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DIGITALIZATION OF PUBLIC-PRIVATE PARTNERSHIP PROJECT ASSESSMENT AND CONCEPT DEVELOPMENT THROUGH AN ELECTRONIC PLATFORM: THE CASE OF WATER MANAGEMENT

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Abstract: The digitalization of Public-Private Partnership project assessment is becoming an increasingly important mechanism for improving the transparency, efficiency, and quality of infrastructure investment decisions, particularly in the water management sector where projects involve substantial capital requirements, long implementation periods, complex technical systems, environmental considerations, and significant operational risks. This article develops an integrated electronic-platform framework for the identification, screening, assessment, financial and economic evaluation, risk allocation, concept development, procurement preparation, and subsequent monitoring of Public-Private Partnership projects in water management, with particular attention to its potential application in Uzbekistan.

Key words: Digitalization, partnership, infrastructure, water, assessment, investment, finance, risk, platform, governance.

INTRODUCTION

Public-Private Partnership has become an important mechanism for attracting private investment, technologies, managerial expertise, and operational capabilities to the development and modernization of public infrastructure. This approach is particularly relevant to the water management sector, where infrastructure projects require substantial long-term investment and are closely connected with economic development, agricultural productivity, environmental sustainability, and the efficient use of water resources. At the same time, the assessment of water management projects involves numerous technical, financial, economic, environmental, and institutional factors, which makes the quality and transparency of project preparation especially important.

The preparation of Public-Private Partnership projects traditionally involves several institutions and separate stages of assessment, which may lead to fragmented information, duplicated procedures, delays, and difficulties in coordinating project decisions. The use of an electronic platform can help address these challenges by integrating project information, assessment procedures, financial analysis, risk evaluation, concept development, and monitoring within a unified digital environment. Such digitalization can improve the consistency of project assessment, reduce administrative costs, strengthen transparency, and support more evidence-based investment decisions.

The relevance of this approach is increasing in Uzbekistan as the country develops its Public-Private Partnership framework and introduces digital mechanisms for project management. The application of these mechanisms to water management can support the modernization of irrigation infrastructure, pumping stations, water supply systems, and other water-related facilities by improving the preparation and evaluation of investment projects. In this context, the present study aims to

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develop a conceptual approach to the digitalization of Public-Private Partnership project assessment and concept development through an electronic platform, with particular attention to the specific requirements of water management projects and the potential of digital technologies to improve infrastructure decision-making.

METHODOLOGY

The research employs systemic, analytical, comparative, and risk-based approaches to examine the digitalization of Public-Private Partnership project assessment in the water management sector. The systemic approach considers technical, financial, economic, institutional, environmental, and social factors as interconnected elements of project development, while the comparative approach examines the differences between conventional project preparation and an integrated electronic-platform model. Financial, economic, and risk analysis are used to assess project feasibility, potential benefits, affordability, and the appropriate allocation of risks between public and private partners.

The study also draws on international approaches to Public-Private Partnership project assessment, feasibility analysis, financial sustainability, and value-for-money evaluation. The proposed electronic platform is considered as an integrated decision-support environment that brings together project information, feasibility assessment, financial analysis, risk evaluation, concept development, and monitoring. This approach allows digitalization to be viewed not simply as the electronic processing of documents, but as a means of improving the efficiency, consistency, and transparency of project preparation and decision-making.

MAIN PART

Digital transformation of public-private partnership project preparation. The digitalization of Public-Private Partnership project preparation should be understood as a transformation of the entire project development process rather than a simple transition from paper-based documentation to electronic documentation. If an existing administrative procedure is transferred to a digital environment without changing its underlying logic, many of the inefficiencies associated with traditional project preparation will remain. A genuine digital system should instead establish a unified project information environment in which the same verified data can be used for technical, economic, financial, legal, environmental, and institutional analysis. Such a system should allow the project initiator to create a single digital project profile that contains the fundamental characteristics of the proposed investment and subsequently allows authorized institutions, consultants, financial organizations, and other stakeholders to work with relevant information according to their responsibilities. The project profile should include the project location, strategic objectives, existing infrastructure, proposed technological solution, expected capacity, estimated capital expenditure, operating expenditure, expected service outputs, potential beneficiaries, potential revenue sources, proposed payment mechanisms, required public support, environmental and social characteristics, land requirements, preliminary risk allocation, proposed contract structure, expected implementation period, and potential private-sector participation. The establishment of such a unified information structure can substantially reduce duplicated data collection, improve consistency among analytical documents, and create a transparent record of how the project develops from its initial idea into a structured investment proposal.

