

Revitalizing Ukrainian Cities: The Role of Public-Private Partnerships in Smart Urban Development

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Received: 10. 11. 2023

Revised: 6. 1. 2024

Accepted: 19. 2. 2024

Published: 17. 5. 2024

ABSTRACT

Purpose: The article examines the role of public-private partnership (PPP) as a key tool for urban infrastructure restoration and the development of Ukrainian cities within the framework of the Smart City concept. It underscores the urgent need for effective mechanisms to restore urban infrastructure, especially in light of the challenges associated with the Russian military aggression and the resulting destruction in Ukrainian cities. The study explores key aspects of smart cities development, including the integration of digital technologies, the use of data, and innovative business models aimed at optimizing city functions.

Design/Methodology/Approach: The research employs a multi-stage methodological approach, encompassing elements such as gauging urban population satisfaction with municipal services, graphical analysis us-

ing CIMI, assessing the relevance of revitalizing Ukrainian cities and the need for mobilizing business resources, sociological surveys, developing a Smart City model based on PPP project outcomes, and formulating key elements of the national Smart City development strategy.

Findings: Emphasizing the importance of strategic planning and cooperation between public and private sectors, the study demonstrates the advantages offered by PPP-based projects. The obtained results highlight the pivotal role of PPPs in promoting urban development initiatives based on the Smart City concept. The study emphasises the potential of PPPs in shaping stable and prosperous smart cities in Ukraine. Through effective PPP utilisation, local governments can restore urban infrastructure, improve service quality, and enhance the quality of life for their citizens.

Practical Implications: The research results can serve as the basis for strategic planning and investment in infrastructure projects necessary for the creation of a smart city. The envisioned strategy will allow for the improvement of legislative acts covering a wide range of aspects of smart cities development while promoting collaboration between public and private entities. This includes bolstering the transportation system, deploying digital technologies, modernizing social institutions, and enhancing the efficiency of urban resource management.

Originality/Value: The originality and value of the study lie in its multifaceted approach to assessing and promoting the Smart City concept in Ukrainian urban development. It combines various research methods, including satisfaction assessments, CIMI-based graphical analyses, sociological surveys, and the development of a Smart City model based on PPP project results. This approach not only provides a comprehensive understanding of the state of urban infrastructure and citizen satisfaction but also offers a strategic framework for smart cities development.

Keywords: infrastructure, public administration, public-private partnership, recovery, smart city, tools, Ukraine, rebuilding

JEL: H41, H54, I38, R42, R58

1 Introduction

A significant number of factors associated with the constant shortage of resources, the impact of information and communication technologies on public life, and the growing need to integrate engineering and transport networks into a single management system encourage municipalities to seek modern approaches to the implementation of basic urban functions. This issue concerns the introduction of digital technologies based on energy-saving approaches, the organization of modern systems for the disposal and processing of domestic waste, the implementation of an e-governance system for providing administrative services and controlling the functioning of infrastructure. The indicated directions of the city's development determine the key goals: ensuring modern socio-economic standards, creating a high quality of life, and guaranteeing the satisfaction of needs for public services. The

trend in the development of large and medium-sized cities in recent decades has been projects united under the concept of a Smart City.

According to forecasts, urbanization processes will intensify, leading to increased population density in cities by 2050 (UN Department of Economic and Social Affairs, Population Division, 2022). This trend makes it necessary to introduce innovative solutions into the urban environment and form new relationships between stakeholders, with a strong focus on technology (Mattoni et al., 2019).

The concept of Smart City, it involves the control and integration of infrastructure elements such as roads, bridges, tunnels, subways, airports, sea and river ports, water supply, and drainage. These actions aim to optimize city resources and expand the provision of services to citizens, improving their quality while reducing costs. Smart City encompasses a combination of built-in infrastructures: physical, social, business, and IT (Kandt and Batty, 2021; Ejdys and Gulc, 2020).

The Russian military aggression in Ukraine and the subsequent destruction of infrastructure in Ukrainian cities have underscored the urgent need for effective mechanisms to restore and modernize these vital urban systems. As a result, finding innovative solutions that can contribute to the sustainable rehabilitation of infrastructure has become a critical imperative for policymakers, government officials, and urban planners.

In the context of Ukrainian cities, studying the potential of Public-Private Partnerships (PPPs) as a strategic tool for achieving infrastructure rehabilitation and urban landscape revitalization is highly relevant. The exploration of PPPs becomes even more crucial given Ukraine's aspirations for sustainable urban development, economic resilience, and overall public welfare after the war.

By integrating the perspectives of local communities, businesses, and civil society into the decision-making process, PPP projects can become more socially inclusive and better address the diverse needs of urban residents (Grimsey, Lewis, 2002; Hodge et. al. 2007; Andonova, 2010; Smith et. al. 2018).

Innovative financing mechanisms are essential to overcome budgetary constraints by mobilizing private capital to complement public investments in infrastructure. This financial collaboration not only accelerates project implementation but also minimizes the fiscal burden on public finances, ensuring a more sustainable and equitable distribution of resources (Stanimirović and Klun, 2021).

