Economia Aziendale Online

Business and Management Sciences
International Quarterly Review

Assessing Risks in PPP Projects for Water Infrastructure in Ukraine: Challenges and Solutions

Olena Dymchenko, Patrizia Gazzola, Oksana Romanenko

Pavia, June 30, 2025
Volume 16 – N. 2/2025

DOI: 10.13132/2038-5498/16.2.343-360

www.ea2000.it
www.economiaaziendale.it

PaviaUniversityPress

Electronic ISSN 2038-5498
Reg. Trib. Pavia n. 685/2007 R.S.P.

Vol. 16-2/2025 - DOI: 10.13132/2038-5498/16.2.343-360

Assessing Risks in PPP Projects for Water Infrastructure in Ukraine: Challenges and Solutions

Olena Dymchenko
Full Professor
Head of the Department
of Entrepreneurship and business-administration. O. M.Beketov National University of Urban Economy in Kharkiv, Ukraine.

Patrizia Gazzola, PhD
Full Professor.
University of Insubria. Varese, Italy.

Oksana Romanenko
Senior Lecturer
Department of Entrepreneurship and Business Administration. O.M. Beketov National University of Urban Economy in Kharkiv, Ukraine.

Corresponding Author:
Olena Dymchenko
dymchenkoov@gmail.com

Cite as:
Dymchenko, O., Gazzola, P., & Romanenko, O. (2025). Assessing Risks in PPP Projects for Water Infrastructure in Ukraine: Challenges and Solutions. *Economia Aziendale Online*, *16*(2), 343-360.

Section:
Refereed Paper

Received: March 2025
Published: 30/06/2025

ABSTRACT

This paper examines the identification and assessment of risks in Public-Private Partnership (PPP) projects in the water supply and sewerage sector in Ukraine. PPPs have become essential for attracting private investment to modernize and expand critical infrastructure. However, these projects face significant risks that can affect their success and financial sustainability. The study identifies six key categories of risks: financial, technological, legal, political, social, and military. Financial risks include currency fluctuations, interest rate changes, and budget deficits, which may impact project costs and profitability. Technological risks arise from outdated technologies and operational failures. Legal risks involve changes in legislation and contract breaches, while political risks stem from policy shifts and instability. Social risks include public opposition and dissatisfaction, while military risks in Ukraine include infrastructure destruction and service disruptions. The research highlights scenario analysis as an effective tool for assessing and managing risks. This method involves creating optimistic, realistic, and pessimistic scenarios to evaluate potential project outcomes. By analyzing financial, political, and technical variables, scenario analysis helps project managers develop strategies to mitigate adverse impacts and enhance financial stability. The paper evaluates three financing models for PPP projects in the water supply and sewerage sector. The classic model (50% government funding, 50% loan) provides moderate financial stability but depends heavily on budget availability. The combined model (30% government funding, 30% grants, 40% loan) is identified as the most effective due to balanced risk distribution and increased financial flexibility. The fully private model (100% loan) is less effective due to high debt pressure and interest rate sensitivity. Key recommendations include creating reserve funds to cover financial shortfalls, securing fixed-rate loans to reduce financial volatility, and engaging international financial institutions to stabilize funding. Strengthening the legal framework for PPP projects is also suggested to protect private investors and improve regulatory consistency. This study contributes to the understanding of PPP risk management by providing a structured analysis of risk factors and assessment methods in Ukraine's water infrastructure sector. The findings offer practical guidance for policymakers and project managers to enhance the efficiency and success of PPP projects.

Questo articolo analizza l'identificazione e la valutazione dei rischi nei progetti di partenariato pubblico-privato (PPP) nel settore dell'approvvigionamento idrico e della rete fognaria in Ucraina. I progetti PPP sono diventati uno strumento essenziale per attrarre investimenti privati e modernizzare le infrastrutture critiche. Tuttavia, l'implementazione di questi progetti è accompagnata da

vari rischi che possono influenzare la loro redditività e sostenibilità. Lo studio identifica sei categorie principali di rischi: finanziari, tecnologici, legali, politici, sociali e militari. I rischi finanziari includono fluttuazioni dei tassi di interesse e dei cambi, nonché deficit di bilancio. I rischi tecnologici riguardano l'uso di tecnologie obsolete e guasti operativi. I rischi legali derivano da modifiche legislative e violazioni contrattuali. I rischi politici includono instabilità governativa e cambiamenti di politica. I rischi sociali riguardano l'opposizione pubblica, mentre i rischi militari in Ucraina includono la distruzione di infrastrutture. L'analisi degli scenari è evidenziata come uno strumento efficace per prevedere e gestire questi rischi. Il modello di finanziamento combinato (30% fondi pubblici, 30% sovvenzioni, 40% prestiti) è identificato come il più efficace, grazie alla distribuzione equilibrata dei rischi e alla maggiore flessibilità finanziaria. Le raccomandazioni includono la creazione di fondi di riserva, l'uso di prestiti a tasso fisso e il coinvolgimento di istituzioni finanziarie internazionali per garantire la stabilità del finanziamento. Questo studio fornisce indicazioni utili per migliorare la gestione dei rischi nei progetti PPP nel settore idrico e fognario in Ucraina.

Keywords: public-private partnership, risk assessment, water supply and sewerage facilities, enterprises, financing, scenario analysis.

1 – Introduction

Public-private partnership (PPP) projects have become an essential component of infrastructure policy in many countries worldwide. They make it possible to attract private investment in critical socio-economic projects, such as the construction of roads, hospitals, and schools, which contributes to the development of infrastructure, increasing the efficiency of public spending and improving the quality of services (Papagiannis et al., 2021).

Water supply and sewerage are among the most critical components of the infrastructure of any country, providing citizens with access to clean water and effective management of water waste. Due to the need to modernize and expand water supply and sanitation infrastructure in the context of limited public finances, public-private partnership (PPP) projects are becoming an important tool for attracting private investment in this sector.