The electronic platform should also introduce standardized assessment procedures that allow projects to be evaluated according to clearly defined criteria. Instead of relying exclusively on individually prepared documents, the platform can establish a sequence of analytical stages through

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which each proposed project must pass. These stages can include strategic screening, technical assessment, economic evaluation, financial analysis, legal and institutional assessment, environmental and social screening, risk analysis, and Public-Private Partnership suitability assessment. The results of each stage can be stored within the project profile and used as inputs for subsequent stages. Such an arrangement would allow decision-makers to identify weaknesses at an early stage and prevent significant resources from being spent on projects that are technically infeasible, financially unsustainable, economically unjustified, or institutionally unprepared. Therefore, the electronic platform should function as a mechanism for improving the quality of project decisions rather than simply accelerating administrative procedures.

Preliminary screening of water management projects. The first analytical stage of the proposed electronic system should be the preliminary screening of potential water management projects. Water-sector institutions may generate a large number of investment proposals involving irrigation systems, pumping stations, drainage networks, reservoirs, water supply facilities, wastewater treatment infrastructure, water-saving technologies, and digital monitoring systems. However, the existence of an infrastructure need does not automatically mean that a Public-Private Partnership is the most appropriate implementation mechanism. Some projects may be more effectively implemented through public investment, international development financing, concessional loans, grants, or other financing instruments. Consequently, the electronic platform should distinguish between the public necessity of a project and the suitability of Public-Private Partnership as a delivery and financing mechanism.

The preliminary screening process can be based on several interconnected criteria, including strategic relevance, technical feasibility, demand, financial potential, economic benefits, private-sector interest, risk profile, environmental impact, social importance, and institutional capacity. Strategic relevance determines whether the proposed project corresponds to national development objectives and water-sector priorities. Technical feasibility considers whether the proposed infrastructure and technology can be implemented under existing geographical, climatic, and engineering conditions. Demand assessment examines whether there is a sufficient need for the services to be provided by the project. Financial analysis determines whether the project can generate sufficient revenues or whether public financial support will be required. Economic assessment considers wider benefits to agriculture, households, businesses, the environment, and the national economy. Risk analysis identifies major uncertainties, while institutional assessment examines whether the public authority has sufficient capacity to prepare, procure, and manage a long-term Public-Private Partnership contract. By combining these criteria, the platform can classify projects according to their readiness and suitability for further preparation.

The use of standardized screening criteria would also improve comparability between different projects. Decision-makers would be able to examine several proposed projects using the same analytical framework and determine which projects should receive priority for further preparation. The platform could automatically identify missing information, highlight critical weaknesses, and assign preliminary project-readiness categories. A project with strong strategic relevance but insufficient financial information could be returned for further analysis rather than rejected immediately, while a project with severe technical or environmental constraints could be identified at an early stage. This approach would help public institutions allocate limited preparation resources more effectively.

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Technical feasibility assessment. Technical feasibility is one of the fundamental components of water management project assessment because the long-term performance of infrastructure depends on the quality of its design, construction, rehabilitation, operation, and maintenance. The electronic platform should therefore collect detailed information about the existing condition of infrastructure, technical capacity, required rehabilitation, proposed technology, construction requirements, energy consumption, water-saving potential, operational requirements, maintenance needs, expected asset life, and exposure to natural and climate-related hazards. For existing pumping stations, for example, the system could contain information about the age and technical condition of pumps, electricity consumption, pumping capacity, frequency of failures, maintenance costs, water delivery volumes, and historical operational performance. Such information would allow the platform to establish a digital baseline against which the expected results of modernization could be measured.