As the world increasingly emphasizes sustainability and resilience in urban development, PPPs should actively promote environmentally friendly infrastructure solutions. From eco-friendly transportation systems to energy-efficient utilities, PPPs can significantly contribute to creating a greener and more sustainable future for Ukrainian cities. Indeed, Ukraine will have to do a lot of work because recent evidence (Zapatrina, 2022) has shown that the low

institutional capacity of the public sector and lack of control in the implementation of PPPs allowed the initiation of only a few such projects.

By promoting collaboration, efficiency, innovation, and sustainability, PPPs hold the promise to drive transformative changes in urban landscapes, ensuring dynamic, sustainable, and prosperous cities for generations to come (Omitted for Peer Review, 2022).

Thus, the purpose of this study is to assess and analyse the implementation of the state's powers in providing public services in cities and to identify opportunities for local governments to form partnerships with the private sector for the development of Smart Cities in the post-war period in Ukraine.

2 Literature review

2.1 From Information to Transformation: The Smart City Evolution

The emergence of Smart City is a result of the intelligent use of digital information and addresses the following tasks: rational consumption of resources, increased investment in human and social capital, and the development of intellectual infrastructure. Furthermore, Smart City is characterized by social integration and the utilization of the Internet to foster new businesses, job opportunities, and the empowerment of citizens through information. By offering efficient and sustainable development, Smart City leverages information to make decisions on ecological issues, housing and communal services, waste management, the city's economy, and the integration of renewable energy sources, thereby shaping the urban environment. The digital foundation also provides an analytical technology for e-government to support social investment, fully aligned with the principles of behavioral economics (Gregor and Lee-Archer, 2016; Ogbodo et al. 2022). ICT companies also propose developing Smart City as a strategy that requires the provision of their own technological solutions and a collaborative model with local governments supporting the Smart City development strategy (Meyer, 2014; Grossi and Pianezzi, 2017; Shah, 2023).

Future changes in municipalities may focus on building a smart society in which the state can address the needs of both society and individuals, based on personalized services in various fields of activity (Bolívar and Meijer, 2016; Mills et. al. 2022; Chang, Smith, 2023; Vitálišová et. al. 2023). Innovative approaches are becoming increasingly important for accomplishing ambitious tasks, modernizing the education system, expanding functionality in the public administration system, and engaging citizens in digital transformation processes.

The pace of urbanization is currently leading to overcrowding of cities, resulting in a general decrease in the quality and comfort of life for each individual. To ensure that modern megacities are comfortable for their inhabitants, elements of the Smart City concept are being introduced worldwide, promoting a rational approach to the organization of living spaces. Creating comfort-

able conditions in urban areas is crucial for both residents and visitors, as the overall brand and attractiveness of a city depend on the quality of its urban environment across various market niches.

In recent years, the concept of Smart Governance has gained momentum in the theory and practice of territorial administration, with its most prominent representation being within the Smart City framework. The analytical agency Frost & Sullivan predicts that by 2022, the global market for information systems and services supporting Smart City functionalities will reach \$1.5 trillion (Amarnath et al., 2013).

Smart City integrates technology, government, and society to achieve reasonability in various aspects, including economy, mobility, environment, population, life, management, energy, technology, infrastructure, healthcare, education, and construction (Basilio et al. 2019; Burksiene et al. 2020; IEEE, 2023). In the third stage (Smart City 3.0), a modern Smart city becomes a place where people's lives are significantly enhanced through the adoption of "smart" solutions. By leveraging technology and digitizing traditional services, individuals can utilize their resources and time more efficiently and productively.

Digital transformation entails organizational or social changes facilitated by the integration of digital technologies into all aspects of human interaction. The availability of knowledge and information has paved the way for a modern form of socio-economic development, optimizing the economy's structure and enhancing labor productivity. At the core of digital transformation lie technological advancements, data utilization, and evolving business models, serving as the driving forces behind this transformative process. The analysis of various policy domains plays a pivotal role in shaping the directions of digital transformation. The framework encompasses interrelated policy dimensions, including access, usage, innovation, workplaces, social prosperity, confidence, and market openness. To harness the benefits and effectively address the challenges of digital transformation, a coordinated effort across all policy domains is essential, considering issues associated with other aspects of structural policy and the implementation of the Smart City concept.

2.2 Public-Private Partnerships: Building Resilience in Critical Infrastructure

In the coming years, crises arising from social dynamics and society's reliance on reliable critical infrastructure will significantly impact citizens' well-being. The involvement of private companies is crucial, as they play a major role in managing critical infrastructure (Boyer, 2019; Bardarai et al. 2023; Liu et al. 2023). Consequently, city governments must make decisions that anticipate and mitigate future challenges by actively engaging the private sector (Petkovšek and Pevcin, 2017; Siokas et al., 2022; Srebalová and Peráček, 2022).

Businesses' services are pivotal for societal well-being, necessitating the incorporation of their operational expertise in bolstering urban resilience (Mc-

Knight & Linnenluecke, 2016). Promoting cooperation between stakeholders is vital to the development of Smart city infrastructure. Public-private partnerships (PPPs) emerge as a promising mechanism for enhancing the regional innovations and resilience of critical infrastructure networks (Maraña et al., 2020).