However, the implementation of such projects is accompanied by numerous risks, among which financial, legal, technological, social, and political aspects can be distinguished. Various methods are effectively used to assess and manage these risks, among which scenario analysis occupies a special place. This method allows you to predict several scenarios and evaluate the likelihood and consequences of various risks that may arise during the project life cycle.

2 – Problems of Implementing PPP Projects in the Water Supply and Sewerage Sector: a Literature review

Public-private partnership (PPP) as a mechanism for implementing infrastructure projects is actively studied in the scientific works of both domestic and foreign authors. Scientists analyze various aspects of PPP, including risks, financing models, management effectiveness, and the application of risk assessment techniques (Papagiannis et al., 2022).

Current issues of cooperation between the public and private sectors were examined Sancino (2010), Amelio, Gazzola, Biancone and Brescia (2024). The mechanism of public-private partnership in the water supply and sewerage sector is examined in the work by Romanenko (2025).

Considerable attention in the scientific literature is paid to the general aspects of public-private partnership, its advantages, and challenges. Thus, Bogdanova (2021) considers the basic principles of risk management in PPP projects and offers methods for their assessment. She emphasizes the importance of a comprehensive approach to risk analysis, which encompasses both financial and social factors. Similar issues were explored by Patel J. in his work on risk management in international PPP projects (Patel & Edwards, 2022).

The essence of risks and the challenges of their management were also analyzed by Giorgetto (2021), Riso and Castellini (2019), Selleri (2016; 2018).

Methods of risk assessment, in particular SWOT analysis, PEST analysis and scenario analysis, are considered in the works of Tkachenko (2022) and Green (2021). Researchers note that scenario analysis is the most effective tool for predicting the development of risks, as it allows you to simulate various scenarios. Using this method in infrastructure projects will enable you to reduce uncertainty and increase the level of adaptation to possible changes in the external environment.

Special attention is paid to the financial aspects of PPP implementation in the field of water supply and sewerage. Jones (2021) examines financial risks in the infrastructure sector and proposes models for minimizing risks through combined financing. In similar studies, Kovalchuk (2022) analyzes the effectiveness of attracting international grants and credit resources for implementing PPP in Ukraine.

Considerable attention is also paid to the issues of PPP legal regulation. Sydorov (2021) investigates the problems of regulatory and legal support of partnership relations between the state and business, in particular, the protection of the interests of private investors and mechanisms for resolving legal disputes. His research emphasizes that the stability of the legal environment is one of the key factors in the success of PPP projects.

In general, the literature analysis indicates a high level of research in the field of public-private partnership but simultaneously reveals several issues that require further study. In particular, methods for assessing risks in PPP projects in water supply and sanitation (Papagiannis et al., 2018), as well as mechanisms for improving the efficiency of financing such projects in the long term, require an extended analysis (Dymchenko et al., 2024a; Dymchenko et al., 2024b).

3 – Risks in public-private partnership projects in the field of water supply and sewerage

First of all, it is essential to define the concept of "risk" in the context of PPP. Risk is defined as the probability of an adverse event that may result in partial or complete loss of resources, failure to achieve the anticipated socio-economic outcomes, or non-fulfilment of the objectives of PPP project implementation (Babiak, 2014). In the PPP field, risks include various factors that can affect the timing, costs, and results of the project. There are several main categories of risks: financial, technological, legal, political, social and environmental (Ameyaw & Chan, 2015). This distribution allows for a more detailed assessment of the potential problems that the parties to the transaction may face.

Risks in PPP can be classified into several main categories:

1. *financial risks* – changes in the cost of resources, exchange rate fluctuations, changes in interest rates, etc.;

2. *technical risks* – problems associated with the choice of technologies or their implementation;

3. *legal risks* – changes in the legislative environment, violation of contractual obligations;

4. military risks - include the destruction of critical infrastructure, the need to ensure high-quality and uninterrupted water supply and sewerage;

5. *political and social risks* – changes in the political environment, public support, or protest movements.

The constituent elements of examining the PPP project, depending on possible risks, are given in Table 1 (Romanenko, 2023).

Table 1 – Constituent elements of the examination of the PPP project (Romanenko, 2023).

1. Analysis of the stability of the economic environment
macroeconomic analysis: actual and forecast fluctuations in prices, costs, production levels, availability and quality, level of competition, demand; availability and location of suppliers, factors of production, and service providers; flexibility, development and structure of the labor market, availability of qualified personnel; actual and projected level of inflation, interest rates, exchange rate, cost and availability of labor resources, materials and services; the general state of the infrastructure, administrative costs for the import-export of goods and services, etc.
2. Analysis of the stability of the political environment, legislative/regulatory analysis
- force majeure events (revolution, change of power, war, political unrest, etc.); - state regulation and taxation of the project, business conditions in the long term (fulfillment of obligations by the state, protection of property rights, provision of guarantees, asset management, risks associated with taxation, the possibility of amending legislation for the period of project implementation, etc.); the availability, availability and efficiency of legal arbitration, including the time and money required for litigation and enforcement of judgments; availability of guarantees regarding the rights granted to creditors, etc.
3. Financial examination of the project
the financial sustainability of the project, its business plan and projected revenues, as well as issues related to financial risks: data on exchange rate fluctuations, inflation and interest rates, the availability of hedging mechanisms, insurance agreements, as well as national tools and measures to prevent financial risks. Checking the vulnerabilities and "margin of safety" of the project in case of risks – in particular, through the procedure of the so-called "stress testing" of financial ratios (ratio of borrowed and own funds, loan debt coverage ratio, debt coverage ratio and profit margin, etc.).
4. Analysis of the technical and technological suitability of the project
the possibility of obtaining permits and approvals for the use of equipment and technologies, the acceptability of the schedule of construction works, their cost, forecasting the costs of operation, maintenance, repair, restoration, etc.