The integration of technical information with financial and economic analysis is particularly important. A technologically advanced solution may require higher initial investment but produce lower operating costs over the project life cycle. Conversely, a solution with lower initial investment may generate substantially higher energy and maintenance costs. Therefore, technical assessment should not be isolated from financial modelling. The platform should enable alternative technological scenarios to be compared according to capital costs, operating costs, energy consumption, maintenance requirements, expected service quality, environmental impacts, and asset life. This would allow decision-makers to evaluate the total life-cycle implications of different technical solutions rather than selecting projects solely on the basis of initial construction costs.

Financial assessment and digital modelling. Financial assessment should determine whether a water management project can maintain sustainable financial performance throughout its implementation and operational period. The electronic platform should include a financial modelling module capable of calculating expected revenues, operating expenditures, maintenance expenditures, financing costs, taxes, debt obligations, public payments, and other relevant financial flows. Depending on the structure of the project, revenues may originate from user payments, service charges, government availability payments, performance-based payments, or other legally permitted sources. The platform should allow different financing structures to be compared and should identify the extent to which public financial support may be required to make the project commercially viable.

The financial model should calculate major investment indicators such as Net Present Value, Internal Rate of Return, Debt Service Coverage Ratio, payback period, life-cycle costs, and the expected level of public financial commitments. However, these indicators should not be considered independently. Water management projects are exposed to changes in demand, inflation, energy prices, interest rates, exchange rates, water availability, and tariff policies. Consequently, the platform should include scenario and sensitivity analysis. A baseline scenario could reflect expected market and operational conditions, while alternative scenarios could examine higher construction costs, lower demand, increased energy prices, reduced water availability, or higher maintenance requirements. Such scenario analysis would enable decision-makers to determine whether the project's financial structure remains sustainable under adverse conditions and whether additional risk-mitigation mechanisms are necessary.

Economic assessment and public benefits. Financial sustainability does not necessarily correspond to economic viability in the water sector. A water management project can generate substantial benefits for society even when direct revenues are insufficient to provide high financial

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returns to a private investor. For example, modernization of irrigation infrastructure may reduce water losses, improve water delivery reliability, reduce electricity consumption, increase agricultural productivity, improve rural livelihoods, and strengthen resilience to drought. These benefits may be distributed across farmers, households, businesses, public institutions, and the wider economy rather than being captured directly by the project company. Therefore, the electronic platform should include a separate economic assessment module that considers the broader economic and social value generated by the project.

Economic assessment should incorporate measurable and, where possible, monetized benefits and costs. The benefit-cost ratio can be used to compare the present value of economic benefits with the present value of economic costs, while sensitivity analysis can examine how the results change under different assumptions. In addition to quantitative indicators, the assessment should consider qualitative outcomes such as improved water security, environmental protection, climate resilience, and social equity. This broader approach is particularly important for public infrastructure because government decisions should reflect not only the profitability of an individual project but also its contribution to long-term public welfare.

Risk identification and allocation. Risk allocation represents one of the most critical elements of Public-Private Partnership structuring. The basic principle should be that each risk is allocated to the party that is best able to control, mitigate, or manage it at the lowest reasonable cost. An electronic platform can strengthen this process by establishing a standardized risk register for each project. The risk register should include construction risks, land and site risks, geological risks, hydrological risks, demand risks, tariff risks, inflation risks, interest-rate risks, foreign-exchange risks, energy-price risks, environmental risks, climate risks, regulatory risks, operational risks, maintenance risks, technological risks, and force-majeure risks. Each risk should be assessed according to its probability, potential financial impact, operational consequences, and possible mitigation measures.

For example, construction delays and construction-cost overruns may generally be allocated primarily to the private partner when the private partner controls design and construction activities. Operational-performance risks may similarly be allocated to the private operator when the operator has direct control over service delivery and maintenance. Regulatory and policy risks may require greater participation by the public partner because government authorities control the regulatory environment. Extreme hydrological events, depending on their nature and contractual arrangements, may require shared allocation. The electronic platform can support this process by generating preliminary risk-allocation matrices based on project characteristics, while final allocation should remain subject to detailed legal, financial, and contractual analysis. A standardized digital approach can improve transparency and reduce the likelihood that major risks remain unidentified until after contract signing.