Public-private partnerships are essential mechanisms for regional development, fostering increased employment opportunities and serving as engines for the establishment of modern logistics infrastructure within a country. International practice exemplifies widespread adoption of PPPs in various economic sectors (Omitted for peer review 2019). Many cities in low- and middle-income countries have leveraged PPPs to attract private sector investments, effectively addressing a myriad of urban development challenges (Kristensen and Scherrer, 2016; Hoyos and Lopez, 2021).

Researchers emphasize that post-war urban recovery is a complex process, taking into account the needs of the historical urban landscape, cultural value (for example, post-war reconstruction of the city of Aleppo) (Dimelli and Kotsoni, 2023). Another example (post-war reconstruction of the city of Mosul in Iraq) illustrates the necessity for further development based on the strategy of integrating former old elements into a new 'smart' environment (Abdulla and Hussein, 2022). The comparison of post-war reconstruction in Sarajevo and Beirut underscores the importance of a well-defined state policy, international assistance, and funding for the transformation of the cities (Bădescu, 2017). The researches (Mishenina and Dvorak, 2022; Schuldners, 2023) highlight the positive experience of using Public-Private Partnerships (PPPs) for sustainable development and urban redevelopment in Poland. Despite the many advantages of PPPs, there are several disadvantages. Wibowo, Alfen (2015) found that only government support can determine whether PPPs in infrastructure development will be successful, as the government can create a favourable investment environment and ensure the attractiveness of the project to investors. According to Pomeroy (1998), there are such limitations of PPPs as capabilities, risk-taking and legitimacy. Regarding capabilities, it is noted that not all capabilities can be possessed by PPPs, and some of them belong exclusively to governments. Risk-taking is another limitation because the private sector needs to invest in new projects, so it takes financial and political risks. In the absence of cases of legitimation, it is rational to involve the private sector in the provision of services. As observed by Rosell, Saz-Carranza (2020), mistrust between the public and private sectors, lack of an enabling institutional environment, and a lack of project capacity are prerequisites for the unsuccessful implementation of PPPs.

Bloomfield (2006) found that public sector organizations are becoming dependent on a single contractor because PPPs are usually long-term contracts. On the other hand, for the same reason, the contractor may begin to perform worse because there is no competitive pressure. Likewise, Reynaers (2014), summarizing the works of other authors, found that PPP projects lack transparency, and the information provided is often inadequate, inaccurate, or

misleading. The research (Othman and Khallaf, 2022) covering different continents revealed that similar barriers exist everywhere, for example regulatory, political, and financial barriers to implementing renewable-energy projects.

The next section will present the methodological approach used in this study.

2 Methods

The study includes several stages of the methodological approach:

- (1) Determination of the level of satisfaction of the population of cities of regional significance of Ukraine with public services in the areas of roads, healthcare and water supply;
- (2) Analysis of selected cities of Ukraine, the Czech Republic and Poland by key parameters of the City in Motion Index (CIMI);
- (3) Defining the Urgency of Restoring Ukrainian Cities;
- (4) Identifying the Need for Business Resource Mobilization to Restore Ukrainian Cities
- (5) Identification of factors contributing to the improvement of the situation in Ukrainian cities based on sociological measurements;
- (6) Development of a model for the formation of a “Smart City” based on the results obtained from the use of public-private partnership projects;
- (7) Formulation of Key Elements of the National Smart City Development Strategy.

Determining the level of satisfaction of the population of cities of oblast significance of Ukraine with public services in 2023 in the areas of roads, healthcare and water supply involves the use of a graphical comparison method. This method is based on the assessment of the quality of public services in 19 Ukrainian cities, where the index value ranges from 1 to 5, where 1 means “terrible” and 5 means “excellent” (International Republican Institute, 2023).

The analysis of the development of individual cities (Kyiv, Prague, Warsaw) in various economic and social aspects was based on the use of key parameters of the City in Motion Index (CIMI), which reflects the level of development in nine sectors (Economy, Human capital, social cohesion, Environment, Governance, Urban planning, international projection, Technology, Mobility and transportation) (Berrone and Ricart, 2020).

Based on the results of a sociological survey of residents in 20 cities (regional centers) (International Republican Institute, 2023), a graphical analysis was conducted to assess the urgency of city restoration needs and the necessity of involving additional business resources.

Based on the results of a sociological survey, the main factors that will contribute to improving the situation in Ukrainian cities are identified. Five main factors for improving the overall situation in cities with a population of more than 100,000 people (state aid, investment, government and community co-

operation, entrepreneurship development, and creation of a favourable business environment) were analysed (KIIS, 2021).

At the final stage, based on the results and trends obtained, a model for the formation of a “Smart City” was developed, which involves the use of public-private partnership projects. The research methodology included the use of comparison methods, graphical methods and sociological methods, which allowed us to determine the level of public service provision, the level of implementation of the Smart City concept, the main needs for the development of Ukrainian cities and to formulate key approaches to the use of public-private partnerships to restore infrastructure in the Smart City concept. Based on the developed models that incorporate the use of public-private partnership projects, key elements of a national strategy for the development of Smart Cities have been proposed.

