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**Management OF Public–Private Partnerships
for Smart City Projects**

**Patent Activity in Central and Eastern Europe
for the Period 2014-2024**

**The Scientific Interest to "E-Marketplaces" –
a Bibliometric Study**

**Endowment Funding as an Effective form
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MANAGEMENT OF PUBLIC–PRIVATE PARTNERSHIPS FOR SMART CITY PROJECTS

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Abstract: The article focuses on the strategic aspects of the management of public–private partnerships (PPPs) in smart city projects. The global trend toward urbanization requires a transformation for which PPPs serve as a highly important instrument. Traditional management approaches prove insufficient due to the rapid dynamics of digital innovations. The research objective of this study is to identify the defining dimensions of a future comprehensive management model integrating financial flexibility, technological incorporation, and digital citizen participation. The analysis explores financing models, the role of technological innovations, and mechanisms for citizen engagement through digital platforms. The main conclusion is that the success of PPPs depends on adapting to the full technology life cycle and developing administrative (expert) capacity.

Keywords: public-private partnerships, smart cities, strategic management, technological innovations.

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Introduction

To a large extent, the emergence of public-private partnerships (PPPs) is driven by the search for efficient and competitive methods for building infrastructure, as noted in a study by **J. Teicher, Q. Alam, and B. Gramberg** (Teicher, 2006, 72 (1)). Governments adopt PPPs for many reasons.

Often, they face budget constraints that limit their ability to finance infrastructure services. Cost efficiency is at the forefront of the arguments. When contractual agreements are properly drafted, PPPs provide a high “value for money,” consistent with the high expectations placed on them. In the opinion of **L. English** they ensure “the best possible outcome at the lowest possible cost” (English, 2006, 29 (3), p. 254). The private sector must perform well to earn profit from the projects. This performance improves service quality and minimizes costs. Another argument arises from the “bundling” of services. The obligation to build, operate, maintain, and transfer the asset to the state at the end of the contract provides an additional incentive to minimize project costs (English, 2006, 29 (3)). As **M. Biygautane** and **S. Clegg** conclude, this approach achieves maximum service efficiency through effective design and construction of infrastructure projects while maintaining minimal expenditure (Biygautane M, 2024, 8(6): 3668, p. 8).

Global urbanization requires transforming urban (eco)systems toward the model of smart cities. These projects are traditionally capital-intensive and require rapid adaptation to technological progress. PPPs are becoming a critical instrument for implementing this strategic infrastructure, ensuring access to necessary private capital and expert know-how. However, managing these partnerships must go beyond traditional frameworks. The dynamics of digital innovations and the need for civic legitimacy require a new approach.

Our research objective is to examine the strategic aspects of managing PPPs in smart city projects, with a focus on planning and executing these complex initiatives.

Research thesis. The successful implementation of smart city projects through PPPs depends on transitioning to adaptive, strategic management. Traditional operational management is insufficient given the rapid technological change. The research thesis is that the sustainability of PPPs is ensured through a triple integration: flexible financing, immediate technological incorporation, and institutionalized digital participation of stakeholders. Only through such a strategic framework can large-scale urban transformations be achieved.

The structure of the paper follows the logic of the triple integration defined in the thesis above. The initial focus is on the financing and implementation models for strategic infrastructure projects, which constitute the economic foundation of any PPP. The analysis then proceeds to the role of technological and know-how innovations as a factor of efficiency. The concluding section examines the mechanisms for citizen participation enabled through digital platforms. The paper begins with an overview of the key financial concepts applicable to smart city investments.

1. Financing and implementation models for strategic infrastructure projects

The use of the PPP toolkit in this context represents a particularly important form of cooperation - a model that transforms the capacity to implement capital-intensive and innovative initiatives. This approach facilitates *the mobilization of significant private investment* - financial resources that supplement limited public funds. At the same time, it enables the seamless deployment of cutting-edge technologies and managerial innovations by the private sector. The successful strategic financing and implementation of key infrastructure projects (such as smart transport systems, modern energy grids, and advanced digital services) require *precisely structured contractual frameworks, clearly defined strategic goals, and effective distribution of responsibilities* between public and private stakeholders (Ju, 2024, 153, 105295).

