially effective. This method also demonstrates the seriousness and reliability of the project for the private sector. However, it consists only of competing costs and revenues and does not show a general social and economic impact.
4) BCR (Benefit-Cost Ratio) - profit-cost ratio. An indicator used to assess the economic efficiency of an investment project, calculated as the ratio of the expected total profit from the project to total costs. This indicator determines how rational and effective the project is. Its calculation formula is as follows:

$$BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$$

in formula:
B_t - profit received in year t;
C_t - cost in year t;
r - discount rate;
t - time (number of years);
n - project duration.
As an important aspect of BCR, it should be noted that BCR plays an important role in assessing social and economic benefits in public-private partnership (PPP) projects. This

method is widely used in comparing the effectiveness of projects in the fields of infrastructure, education, healthcare, transport, and energy. BCR allows investors and government organizations to determine which projects are being effectively allocated resources to.

Table 5 Interpretation of the results of the BCR method and its advantages and disadvantages

BCR value	**Interpretation**
BCR > 1	The project's profit exceeds the cost, approved
BCR = 1	Profit and cost equal, neutral decision
BCR < 1	Cost is higher than profit, unacceptable
Benefits	**Shortcomings**
Between profit and cost gives a precise ratio	It can be difficult to accurately assess all the benefits and costs.
Convenient for comparing projects	Profit can be assessed subjectively or unsatisfactorily
Social and economic analysis Suitable for	In some cases, it may not provide a complete economic picture

The BCR assessment method is one of the most important and reliable methods for assessing the effectiveness of investments in public-private partnership projects. It shows how much profit each sum invested in the project can bring. However, when used in conjunction with other methods such as NPV, IRR, Payback Period, it allows for more substantiated conclusions.

Methods of Economic Valuation

In assessing the effectiveness of public-private partnership projects, it is important to identify economic benefits and losses. Economic evaluation methods show social and economic results through the project, helping to understand the significance of the project for society.

Cost-Benefit Analysis: This method considers the costs directed to the project (investments, operating costs, etc.) and the potential social, economic, and environmental benefits it can bring (new jobs, infrastructure improvement, reduction of environmental impact). This method provides wide opportunities for calculating project profits and losses, as well as ensures a comparison of different scenarios that correspond to the needs of the public and private sectors.

2) Analysis of benefits and losses for society (Social Impact Assessment): A method aimed at assessing the social impact of the project, which helps to determine the benefits and losses indicated for various rural, urban, and social categories of society. Factors such as the likelihood of social benefits, job growth, improvement in information and educational opportunities, and an increase in the level of medical services are taken into account.

3) Indicators and Ratios: Some indicators should be used to assess the social and economic effectiveness of public-private partnership projects. These indicators are related to the project's social impact, innovative added value, job creation, social losses, and benefits.

Assessment of social and environmental effectiveness. Along with the financial effectiveness of public-private partnership projects, an assessment of their social and environmental impact is also important. Determining the impact of the project on the environment and society is a factor influencing the long-term sustainability of the project.

1) Social Impact Assessment (SIA) **.** The Social Impact Assessment is aimed at determining the impact of the project on society. The purpose of this analysis is to assess the positive impact of the project, such as job creation, opportunities for knowledge and skills development, improvement of social infrastructure, and raising the standard of living of the population. Social impact can be assessed based on several indicators or metrics. These indicators can show changes in various social networks, such as jobs, education levels, and social and economic stability. For example, the following formula can be used to assess the social impact of one job:

$$S = \frac{I}{T}$$

in the formula:

C - social impact;

I - number of jobs created;

T - total population or number of active job seekers.

Based on this formula, it is possible to assess the social impact of job creation.