3 Results

There are key aspects of smart information-driven approaches in Smart City:

- a modern digital infrastructure combined with secure access to public data, allowing citizens to access the information they need at any time.
- highlighting the needs of citizens and exchanging management information to ensure consistent service delivery.
- an intelligent physical infrastructure that enables service providers to inform about strategic investment opportunities in the community.
- openness to learning experiences, experimenting with new approaches and business models, and transparency of results (Department for Business, Innovation and Skills, 2013).

To implement the Smart City concept, having the necessary infrastructure is crucial. The term “infrastructure gap” is often used in global practice to refer to a situation in which the current level of infrastructure development is unable to fully meet the growing needs of society and the economy. According to experts, if the current global volume of investments in infrastructure is about 2.5 trillion US dollars per year, this figure should be increased to 3.3 trillion US dollars annually by 2030 to close the existing gaps (McKinsey Global Institute, 2016). Modelling indicates that, under the current scenario of world trends, it will be necessary to continue allocating the share of GDP to infrastructure spending at the previous level, or 3.0%. However, to meet the infrastructure needs identified in a more ambitious investment scenario, the share of GDP allocated to infrastructure investment should increase to 3.5% (Global Infrastructure Hub, 2017).

Given the consequences of Russian military aggression, the question of Ukrainian infrastructure recovery has become exceedingly complex. As of September 1, 2023, the damage inflicted by Russian military aggression amounted to \$151.2 billion (reconstruction cost). The housing sector incurred losses of \$55.9 billion, while the infrastructure and industrial sectors collectively suffered loss-

es of \$48 billion. The war caused \$10.1 billion in damages to the education sector, and losses in the healthcare field reached \$2.9 billion (with 1,223 medical facilities either destroyed or damaged) (Kyiv School of Economics, 2023).

We will analyze the dynamics of capital expenditures in individual urban territorial communities that border the areas of active hostilities in the Kharkiv, Donetsk, and Mykolaiv regions (Table 1). We observe a significant decline in capital expenditures in 2022-2023, which is challenging to compensate for in the conditions of a budget deficit. This requires the search for alternative solutions. Thus, increasing the number of infrastructure facilities will be a key task in implementing the Smart City concept.

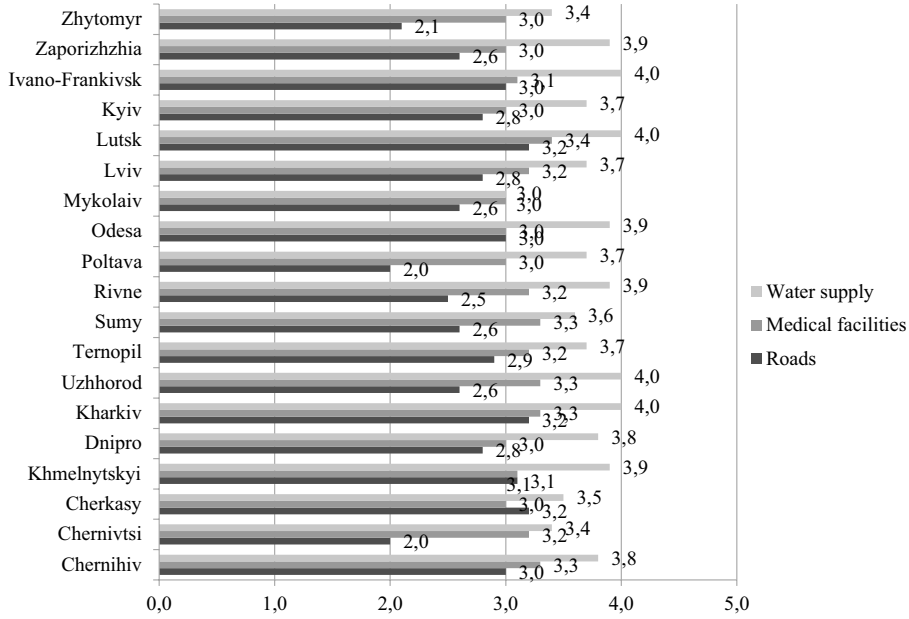
Table 1. Dynamics of capital expenditures of territorial communities bordering areas of active hostilities in Ukraine.

Territorial Community	Population, thousand people, 2023	Total expenses, thousand UAH, 2023	Capital expenditures, thousand UAH		
			2021	2022	9 months, 2023
Vovchansk city (Kharkiv region, Chuhuiv district)	35,542	78955,0	26019,1	39,9	106,0
Chuhuiv city (Kharkiv region, Chuhuiv district)	37,962	207007,6	90555,2	43644,5	63044,1
Zmiiv city (Kharkiv region, Chuhuiv district)	40,563	227200,2	56053,5	9251,7	14212,7
Bohodukhiv city (Kharkiv region, Bohodukhiv district)	36,348	244129,0	44810,9	14771,2	41266,9
Kupiansk city (Kharkiv region, Kupiansk district)	54,431	134586,7	44355,3	1,57	36494,3
Merefa city (Kharkiv region, Kharkiv district)	25286	134758,4	33997,5	19716,3	18172,0
Bilozersk city (Donetsk region, Pokrovsk district)	15,417	67394,7	9230,4	481,344	4240,8
Novyi Buh city (Mykolaiv region, Bashtanka district)	18,078	93078,2	16856,12	2398,6	7368,1

Source: ULEAD with Europe, 2023

Another important indicator is satisfaction with the quality of public services in cities. The study (International Republican Institute, 2023) characterizes the level of quality of services in certain areas of activity (medical institutions, roads, and water supply) in 2023 (Fig. 1). The index value ranges from 1 to 5, where 1 means 'terrible' and 5 means 'excellent.'