A particularly notable example for strategic financing through PPPs is the construction and development of complex smart transport systems. As **G. Lyons** and **C. Davidson** emphasize, these systems integrate multimodal forms of urban mobility, including public transport, electric vehicle fleets, and expanded cycling infrastructure. Within this model, the private sector provides, first, the necessary financial capital and, second - the most important technologies and specialized expertise. This is required for the deployment of IoT (Internet of Things)-based traffic management systems, the development of MaaS (Mobility-as-a-Service) applications, and the construction of extensive charging infrastructure for electric vehicles. The public sector, for its part, acts as the strategic regulator, ensuring the creation of a supportive legal and regulatory framework. It also guarantees that the projects evolve in full alignment with public interests and the long-term strategic objectives for the city's sustainable development (Lyons, 2016, 88).

Another highly significant area of *strategic cooperation (within PPP frameworks)* is the large-scale deployment of *smart energy grids*. In this regard, the private sector often makes *the initial capital investment* for constructing critical infrastructure (including smart metering systems, energy storage solutions, and decentralized generation capacity). Meanwhile, the public sector provides *the necessary regulatory support* for the expansion and liberalization of such grids. It also ensures compliance with strict environmental standards and emission regulations.

Table 1

Models for financing and implementing strategic infrastructure projects through PPP in smart cities

PPP model	Main focus and applicability	Strategic advantages	Challenges and managerial aspects
<i>Build-Operate-Transfer</i>	Full management by the private sector (financing, design, construction, operation for a defined period, followed by transfer to the public sector). Applicable to large-scale infrastructure projects.	Mobilizes private capital and reduces public financial risk; attracts high-tech expertise; stimulates long-term efficiency and innovation.	Requires precise long-term contracts; complex risk allocation; potential conflicts of interest; needs strong public oversight.
<i>Build-Own-Operate</i>	The private sector finances, designs, builds, owns, and operates the facility indefinitely. The public sector procures services. Suitable for highly specialized projects.	Full transfer of financial and operational risks to the private sector; encourages long-term efficiency and maintenance; frees up public resources.	High levels of private-sector control; contract termination can be difficult; necessitates competitive procurement procedures.
<i>Service concessions</i>	Private sector is granted the right to provide a public service (e.g., water supply, waste services) for a specified period while investing in the infrastructure.	Improves service quality and efficiency through private management and technology; distributes investment risk; generates revenues for the public sector.	Requires robust regulatory mechanisms to protect consumers; risk of monopolistic behavior; need for price-setting transparency.

<i>Joint Ventures</i>	Formation of a joint enterprise between public and private partners to carry out a specific project.	Sharing of risks and resources; using synergies from different fields; flexibility of the management structure; facilitating the transfer of knowledge.	A high degree of trust and alignment between partners is required; potential difficulties in decision-making; challenges when “exiting” the partnership.
<i>Work/service contracts</i>	The public sector retains ownership, but assigns the design, construction, or operation to a private company.	Rapid implementation of technologies; access to specialized expertise; relatively lower financial risk for the public sector; flexibility.	The public sector retains a large part of the risk; fewer opportunities for innovation from the private sector; relatively lower long-term efficiency.

Source: Author’s own interpretation

We can add here that the financing and implementation of *digital service* projects is also a very important component of strategic cooperation between the public and private sectors. Smart cities increasingly rely on private partners for the development, implementation, and maintenance of e-government platforms, mobile applications for citizen services, and the construction of high-speed broadband networks. Private companies provide the necessary technologies, innovative solutions, and capital investments, while the public sector strategically ensures that access to these services is inclusive, equitable, and secure for all citizens. At the same time, the principles of data protection and digital equality must be strictly observed.

The assessment presented in Table 1 clearly shows that such models have the potential *to significantly accelerate the implementation of large-scale and complex infrastructure projects* in smart cities. At the same time, they lead to increased *efficiency, innovation, and long-term sustainability*. An important strategic condition for success here is *the precise and fair distribution of responsibilities, risks, and benefits* between the partners (based on transparency and mutual trust). This ensures financial viability. It also guarantees the sustainable implementation of long-term urban initiatives that improve the quality of life for citizens.