Development of the project concept through an electronic platform. The transition from an initial project idea to a complete Public-Private Partnership concept represents a decisive stage in project preparation. The project concept should clearly explain the problem to be addressed, the infrastructure or service required, the proposed technical solution, the expected outputs, the financing structure, the responsibilities of the public and private partners, the main risks, the expected benefits, and the justification for using Public-Private Partnership rather than an alternative procurement mechanism. The electronic platform can transform these requirements into a structured digital workflow in which project information is progressively developed and verified. Instead of preparing

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the same information repeatedly in separate documents, the platform can use the project profile and results of earlier analytical stages to automatically populate relevant sections of the concept document.

The concept-development module should include strategic, technical, financial, economic, institutional, legal, environmental, social, and risk-related sections. The strategic section should describe the policy problem and project objectives. The technical section should define infrastructure scope, capacity, technology, implementation schedule, and service requirements. The financial section should describe investment needs, operating costs, revenue sources, and potential public support. The Public-Private Partnership structure should define the responsibilities of each partner, contract duration, payment mechanisms, service standards, and performance requirements. The risk section should present the principal risks and proposed allocation. Environmental and social sections should describe potential impacts and mitigation measures. By combining these elements within one electronic environment, the platform can produce a standardized and analytically supported preliminary project concept that can subsequently be reviewed by the responsible authorities.

Value-for-money assessment. The decision to use Public-Private Partnership should be based not merely on the availability of private financing but on whether the partnership arrangement provides better overall value for the public sector than alternative procurement and financing options. The electronic platform should therefore compare the expected life-cycle cost of a Public-Private Partnership structure with an appropriate public procurement alternative. The comparison should consider construction costs, operating costs, maintenance costs, financing costs, transferred risks, public financial obligations, service quality, expected efficiency gains, and residual asset value. This analysis should also take into account the distribution of risks between the public and private partners because the transfer of a risk to the private sector may have financial value even when the project costs are higher in nominal terms.

Value-for-money analysis should not be treated as a one-time exercise conducted only at the beginning of project preparation. Project assumptions may change during detailed feasibility studies, market consultations, procurement, and contract negotiations. Therefore, the electronic platform should allow the assessment to be updated at predefined decision points. This stage-gate approach would enable authorities to reconsider whether Public-Private Partnership remains appropriate when significant changes occur in investment costs, financing conditions, risk allocation, expected demand, or public financial commitments. Such continuous assessment would reduce the possibility of approving a project based on outdated assumptions.

Digital management of the entire project life cycle. An effective electronic platform should cover the entire life cycle of a Public-Private Partnership project rather than stopping at project approval. The first stage should involve digital project initiation and registration, followed by preliminary screening and feasibility assessment. The next stages should include concept development, detailed feasibility studies, financial structuring, risk allocation, value-for-money assessment, institutional approval, procurement, contract award, contract management, operational monitoring, and post-project evaluation. At each stage, the system should record decisions, responsible institutions, supporting documents, assumptions, changes, and approvals. This would create a continuous digital history of the project and allow authorized stakeholders to understand how and why project parameters changed over time.

The operational phase is particularly important because the ultimate success of a water management Public-Private Partnership should be measured by actual service performance rather than

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by the completion of construction alone. The platform should therefore monitor indicators such as water losses, energy consumption per unit of water delivered, pumping efficiency, infrastructure availability, frequency of service interruptions, maintenance response time, water-delivery reliability, irrigation efficiency, operational cost, payment collection, environmental compliance, and customer complaints. If actual performance deviates significantly from contractual requirements, the system can generate alerts for responsible institutions. This creates a transition from periodic manual reporting to continuous performance-based monitoring and can strengthen the accountability of both public and private partners.

Integration with digital water technologies. The effectiveness of an electronic Public-Private Partnership platform can be significantly increased through integration with existing and emerging digital water technologies. Geographic Information Systems can provide spatial information about infrastructure, water sources, irrigation networks, pumping stations, reservoirs, and service areas. Internet of Things devices can provide real-time information about water flow, pressure, energy consumption, equipment condition, and other operational variables. Supervisory Control and Data Acquisition systems can support the monitoring and control of infrastructure operations. Smart meters can improve measurement and billing, while remote sensing can provide information about irrigation areas, water availability, land use, and environmental conditions. Artificial intelligence can be applied to demand forecasting, anomaly detection, predictive maintenance, risk assessment, and identification of unusual operational patterns.