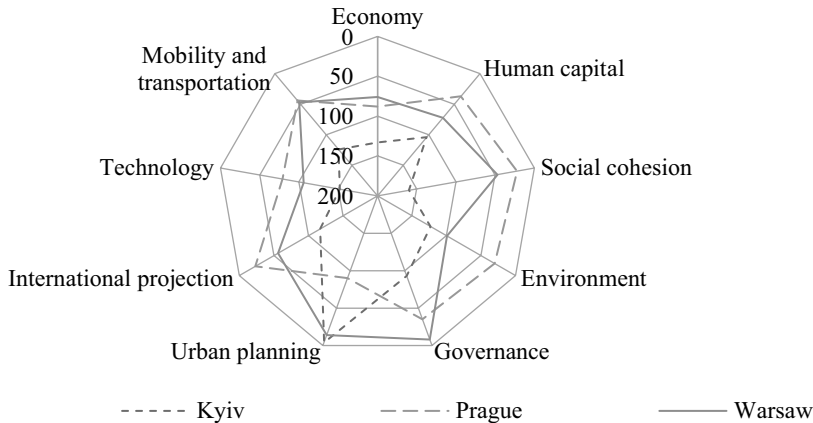
Figure 1. Assessment of the quality of public services provided in certain cities of Ukraine, 2023



Source: International Republican Institute, 2023.

There are various indicators and indices that demonstrate the development of cities in different economic and social aspects. One such index is the IESE City in Motion Index (CIMI) (Berrone and Ricart, 2020). The analysis of cities (Kyiv, Prague, and Warsaw) allows us to determine the level of development of the key parameters of the CIMI index (Fig. 2).

Figure 2. Analysis of the development of individual cities based on the CIMI index, 2020



Source: Berrone and Ricart, 2020.

It can be observed that Kyiv lags significantly behind Prague and Warsaw in almost all positions (except for urban planning). These data indicate the need for significant changes in the city's development policy and the search for new approaches to accelerate the implementation of the Smart City concept by attracting additional resources.

The sustainable development of the economy necessitates modern infrastructure facilities capable of meeting the needs of businesses and society. Unfortunately, the state's capabilities are not sufficient to fully address the existing requirements for developing the necessary urban infrastructure facilities. Cities must embrace strategic planning processes to identify paths to innovation and prioritize critical aspects of their future. This process must be active and flexible, defining a sustainable plan of action that will make the metropolis both unique and renowned.

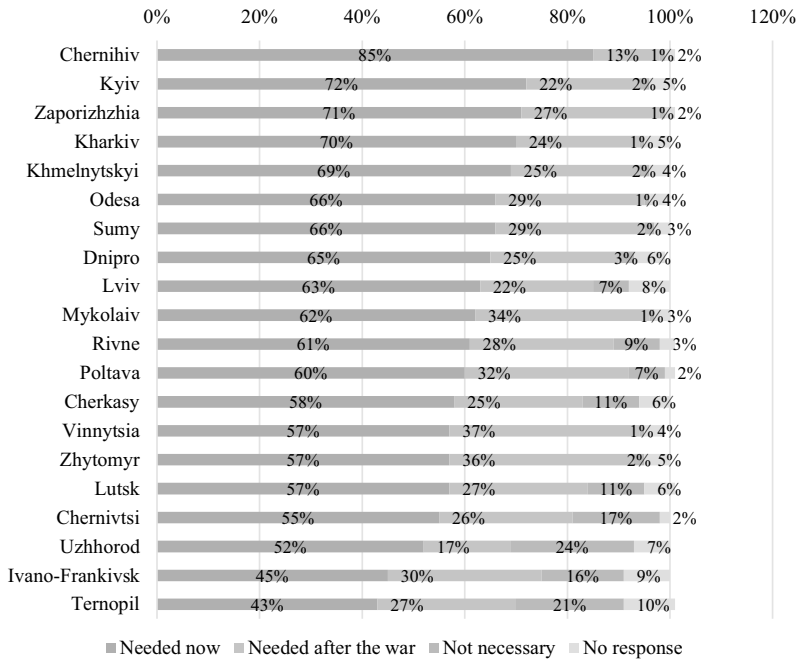
It is possible to propose strategic directions for achieving a sustainable Smart city ecosystem in a broad sense. Strategic directions for achieving a sustainable Smart city ecosystem for implementation in the public administration system can include:

- localization of resources and services through local centers;
- improved transport links to enhance mobility;
- rational mobility solutions for efficient transportation;
- a single window system for basic services to streamline access for citizens;
- use of alternative energy sources to promote sustainability;
- innovative waste management mechanisms for effective resource utilization;
- remote monitoring and control systems for efficient governance;
- localized management of water supply to ensure optimal use.