2. Using technological innovations and know-how through partnerships

Under contemporary conditions *the strategic integration of technological innovations and specialized know-how* in the management of smart cities is practically inseparable from *close cooperation between the private sector and public authorities*. This interrelation is often conceptualized as “*network governance*” or the “*quadruple helix*”. It enables urban (municipal) administrations to benefit from the expert knowledge and dynamic innovation potential of private companies, while at the same time the public sector provides *the necessary regulatory framework and strategic support* for the sustainable scaling and implementation of innovative solutions in the urban environment.¹

Private companies play *an important role in the innovation process*. They develop and implement *new technologies* that optimize the functioning of urban infrastructure.

Another important aspect of this *strategic partnership is the implementation of smart energy solutions*. Private companies are leading *the development of innovations for optimizing energy consumption*. In this regard, the public sector has *a strategic role* by creating *fiscal incentives and regulatory relief* for investing in sustainable energy technologies, as well as by providing favorable conditions that facilitate the seamless integration of these solutions into the existing urban energy infrastructure.

Public–private partnerships are also a key factor in *introducing innovations in waste management*. Through close cooperation with technological companies, cities have the opportunity to develop and implement *smart platforms for monitoring and managing waste*, as well as programs that optimize the logistics of collection and processing, leading to significant reductions in operational costs and increased resource efficiency. These innovations contribute to substantial resource savings and significantly improved quality of urban services when combined with *commitment and a strategic vision on the part of the public sector*.

Furthermore, (through technological innovations in sustainable construction and smart buildings) private companies can propose cutting-edge approaches to designing and developing infrastructure with a minimal “environmental footprint” and maximum efficiency. As emphasized by **C. Debrah, E. Ohene, L. Weerasinghe, A. Darko and A. Chan**, combining green building practices with digital transformation in construction accelerates the pace of sustainable development and improves energy efficiency. The public

¹ The role of the public sector in the strategic development of smart cities is fundamental. It is multifaceted, extending beyond traditional functions. The public sphere does not simply impose regulations - it is the “designer” of a favorable ecosystem for innovation.

sector can strategically support these efforts by providing regulatory incentives that promote programmes and standards encouraging the construction of highly-efficient and sustainable buildings integrated into the overall urban ecosystem (Debrah, 2025).

We believe, that successful cooperation between the private sector and public authorities in the field of technological innovation and know-how is crucial and determines the achievement of the strategic goals of smart cities. By combining extensive expertise, innovation capacity, and solid regulatory support, cities can build highly efficient and sustainable infrastructure - one that improves the quality of life for citizens and positions the city as a global leader in sustainable urban development.

3. Mechanisms for citizen participation through digital platforms in public-private partnerships

In the contemporary dynamics of smart city development, *active citizen participation* supported by *digital platforms and innovative applications* is not merely an element, but *a strategic imperative* for the success of sustainable urban transformations - especially when they are implemented through PPPs. Engaging citizens in the processes of decision-making and urban development ensures greater *managerial transparency, public legitimacy, and the long-term effectiveness* of adopted policies. Through PPPs, which initiate and maintain these digital tools, cities are generally able to involve residents in proactive participation, creating an environment of *shared responsibility and trust*.

Digital platforms provide unlimited opportunities for citizens to voice informed opinions, propose innovative solutions, and participate actively in the strategic planning and operational management of various initiatives. This is confirmed by **S. Tappert, A. Mehan, P. Tuominen, and Z. Varga**, who examine the role of digital citizen participation and digital agency in democratic transformation and the rethinking of urban governance (Tappert, 2024, 9 (1)).