Usually, in most infrastructure projects implemented under the project financing scheme, it is considered that certain risks, such as demand risk, individual financial risks, or the risk of late

completion, are borne by the project company, regardless of its role in the project (Grimsey, & Lewis, 2002). In exchange for accepting these risks, the company receives compensation in the form of an increased rate of return. However, since in practice the financing of PPP projects is mostly carried out at the expense of creditors, and not public or private investors, lenders strive to minimize the risks assumed by the project company. They require the company to transfer the maximum share of these risks to other project participants, including service consumers, product buyers, contractors, subcontractors, and operators.

The effective distribution of PPP risks from the standpoint of the state is shown in Figure 1 (Romanenko, 2023).

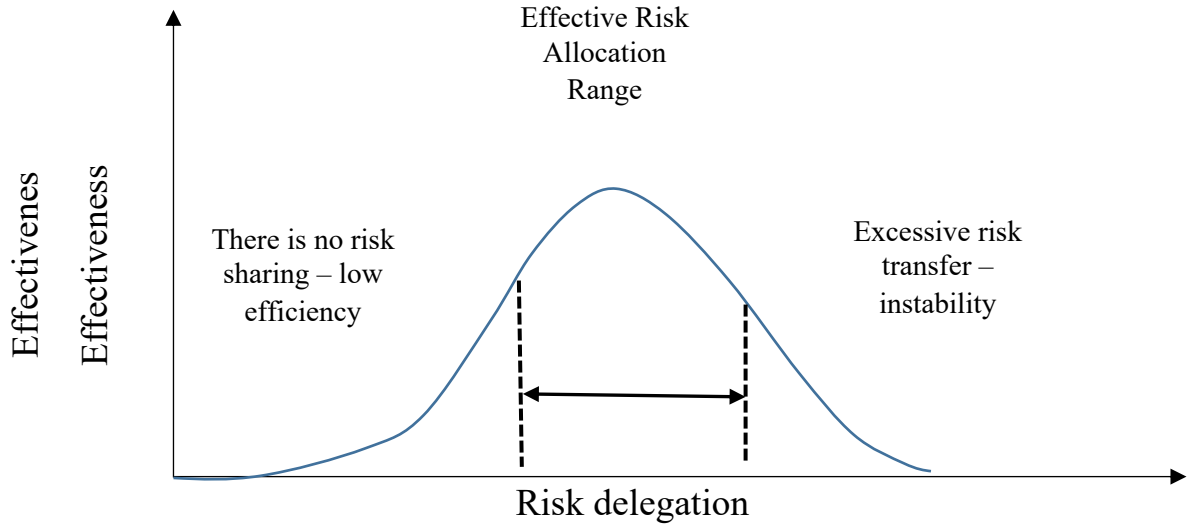

Fig. 1 – Effective distribution of PPP risks from the standpoint of the state
(*Source*: Romanenko, 2023)

Understanding which risks are most significant at different stages of the project lifecycle is key to managing them effectively. The life cycle of a PPP project in the field of water supply and sewerage covers several stages, each of which has its own characteristics, challenges and potential risks.

Public-private partnerships in water supply and sanitation provide cooperation between state and private companies for implementing infrastructure projects, where the private sector assumes part of the financial, technical, and managerial obligations. In the context of water supply and sewerage, PPP may include the following aspects:

A. *modernization and reconstruction of infrastructure*. Improvement of existing water supply and sewerage networks;

B.*construction of new facilities*. Construction of new water treatment plants, pumping stations, sewerage networks, etc.;

C. *operation and maintenance of facilities*. A private company can take over the operation of water supply and sewerage facilities, ensuring their effective functioning and repair work.

PPP in the field of water supply and sewerage makes it possible to optimize the use of public resources, reduce costs and improve the quality of services.

The life cycle of a PPP project in the field of water supply and sewerage includes several key stages, as shown in Figure 2:

1. planning and preparation stage;
2. the stage of financing and attracting investments;
3. construction and implementation stage;
4. operation and maintenance stage;
5. The stage of project completion.