Meanwhile, in Ukraine, according to a conducted sociological survey, there is a significant demand for the urgent restoration of destroyed infrastructure in cities, without waiting for the end of the war (Fig. 3).

However, local governments may face challenges in independently implementing intellectualization and digital transition. To introduce smart technologies, building partnerships and engaging in cooperative actions with business entities are key at the initial stage. Nevertheless, it is essential to acknowledge that the fundamental challenge for the development of Smart cities in Ukraine and the successful implementation of digital transformation lies in resource constraints and the imbalance of powers faced by municipalities. Without reforming the current system of powers' delimitation, budget allocation, and tax legislation, the intensive development of smart digital cities will be significantly impeded.

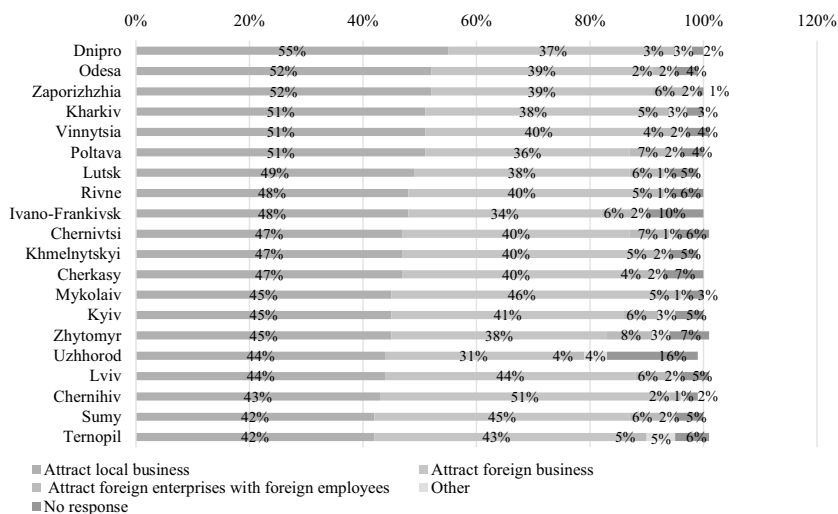
Figure 3. The need for the restoration of destroyed objects in cities



Source: International Republican Institute, 2023

The sociological survey conducted in 2023 among residents of Ukrainian cities revealed that the majority of respondents believe it is necessary to involve both local and foreign businesses in the post-war recovery processes (Fig. 4).

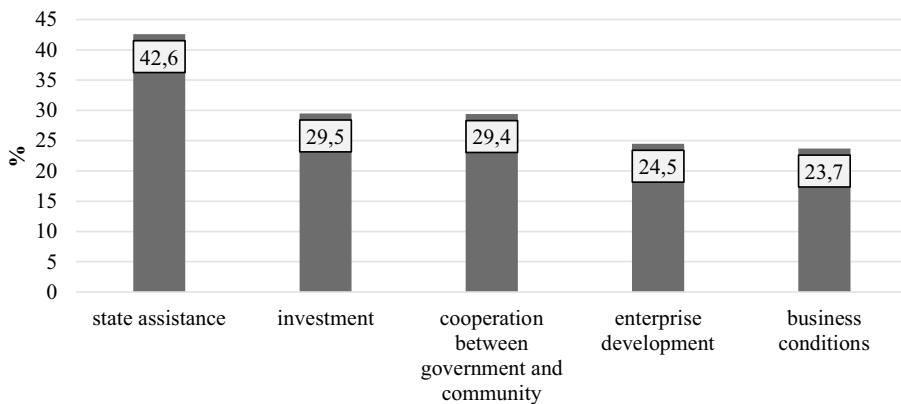
Figure 4. Results of a survey of community residents regarding the need to involve businesses in the city's reconstruction



Source: International Republican Institute, 2023.

Analysing the five main factors that could improve the situation in large cities with populations of more than 100 thousand, they include state assistance, investment, increased cooperation between government and the community, enterprise development, and the creation of a favourable business environment (Figure 5) (KIIS, 2021). These data indicate the city's needs, which can be addressed through public-private partnerships, fostering increased cooperation, providing investment resources, enhancing the business environment, and expanding the number of enterprises.

Figure 5. Factors contributing to the improvement of the situation in the cities of Ukraine, 2021