Digitalization strategically expands the possibilities for participation in public consultations and collective decision-making. Many smart cities organize *virtual forums, online surveys, and consultations*, which allow citizens to express their views on major projects, strategic initiatives, and the allocation of public funds. These platforms, first, increase community engagement, and second, provide *valuable data and real-time feedback* to local authorities and their private partners. This information is particularly important for *adaptive*

planning and project implementation because it can ensure that final decisions are better aligned with the real needs and priorities of the urban population.²

Table 2

Strategic dimensions of digital citizen participation in PPPs

Strategic aspect of participation	Key management and planning goals	Digital mechanisms and platforms	Strategic benefits for urban development and governance	Challenges (managerial)
<i>Feedback and reporting</i>	Increasing operational efficiency; identifying problems in real time; enhancing transparency.	Mobile apps for reporting issues; online forms for submitting suggestions and complaints; IoT-based sensors connected to citizen interfaces.	Faster response and problem resolution; improved accountability of service providers (public/private); enhanced quality of urban services.	Risk of “digital divide”; managing the volume of data/signals; ensuring authenticity and quality of information; data privacy protection.
<i>Consultation and decision-making</i>	Legitimizing strategic decisions; incorporating citizen priorities; promoting democratic processes.	Virtual forums and online surveys on strategic plans and projects (budget, urban planning); platforms for collective voting; crowdsourcing platforms for idea generation.	Greater public support and ownership of projects; more appropriate policies; reduced resistance during implementation	Need to balance expert and public opinion; risk of polarization of views; ensuring representativeness of participating groups; potential manipulation of results.

² An interesting initiative is the development of a crowdsourcing platform, where citizens propose ideas for improving the urban environment. Subsequently, the public sector and/or private partners provide resources and funding to implement the selected projects. Crowdsourcing increases the diversity of proposed solutions and encourages social engagement and community solidarity. In this process, citizens are transformed from “passive consumers of services” into “active creators of the urban environment.”

<i>Co-creation and innovation</i>	Leveraging collective intelligence; generating innovative solutions; fostering entrepreneurs hip.	Hackathons and ‘design sprints’ with citizen participation; live urban laboratories for testing innovations; open data platforms stimulating app development by citizens and start-ups.	Development of creative and sustainable solutions; acceleration of the innovation cycle; creation of new business opportunities; increased citizen participation.	Need for mentorship; funding pilot projects; scalability of generated solutions; ensuring inclusion of diverse social groups.
<i>Monitoring and Accountability</i>	Tracking project progress; building trust; ensuring fulfillment of PPP contracts.	Interactive dashboards with publicly accessible project performance data; citizen monitoring tools for public services; feedback platforms on private partners’ service quality.	Increased transparency and control over project implementation; strengthened trust between citizens and administration; improved accountability of public and private sectors.	Risk of information overload; need for comprehensible indicators; ensuring data reliability.

Source: Author’s own interpretation

In practice, the strategic integration of digital platforms for citizen participation in PPPs provides new, transformative opportunities for engaging citizens. This is crucial for building sustainable, adaptive, and inclusive smart cities. Smart cities that, first, reflect the needs and desires of their residents, and second, actively leverage so-called collective intelligence and resources to achieve common well-being.

Conclusion

This study has confirmed that traditional management approaches are insufficient for the strategic implementation of smart city projects through PPPs. The sustainability of these partnerships depends on the adaptive integration of three key elements: financial flexibility, technological integration, and digital legitimacy. It was found that innovative financial models (such as blended financing and results-based financing) minimize public risk and ensure

capital efficiency. Successful management imperatively includes mechanisms for the continuous implementation of innovations. The most significant finding is that institutionalizing citizen participation through digital platforms is a decisive factor for public support and the long-term viability of a project.

In light of the above, we propose the following *future-oriented guidelines*:

1. *Prioritising the technology life-cycle*. Strategic PPP planning should include flexible clauses for updating and replacing technologies. Contracts should provide for periodic reassessments of the market viability of the implemented smart solutions.
2. *Developing an integrated risk-model*. A risk management model is required that covers not only financial and operational risks, but also technological risks (software obsolescence, cybersecurity) and social risks (insufficient citizen adoption).
3. *Standardization of digital participation*. Public authorities should develop unified protocols and performance indicators for citizen participation digital platforms. This will ensure transparency and transform citizen feedback into a measurable input for PPP governance.
4. *Focus on capacity building*. Future efforts should concentrate on developing expert public-sector capacity. Specialists are needed who can manage technologically complex PPPs and maintain strategic dialogue with the private sector and the public.

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