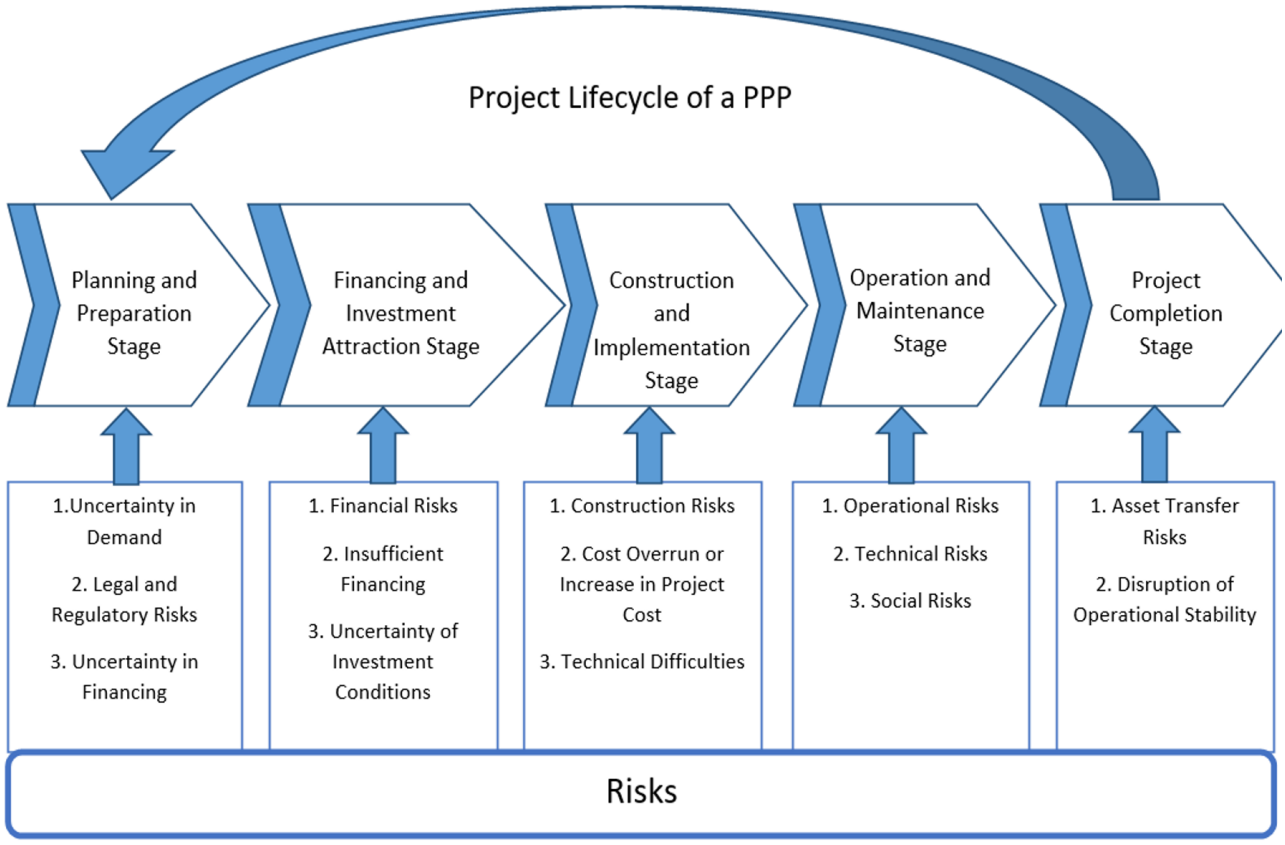

Fig. 2 – Life cycle of a PPP project in the field of water supply and sewerage
(*Source*: Authors' elaboration)

[1] At the first stage – PLANNING AND PREPARATION – it is important to assess the region's needs for water supply and sewerage infrastructure, determine the amount of necessary investments and technical requirements for facilities. An assessment of the effectiveness of the project at the initial stage should include:

– analysis of the need for water supply and sewerage in a particular region;

– development of a feasibility study of the project;

– conducting a preliminary assessment of financial and technical risks, such as possible fluctuations in material prices or changes in the regulatory environment;

– determination of the legal conditions that will govern cooperation between the state and the private partner, including the terms of a concession or partnership agreement.

At the stage of planning and preparing the project, the following *risks* are possible:

- uncertainty in demand: incorrect assessment of water supply and sanitation needs can lead to cost overruns or non-satisfaction of consumer needs;
- legal and regulatory risks: changes in the legislative environment may complicate the implementation of the project;
- uncertainty in financing: difficulties in attracting financing, lack of a clear strategy for attracting private investment.

[2] At the stage of FINANCING FOR THE IMPLEMENTATION of a project in the field of water supply and sewerage, it is important to find optimal sources of investment:

– the state can partially finance the project through budget funds, but a significant part must be attracted from private investors;

– the private sector can attract financing through banks, investment funds or through other mechanisms (for example, bond loans);

– joint financing with the state allows you to increase the volume of investments and reduce financial risks for a private partner.

The following *risks* are characteristic of the stage of financing and attracting investments:

- financial risks: instability in the capital market, changes in interest rates or exchange rates can make it difficult to attract investment or increase the cost of the project;
- insufficient funding: problems with covering costs at different stages of the project due to lack of sufficient capital;
- uncertainty of investment conditions: lack of clear mechanisms for attracting investments or changing the terms of financing.

[3] At the stage of CONSTRUCTION AND IMPLEMENTATION OF THE PROJECT, it is important to ensure:

– compliance with the timing and budget of the project;

– selection and attraction of contractors for the construction of water supply and sewerage facilities;

– compliance with environmental and technical standards in the construction of infrastructure;

– preparation of the necessary documentation for the transfer of facilities into operation.

The stage of construction and implementation of the project is characterized by the following *risks*:

- construction risks: delays in construction due to weather conditions, technological difficulties or low-quality building materials;

- increase in the cost of the project: changes in prices for building materials, the need for additional costs associated with reconstruction or adjustments;
- Technical difficulties: problems with the design or implementation of new technologies.

[4] After the completion of construction and commissioning of facilities, the OPERATION STAGE begins:

– a private partner can take over the management of water supply and sewerage networks, ensuring their effective functioning;

– it is important to implement water quality monitoring and control systems, as well as a system for maintenance and repair of facilities;

– operational risks at this stage include ensuring a stable supply of water, managing leaks or failures in sewer systems;

– tariffs for consumers for water supply and sewerage services are agreed, as well as disputes between public and private partners are resolved.

At the stage of operation and maintenance, the following *risks* are possible:

- operational risks: system failures, inefficient use of resources, equipment malfunctions;
- technical risks: rapid obsolescence of equipment, the need for expensive repairs or upgrades;
- social risks: citizens' dissatisfaction with water quality or high tariffs, which can lead to protests or legal disputes.

[5] At the *final stage*, THE PROJECT CAN BE COMPLETED OR TRANSFERRED for long-term management to the state or a private partner:

– the results of the project implementation are evaluated in terms of the quality of services provided and the achievement of the planned indicators;

– if the project is a concession, at this stage the possibility of extending the concession period or transferring the infrastructure to the state may be considered.

Possible *risks* at the stage of project completion:

- risks of asset transfer: misunderstandings or disputes during the transfer of an infrastructure facility;
- disruption of stable functioning: Handover to national authorities or a private partner can lead to difficulties in maintaining the level of services.