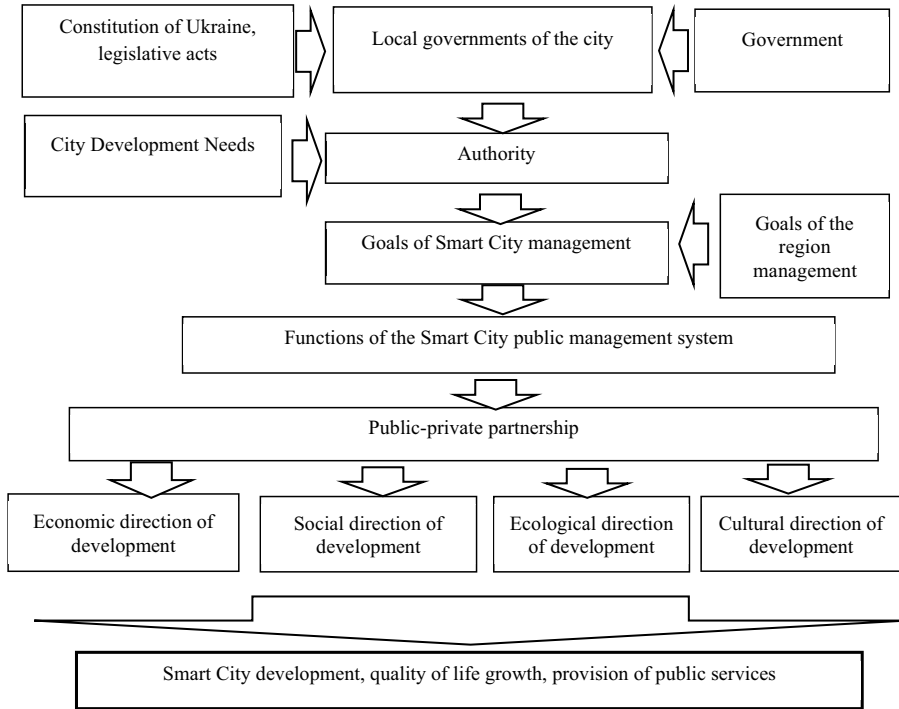
Source: KIIS, 2021.

First of all, the initiatives of local government and private businesses to develop the concept of Smart City encompass energy, public services related to transport, healthcare, and waste management (H-UTokyo Lab., 2020). Innovative technologies are expected to improve traffic, increase mobility, save energy, enhance environmental parameters, promptly identify and resolve issues, and facilitate information collection and data exchange for more effective decision-making and cooperation between governmental entities and territorial subjects.

4 Discussion

The model of government management for the development of a Smart City, using public-private partnerships to achieve key goals, is presented in Figure 6. The system (Fig. 4) entails the utilization of own and delegated powers, established goals, and management functions, allowing for public administration in the economic, social, environmental, and cultural spheres of the city through public-private partnerships.

Figure 6. Model for the implementation of powers in the public administration system of a Smart City



Source: Prepared by the authors.

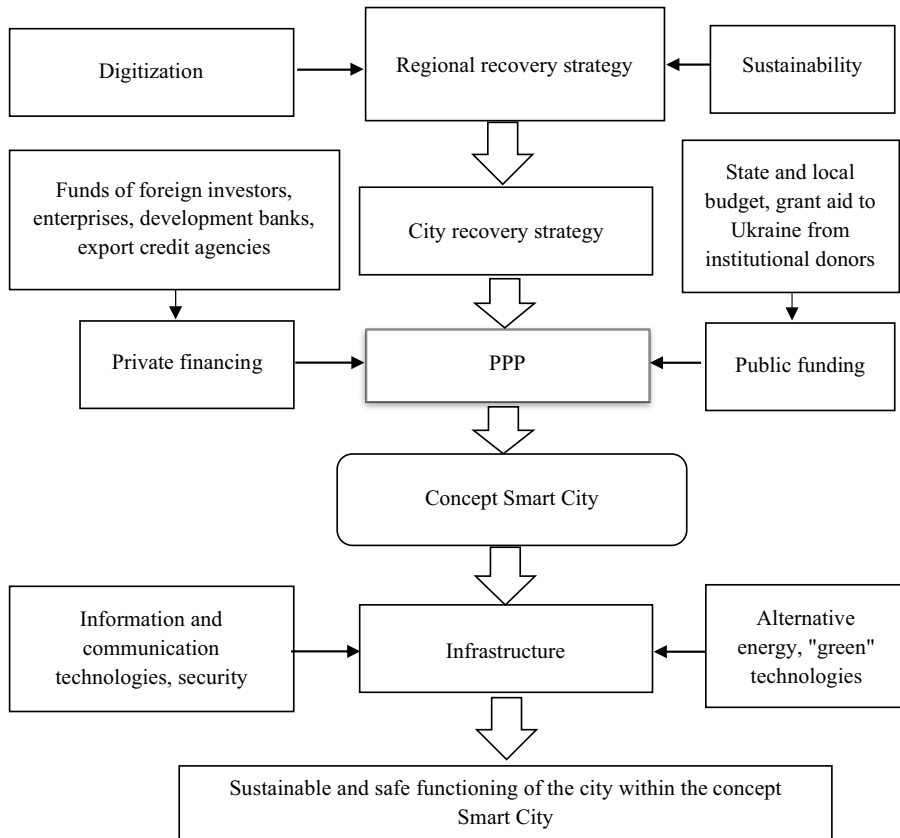
Modern research indicates that partnerships between the private and public sectors play a crucial role in the urban system, particularly when implementing initiatives focused on the Smart City concept. PPP provides the means to achieve desired outcomes and facilitates the successful implementation and completion of Smart City projects (Siokas et al., 2022). Other researchers have also confirmed the feasibility of financing Smart City projects with the help of PPP (Mirzaee and Sardroud, 2022). Joint policy-making could help develop projects to address these issues at a strategic level (Laufs et al., 2020).