2) Environmental Impact Assessment (EIA). Environmental Impact Assessment involves an analysis of the project's impact on natural resources, biodiversity, and the environment. This method allows for waste management, assessment of water and air quality, energy consumption, and environmental impact. If it is necessary to jointly assess the environmental and social impact, this is also carried out through integrated models. For example, assessing social and environmental parameters with weights corresponding to each indicator:

$$SIA = w_1 \cdot S + w_2 \cdot E$$

in formula:

SIA - general social impact;

w_1, w_2 - weighting factors for social and environmental factors;

S - social indicators (for example, jobs, education);

E - environmental indicators (e.g., CO_2 emissions, resource consumption).

3) Sustainability Indicators **.** To ensure sustainability, special indicators can be used to measure the environmental and social impacts of the project. These indicators include factors such as environmental efficiency, energy saving, reduction of CO_2 emissions, and social improvement of society.

4) Indicators of negative and positive impacts. If there is data on the negative and positive impacts of the project, the following formula can be used to calculate their overall index:

$$Impact\ Index = \frac{Positive\ Impacts - Negative\ Impacts}{Total\ Impacts}$$

Formula Positive Impacts - positive impacts, **Negative Impacts** - negative impacts, **Total Impacts** - means total impacts.

Risk analysis and scenario modeling in the evaluation of public-private partnership projects - are tools for predicting project-related uncertainties, potential risks and their consequences, as well as forecasting how the project will work under various economic, financial, and legal conditions. This process plays an important role in assessing the effectiveness of the project. Risk analysis in public-private partnership projects is important, as these projects may face financial, social, and environmental risks. A correct assessment of project risks helps to develop a strategy for their mitigation and management. Risk Analysis. Determination of financial, environmental, and social risks of the project. It is necessary to consider ways to minimize the impact of these risks and manage them correctly. The main objectives are to identify project uncertainties and risks, assess risk sources (economic, political, legal, environmental, and technical), analyze potential impacts and potential outcomes, and properly distribute risks (between the public and private sectors).

The methods used in risk analysis include:

Sensitivity analysis. Evaluates how NPV and IRR are affected when key indicators change. Boundaries and Scenarios (Sensitivity Analysis) consider how the social, economic, and financial effectiveness of the project changes under different conditions.;

Risk matrix (Risk matrix) is the classification of risk probability and impact into four quarters;

Monte Carlo simulation repeated modeling of results based on probable scenarios;

SWOT analysis is used to identify strengths and weaknesses, opportunities and risks.

Scenario Modeling is the process of modeling the operation of a project based on various possible economic, political, and financial conditions, the main goals of which are the assessment of project results in various scenarios (optimistic, realistic, pessimistic), preparation for various conditions for decision-makers, and checking the sustainability of the project in a changing economic environment.

Risk analysis and **scenario modeling** play an important role in the effective implementation of public-private partnership projects. Through them, it will be possible to identify project risks in advance and assess how they will work under various possible conditions. This contributes to the rational adoption of financing decisions and ensures the sustainability of the project.

Table 6 Types and models of scenario modeling in assessing the financial effectiveness of public-private partnership projects

Script types	
Optimistic scenario	high economic growth, low risks
Realistic script	expected standard conditions
Pessimistic scenario	inflation, devaluation of the sum, changes in laws
Applicable models:	
Financial model	NPV, IRR, ROI are calculated based on different scenarios.
Cash flow model	The cash flow is structured according to the income and expenditure scenarios.
Stochastic model	Probability-based models (Monte Carlo, Decision Tree)

CONCLUSION

Evaluating the effectiveness of public-private partnership projects requires the use of various methods. Assessment of financial, economic, social, environmental, and risk factors helps to determine the specifics of the project. Correct assessment of the effectiveness of projects helps to understand their social and economic significance. This, in turn, contributes to the minimization of the project's financial condition, social stability, and environmental impact. Such assessments help in making project-related decisions and contribute to future social and economic development.

A comprehensive approach to assessing PPP project effectiveness—combining financial, economic, social, environmental, and risk-based methods—enables more balanced and evidence-based investment decisions. Proper evaluation not only ensures efficient use of public funds and increased investor confidence but also enhances social welfare and environmental sustainability. The implementation of these methods is a key factor in forming a stable and attractive investment climate for regional development.

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