After identifying possible risks, you need to assess them. Among the traditional methods of risk assessment, it is worth highlighting SWOT analysis, which allows you to identify the strengths and weaknesses of the project, as well as threats and opportunities. Another popular method is PEST analysis, which analyzes political, economic, social, and technological factors. However, these methods are limited because they usually focus on current or near-term trends and do not take into account the possibility of drastic changes occurring in the future (Bogdanova, 2021).

4 – Scenario analysis of risk assessment in public-private partnership projects

Scenario analysis is a method that allows you to predict various future events based on different assumptions about the future. This method involves the construction of several scenarios reflecting different scenarios, on the basis of which possible consequences for the project can be assessed. For risk analysis in PPP, it is important to take into account variables that can significantly affect the project, such as changes in the economic environment, political conditions, or technological innovations.

The scenario analysis process usually consists of several stages: identifying key variables, building scenarios (optimistic, pessimistic, baseline), and estimating the probabilities for each scenario. Especially important is the stage of identifying critical variables, such as fluctuations in the cost of resources, changes in the legislative environment or possible social protests that may lead to delays in the implementation of the project.

When building risk scenarios in PPP projects, it is important to identify the main variables that can affect the result. Such variables include macroeconomic indicators (interest rates, inflation), political factors (change of governments, legislative initiatives), technological innovation (introduction of new technologies in construction or management) and social aspects (changes in the needs of citizens or social movements).

The development of scenarios involves the formulation of several options for the development of events: an optimistic scenario in which all conditions are favorable; pessimistic, where most factors negatively affect the project, and the baseline scenario, which is the most likely, but takes into account certain risks. It is important that these scenarios reflect possible changes in many aspects, such as material prices, political decisions, or social sentiment (Tkachenko, 2022).

Scenario analysis has been successfully applied in real PPP projects around the world. One of the most striking examples is the project to build a bridge across the strait in the UK. This project considered various development scenarios, including the possibility of an increase in the cost of building materials, changes in the political situation, and social protests. The assessment of various scenarios significantly reduced risks and ensured the successful implementation of the project (Patel & Edwards, 2022).

Another important example is an infrastructure project in India that involved the construction of a new airport in one of the country's major cities. Scenario analysis was used to assess risks such as changes in the political situation in the country, fluctuations in exchange rates, possible natural disasters and changes in demand for air transportation.

The main scenarios were as follows:

1 – *Optimistic* scenario**:** infrastructural development contributes to stable economic growth, demand for air travel is growing, investments from private partners exceed expectations.

2 – *Pessimistic* scenario**:** political changes lead to changes in legislation, which complicates the implementation of the project, and financial problems arise due to changes in exchange rates.

3 – *Baseline* scenario: construction delays due to unpredictable changes in demand for air travel or natural disasters, but the project is still completed with minimal damage.

The scenario analysis helped to identify strategic directions for overcoming the negative impacts on the project. This included hedging currency risks, creating reserves in case of

political instability, and developing alternative financing schemes to minimize possible financial losses (Green, 2021).

Another example is projects in the field of healthcare, where scenario analysis helped to predict possible changes in demand for medical services, the impact of new technologies on the effectiveness of treatment, and changes in funding from the state budget. Risk assessment using scenarios made it possible to minimize negative consequences and reduce uncertainty in cost planning (Jones, 2021).

In Ukraine, scenario analysis was also actively used for the implementation of PPP projects in the field of healthcare. One of the largest projects was the construction of new hospitals in regions where there are not enough medical facilities to meet the needs of the population. Risk assessment was particularly important due to potential funding issues, changing requirements for healthcare services, as well as the impact of the COVID-19 pandemic on demand for healthcare services. The use of scenario analysis helped to adapt funding and prepare the project for different scenarios, which ensured stability and reduced the level of risks for all participants in the partnership (Kovalchuk, 2022).

Scenario analysis has several significant advantages compared to other risk assessment methods. It allows you not only to predict probable events, but also to respond flexibly to changes, as it includes several possible scenarios for the development of events. This allows the project parties to have a clear idea of how to adapt their strategies depending on which scenario comes true. However, there are also limitations to the use of scenario analysis. One of them is the difficulty in accurately predicting some variables, such as political or social factors. In addition, building multiple scenarios requires significant resources for data collection and analytical work, which may not be available to some organizations (Sidorov, (2021).

The main stages of scenario analysis are shown in Figure 3.

Fig. 3 – The main stages of scenario analysis in the field of water supply and sewerage services (*Source*: Authors' elaboration)

First, let's identify the main risks in the implementation of public-private partnership (PPP) projects in the water supply and sewerage sector (Table 2).

Table 2 – Risks of the PPP project in the water supply and sewerage sector (*Source*: Authors' elaboration)

Name of the risk group	Examples	Impact on the project
Political risks	Changes in legislation, change of government, instability	May affect financing conditions or tax benefits
Financial risks	Rising interest rates on loans, devaluation of the hryvnia	Increase in the cost of financing
Economic risks	Inflation, falling demand for services	Decrease in expected revenues
Technological risks	Lag in technology adoption	Rising operating costs
Legal risks	Litigation, changes in the legal framework of PPP	Possibility of contract termination

The next step is to form three possible scenarios for the development of events: optimistic, basic (realistic) and pessimistic as shown in Figure 4.