The integration of these technologies would fundamentally change the nature of project assessment. Instead of relying exclusively on historical reports and static technical studies, the electronic platform could continuously receive operational information and compare actual performance with assumptions used in the original financial and economic models. For example, if a modernized pumping station consumes less electricity than expected, the platform could update the project's operating-cost indicators and estimate the resulting economic benefits. If water availability declines because of climatic conditions, the system could evaluate the effect on service output, revenues, and contractual obligations. Consequently, digital integration would make project management more adaptive and evidence-based.

Application to Uzbekistan's water management sector. The proposed framework is particularly relevant to Uzbekistan because water management represents a strategically important component of national economic and agricultural development. The modernization of irrigation infrastructure, reduction of water losses, improvement of pumping efficiency, and introduction of modern operational technologies require substantial investment and long-term institutional coordination. At the same time, the development of Public-Private Partnership mechanisms in Uzbekistan creates opportunities to attract private capital and expertise into infrastructure modernization. Recent initiatives involving the modernization and operation of irrigation pumping stations demonstrate the growing practical relevance of this approach.

The development of a unified electronic platform for Public-Private Partnership project management provides an important institutional basis for integrating these processes. A water-management project registered in the system could contain information about the technical condition of infrastructure, historical energy consumption, water-delivery volumes, rehabilitation requirements, estimated investment costs, projected operating expenses, expected service improvements, environmental and social impacts, potential revenues, public support requirements, and proposed risk

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allocation. These data could then be used to generate financial scenarios, assess economic benefits, determine the suitability of Public-Private Partnership, and develop a standardized project concept. Such a system would be particularly valuable for large groups of similar infrastructure assets, such as pumping stations, because the electronic platform could compare their technical and economic characteristics and help identify projects with the greatest potential for efficiency improvements.

DISCUSSION

The analysis shows that the main benefit of digitalization in Public-Private Partnership development is not only faster document processing but also improved quality, consistency, and transparency of investment decisions. An integrated electronic platform can connect technical, financial, economic, environmental, and institutional assessments, allowing changes in one area to be reflected in others. This integrated approach is particularly important in water management, where energy costs, water availability, demand, environmental conditions, service quality, and financial sustainability are closely interconnected. By using common data and analytical assumptions, the platform can also support more objective comparison of project alternatives and help determine whether Public-Private Partnership is the most appropriate delivery mechanism.

Digitalization is also important throughout the long-term implementation of water management projects. Since Public-Private Partnership contracts may operate for many years, changes in water resources, energy prices, climate conditions, demand, technology, and maintenance requirements can significantly affect project performance. An electronic platform can continuously compare planned indicators with actual results, improve monitoring and accountability, and provide information for timely decision-making. In this way, digitalization can transform the platform from a project preparation and management tool into a continuous decision-support and institutional learning system for the water sector.

CONCLUSION

The digitalization of Public-Private Partnership project assessment and concept development can significantly improve the quality, transparency, and efficiency of infrastructure decision-making in the water management sector. An electronic platform should serve not only for document submission and storage but also as an integrated environment connecting technical, financial, economic, environmental, institutional, and risk-related information. Such integration can support early project screening, more consistent feasibility assessment, improved risk allocation, and evidence-based project development.

Water management projects require consideration of both financial and wider public benefits, including efficient water use, reliable services, reduced resource losses, environmental protection, and resilience to changing conditions. Therefore, digital assessment should combine different types of analysis and enable continuous monitoring throughout the project life cycle. For Uzbekistan, the development of a unified electronic platform provides an important basis for improving the preparation and management of water infrastructure projects and strengthening cooperation between public and private partners.

Ultimately, the effectiveness of digitalization should be measured by the quality of decisions and project outcomes rather than by the volume of documents processed electronically. An integrated digital platform can transform Public-Private Partnership management into a more transparent, consistent, and data-driven process, contributing to better investment allocation, risk management, infrastructure performance, and sustainable water services.

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