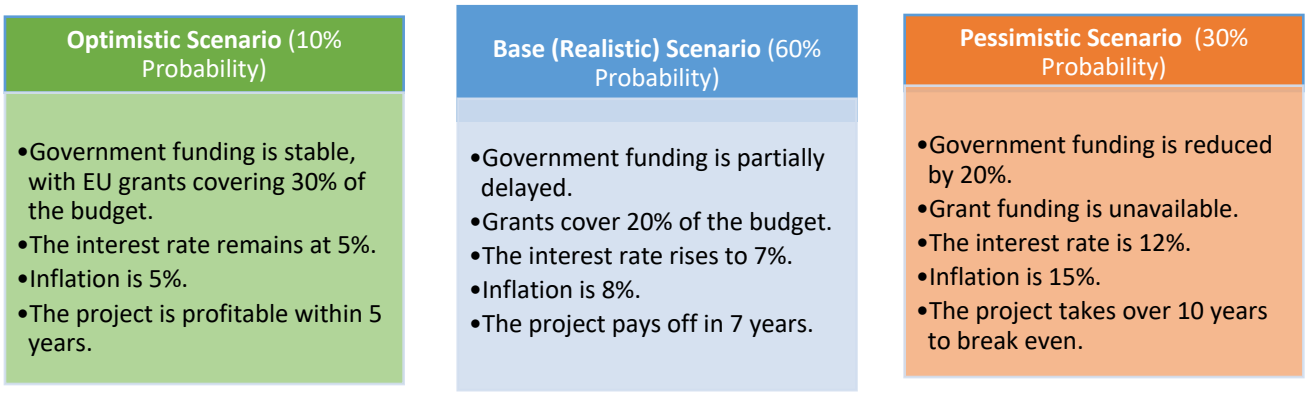

Fig. 4 – Scenarios for the implementation of the PPP project in the field of water supply and sewerage (*Source*: Authors' elaboration).

Suppose that an initial investment of USD 100 million is required to modernize the company's water supply network, the expected operating income varies according to scenarios, operating expenses account for 30% of revenue, and the discount rate depends on financial risks.

The input data for scenario analysis is given in Table 3 (see next page). Based on the input data, we will calculate the financial indicators of the PPP project in the field of water supply and sewerage in all possible scenarios.

To assess the effectiveness of the project, we will use the following indicators: NPV (Net Present Value), IRR (Internal Rate of Return) and Payback Period.

Table 3 – Input data for assessing PPP project implementation scenarios in the field of water supply and sewerage (*Source*: Authors' elaboration)

Parameter	Optimistic scenario	Realistic scenario	Pessimistic scenario
Initial investment (USD million)	100	100	100
Annual revenue (USD million)	30	25	20
Operating expenses (% of income)	30%	35%	40%
Net cash flow (USD million)	21	16.25	12
Public funding (%)	50%	40%	30%
Grant funding (%)	30%	20%	0%
Credit financing (%)	20%	40%	70%
Interest rate on the loan	5%	7%	12%
Discount rate (%)	8%	10%	15%

The net present value (NPV) is calculated using the formula:

$$NPV = \sum \frac{CF_t}{(1+r)^t} - I \quad (1)$$

where:

- CF_t is cash flows in each year;
- r is the discount rate;
- t is the number of the year;
- I is the initial investment.

The internal rate of return (IRR) formula is calculated by finding r, at which NPV=0.
The payback period (PP) is calculated according to the formula:

$$PP = \frac{\text{Investments}}{\text{Net Annual Profit}} \quad (2)$$

The results of the calculations are given in Table 4 (see next page).
We believe that the following key measures should be taken to reduce risks:

- create a reserve fund (10-15% of the budget) to cover financial delays;
- attract EU grant funds to reduce the debt burden;
- choose loans with a fixed rate to minimize the impact of rate increases;
- apply hedging of currency risks when attracting international financing;
- to carry out permanent monitoring of changes in legislation to prevent legal risks.

Table 4 – Estimated performance indicators of the PPP project in the field of water supply and sewerage depending on scenarios (*Source*: Authors' elaboration).

Script	NPV (USD million)	IRR (%)	Payback (years)	Risks	Measures
Optimistic	40.91	14%	4.8	Minimal risks	Use more grant funds
Realistic	-0.05	9.5%	6.2	Possible financial difficulties	Diversification of financing, insurance
Pessimistic	-39.7	4%	8.3	High debt pressure, low profitability	Revision of the business model, change of financial sources

5 – Financial risks and assessment of the effectiveness of various financing schemes for public-private partnership projects

When implementing public-private partnership (PPP) projects in the water supply and sewerage sector, financial risks have a great impact on the success of the partnership, the list of which is given in Table 5.

Table 5 – Financial risks of the PPP project in the field of water supply and sewerage (*Source*: elaboration of the Authors).

Risk type	Possible impact on the project	Probability (Low/Medium/High)
Risk of lack of funding	The state/private partner cannot finance the project on time, which leads to a delay or stop in construction	Average
Risk of changes in the cost of credit capital	Increasing interest rates increases the financial burden	High
Risk of lack of grant funds	The project becomes less profitable, it is possible to reduce the scale of work	Average
Risk of currency fluctuations	When attracting international loans or grants, costs may increase due to the devaluation of the national currency	High
Risk of delay in budget financing	The state does not fulfill its obligations on time, which leads to the suspension of the project	High
Risk of budget overrun	Real costs may be higher than planned, which requires additional resources	High

Let's analyze *three schemes* for financing PPP projects (Figure 5) in the field of water supply and sewerage using the scenario analysis methodology.

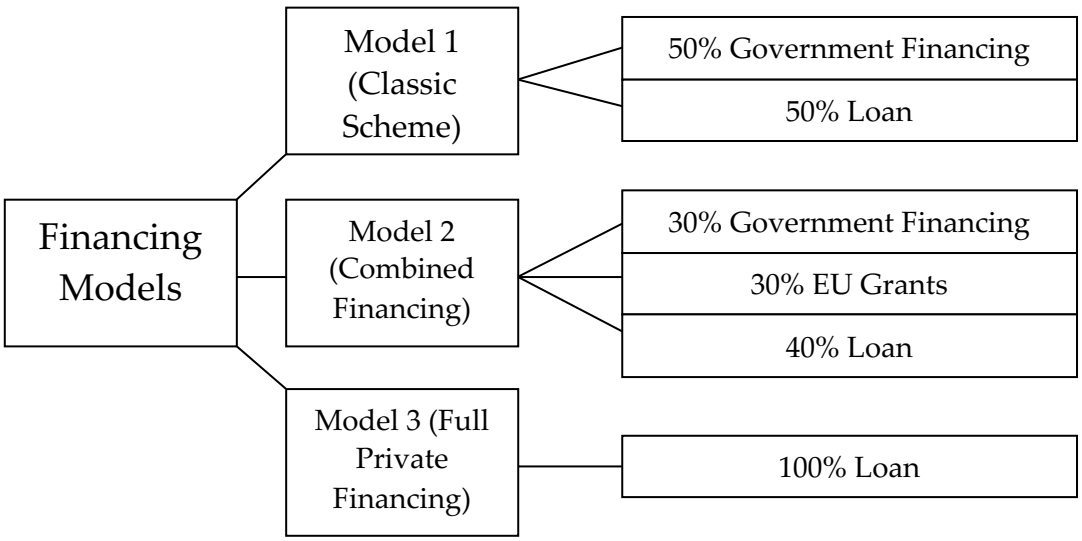

Figure 5 – Models of financing PPP projects in the field of water supply and sewerage (*Source*: Authors' elaboration).

Suppose that an initial investment of USD 100 million is required to modernize the company's water supply network, the expected operating income is USD 30 million/year, operating costs are 30% of revenue, the discount rate is 10%, and the project duration is 10 years.

We will evaluate various financing schemes.

5.1 – Model 1: *Classic scheme (50% government funding + 50% loan)*

Calculation hypothesis:

1 – the state invests USD 50 million., the rest is financed by a loan (USD 50 million);

2 – interest rate on the loan – 10%;

3 – repayment of the loan in equal installments over 10 years.

The calculation of the *cost of credit* financing is carried out according to the formula:

$$R = P \times r / (1-(1+r)^{-n} \quad (3)$$

where:

- R is the annual payment;
- P is loan amount (UAH 50 million);
- r is the annual interest rate (10%);
- n is the number of years (10).

The calculation gives an annual payment of 8.14 million dollars, NPV = 10 million dollars.

The *risks* of the classical financing model include:

- high credit pressure on a private partner;- dependence on budget financing;
- possible increase in lending rates in the future.

5.2 – Model 2: *Combined funding (30% budget + 30% EU grants + 40% loan)*

Calculation hypothesis:

1 – The state finances USD 30 million;

2 – grants cover USD 30 million;

3 – a private partner takes out a loan for USD 40 million. at 8% per annum.

The estimated cost of loan financing is USD 5.83 million/year, NPV = USD 10 million.

Combined funding is characterized by the following *risks*:

- dependence on receiving grants (if the grant is not provided, the model will fail);
- transparent reporting is required for grant programs.

5.3 – Model 3: *Full Private Financing (100% Loan)*

Calculation hypothesis:

1 – The private partner fully finances the project with a bank loan;

2 – loan rate – 12%;

3 – payment in equal installments over 10 years.

The estimated cost of loan financing is USD 17.7 million/year, NPV = - USD 5 million. (unprofitable project). The characteristic *risks* are

- high credit pressure
- risk of rising interest rates.

A comparative analysis of the three financing models is synthesized in Table 6.

Table 6 – Comparative analysis of PPP financing models in the field of water supply and sewerage (*Source*: Authors' elaboration)

Model	Sources of funding	NPV (USD mln)	Risks	Payback (years)
Classic	50% power, 50% credit	10	Dependence on budget financing	6.5
Combined	30% state, 30% grants, 40% credit	25	Dependence on grants	5.2
Private financing	100% credit	-5	Very high credit load	10+

As you can see, combined model (grants + budget + credit) is the most effective, because it allows you to reduce credit pressure and get a positive financial effect.

100% loan financing is too risky, because a high interest rate makes the project unprofitable.

The classic scheme (50% budget + 50% loan) is possible, but has an average profitability.

Financial risk management strategies should be as follows:

- creation of a reserve fund (10-15% of the budget) to cover unforeseen expenses;
- fixing the interest rate on a loan or attracting loans with preferential terms;
- involvement of international financial institutions (EBRD, World Bank) to reduce risk;
- diversification of funding sources (combination of budget funds, loans and grants).

6 – Conclusions

Public-private partnership projects in the water supply and sewerage sector of Ukraine present a vital mechanism for attracting private capital to modernize essential infrastructure. However, the successful implementation of such projects is significantly constrained by a complex spectrum of risks—financial, technological, legal, political, social, and military—which must be systematically identified, assessed, and managed throughout the project lifecycle.

This study provides a comprehensive classification and analysis of risks inherent in PPP initiatives and offers an innovative approach to their assessment through scenario analysis. By constructing optimistic, realistic, and pessimistic scenarios, the analysis enables stakeholders to anticipate project outcomes under various conditions and to design adaptive financial and managerial strategies. Notably, the study demonstrates that scenario analysis not only enhances predictive accuracy but also strengthens decision-making by accounting for multidimensional uncertainties.

The financial modeling results underline the critical importance of selecting appropriate financing structures. Among the three examined models, the combined scheme—incorporating public funding, international grants, and loans—proved to be the most viable, offering a balanced distribution of financial responsibility and optimal project outcomes. Conversely, the fully private model, relying exclusively on credit financing, revealed high financial vulnerability, with negative net present value and prolonged payback periods, making it economically inefficient under current conditions.

The analysis further indicates that effective risk mitigation requires a set of interrelated measures, including the creation of reserve funds, use of fixed-rate loans, active engagement with international financial institutions (e.g., EBRD, World Bank), and improved legal protections for private partners. Particular emphasis is placed on the need for legal and institutional reforms that enhance the transparency, consistency, and reliability of the regulatory environment governing PPPs in Ukraine.

Moreover, the study highlights the dynamic nature of risk across different stages of PPP project development—from planning and financing to construction, operation, and final handover. Each stage demands tailored risk management instruments and the proactive involvement of both public authorities and private entities. The identification of stage-specific risks and countermeasures contributes to the resilience and sustainability of PPP infrastructure projects, particularly in the volatile Ukrainian socio-economic and geopolitical context.

The findings of this research contribute significantly to the theoretical and practical understanding of PPP risk management in transitional economies. They offer concrete policy recommendations for improving the effectiveness of PPP implementation, with potential applicability not only in Ukraine but also in other countries facing similar infrastructural and financial challenges. Further research should explore the integration of digital tools and real-time monitoring systems to enhance the responsiveness of risk management frameworks in PPP environments.

7– References

Amelio, S., Gazzola, P., Biancone, P., & Brescia, V. (2024). Sustainability and performance evaluation in third sector partnerships: the case of turin fast track city. *Financial Accountability & Management*, *41*(2), 381-397.

Ameyaw, E. E., & Chan, A. P. (2015). Risk ranking and analysis in PPP water supply infrastructure projects: An international survey of industry experts. *Facilities, 33*(7/8), 428-453.

Babiak, N. D. (2014). Risk control of public-private partnership projects. *Finances of Ukraine, 6*, 95-111.

Bogdanova, I. M. (2021). Risk Assessment in the Management of Public-Private Partnership Projects. *Actual Problems of Economics and Management*, 45-58.

Dymchenko, O. V., Khailo, Y. M., & Khailo, V. O. (2024a). Organizational and managerial aspects of regional development of life support enterprises of cities. *Electronic scientific publication "Public Administration and National Security*", №9. Retrieved from: https://doi.org/10.25313/2617-572X-2024-9-10333

Dymchenko O., Sepashvili E., Gazzola P., & Slavata D. (2024b). Capabilities of utility enterprises in the entrepreneurial context. Entrepreneurship and Business Administration in Wartime: Modern Challenges, Trends and Transformations. *Materials of the International Conference. Scientific and Practical Internet Conference*, Kharkiv, NUUE, 372. Retrieved from: https://eprints.kname.edu.ua/65283/1/%D0%97%D0%B1%D1%96%D1%80%D0%BD%D0%B8%D0%BA%202024.pdf

Giorgetto, S. A. (2021). Risk and crisis management. An overview. *Economia Aziendale Online,*12(1), 1-12.

Green, A. (2021). Risk Assessment in Infrastructure Projects. *Journal of Infrastructure and Development, 35*(2), 98-115.

Grimsey, D., & Lewis, M. K. (2002). Evaluating the risks of public private partnerships for infrastructure projects. *International journal of project management, 20*(2), 107-118.

Jones, P. (2021). Health Sector PPPs: Risk Assessment and Management. *Journal of Health Economics*, *29*(4), 345-360.

Kovalchuk, T. V. (2022). Risk Management in PPP Projects in Ukraine. *Economics and Management in the Context of Globalization,* 67-81.

Papagiannis, F., Gazzola, P., Burak, O., & Pokutsa, I. (2018). Overhauls in water supply systems in Ukraine: A hydro-economic model of socially responsible planning and cost management. *Journal of cleaner production,* 183, 358-369.

Papagiannis, F., Gazzola, P., Burak, O., & Pokutsa, I. (2021). A European household waste management approach: Intelligently clean Ukraine. *Journal of environmental management*, 294, 113015.

Papagiannis, F., Gazzola, P., Slavata, D., & Grechi, D. (2022). Designing successful business strategies for private public partnerships: an ontological approach. *Kybernetes, 51*(2), 641-658.

Patel, J., & Edwards, R. (2022). Public-Private Partnerships: Risk Management Frameworks. *International Journal of Project Management*, *40*(3), 233-250.

Riso, V., & Castellini, M. (2019). Poor integration between operational risk management activities and internal control system in the municipalities: an analysis of the Italian legislative framework. *Economia Aziendale Online*, *10*(1), 149-158.

Romanenko, O. (2023). Risk management of public-private partnership. Financial and Information-Analytical Support for Business Security in the Conditions of a Wartime Economy and Post-War Recovery. *Materials of the XII International Scientific and Practical Conference*, Kharkiv, 254-257. Retrieved from:

https://eprints.kname.edu.ua/65790/1/%D0%A2%D0%B5%D0%B7%D0%B8%D1%81%D0%B8_2023_2-254-257.pdf

Romanenko, O. (2025). Mechanism for implementing public-private partnership in water supply and sewerage enterprises. *Municipal Economy of Cities*, *2*(190), 15–21. DOI: https://doi.org/10.33042/2522-1809-2025-2-190-15-21

Sancino, A. (2010). L'attuazione del paradigma della public governance negli enti locali: implicazioni per il management. *Economia Aziendale Online*, 1(1), 49-58.

Selleri, L. (2016). L'Enterprise Risk Management quale sistema di protezione e di creazione di Valore. *Economia Aziendale Online-*, *7*(3), 153-163.

Selleri, L. (2018). L'impresa e la Gestione del Cambiamento: dal Fronteggiamento dei Rischi Imprevedibili alla Disruptive Innovation. *Economia Aziendale Online*, *9*(2), 205-239.

Sidorov, V. M. (2021). Risk Management in Large Infrastructure Projects. *Kharkiv University of Economics*, 150-175.

Tkachenko, S. V. (2022). Methods and Tools of Risk Analysis in PPP. *Economic Analysis and Strategic Management*, 112-127.