In preparing and implementing PPP projects in the infrastructure sector, it is essential to consider the priorities of the local government concerning the economy and the direction of development. Key factors include institutional support for the development of public-private partnerships (having a legislative framework, policies, and sectoral strategies), the capacities of local governments (experience in participating in PPP models), communication readiness (organizational arrangements, internal interaction, approval processes), and available resources (technology, qualified personnel, consultants, and funding).

The main approaches to infrastructure construction are depicted in the model of financing and implementation of PPP-based projects in the Smart City concept (Fig. 7). These elements pertain to sustainable infrastructure (trans-

portation, education, medicine, and housing) in the formation of a Smart City, promoting sustainable and safe functioning through interconnected systems. The main moderating block is the city strategy, which considers the requirements of digitalization and the concept of sustainable development. This strategy ultimately determines the extent to which the city is focused on implementing the Smart City concept (Omitted for peer review, 2022).

Figure 7. Model of financing and implementation of infrastructure restoration based on PPP projects in concept Smart City.



Source: Prepared by the authors.

Of course, a smart society should be formed on the basis of the timely introduction of innovations; the functioning of new paradigms of public administration, interacting with most social and business processes; and the ability of citizens to influence the main processes of digital transformation and control these actions. The concept of Smart City is urgent, given the growing infrastructure needs of society. The combination of control over existing communications based on information and communication technologies will optimize the use of resources, increase the interaction of various areas of the functioning of city networks and the provision of necessary services, and simplify the mechanisms of communication between citizens and public authorities.

To implement the proposed models of public-private partnership in the Smart City concept, it is necessary:

- to ensure the priority of urban development in the regional development strategy;
- implement innovative components in the construction and reconstruction of engineering and logistics facilities based on information and communication technologies;
- carry out city development planning, taking into account the need to introduce the technological architecture of a Smart City (control over the operation of transport networks, the Internet of things platform, e-government resources);
- and identify promising areas in the system of city development on the basis of public-private partnership.

The use of public-private partnerships for the revitalization of Ukrainian cities is not devoid of potential drawbacks and challenges in the post-war reconstruction period. Large-scale Smart City projects, considering substantial infrastructure losses, are financially demanding. Funding these initiatives will require the search for significant investments in technology, infrastructure, and human resources. Ukrainian cities in the post-war period may face budgetary constraints that hinder their ability to secure the necessary resources, which could be a significant obstacle for the use of PPPs. Furthermore, Ukrainian cities may encounter issues related to outdated or insufficient technological infrastructure, necessitating investments in modernization or replacement of existing systems.

While Smart City initiatives have the potential to enhance sustainability and reduce environmental impact, there is the possibility of unforeseen consequences. For example, the proliferation of technology may lead to increased energy consumption or electronic waste. Simultaneously, changing the way cities are governed and managed may encounter resistance, both politically and administratively. Implementing new approaches to governance requires significant changes in the public administration system and models of public-private partnerships.

Addressing these challenges requires a comprehensive strategy that considers legal and regulatory reforms, investment strategies, and a commitment to addressing issues of equity and sustainability, which involves implementing new approaches to infrastructure project execution.

Based on the developed models, approaches can be proposed for the formulation of a National Smart City Development Strategy. This strategy serves as a comprehensive roadmap designed to harness the potential of digital technologies for the benefit of society, businesses, and government within the framework of the Smart City concept. The objectives encompass the transformation of various sectors, the improvement of citizens' lives, the stimulation of innovation, and positioning the country as globally competitive. Defining the objectives determines the envisioned digital future of the redeveloped

cities. The tasks outline specific goals that can range from the development of digital infrastructure to data security (Table 1).

Table 2. Elements of the National Smart City Development Strategy

Key Direction	Rationale for Necessity
Infrastructure development	Infrastructure development includes expanding high-speed internet connectivity, establishing data processing centers, enhancing cybersecurity measures, and ensuring digital access for all citizens. To efficiently achieve these goals, the government collaborates with private enterprises.
Data Management and Privacy	The strategy establishes the framework for data collection, storage, and utilization to ensure confidentiality and security. Adherence to international data protection standards is often integrated to facilitate data flow and encourage global partnerships.
E-Governance and Public Services.	Integrating technologies into public services enhances efficiency and transparency. The strategy prioritizes the development of solutions for e-governance, enabling citizens to access services online, reducing bureaucratic barriers, and promoting accountable management.
Innovations and Research.	Promoting innovations and research is an integral component to stay at the forefront of technological progress. The strategy encompasses incentives for research and development, collaboration between research institutions and industry, as well as support for startups and technology incubators.
International Cooperation.	The national strategy emphasizes partnerships with other countries, international organizations, and the private sector to exchange best practices, technologies, and knowledge.
Monitoring and Evaluation	To ensure the success and adaptability of the strategy, monitoring mechanisms are implemented to assess progress and evaluate outcomes. Regular assessments measure the impact of the strategy, enabling the necessary adjustments to achieve optimal results.

Source: Prepared by the authors

So, the national strategy for the development of Smart Cities is a comprehensive approach designed to guide Ukraine into a future with digital capabilities. Through infrastructure development, data management, e-governance, innovation promotion, international collaboration, and continuous assessment, it is possible to enhance economic growth incentives, improve citizens' well-being, and ensure competitive positions in the global digital landscape.

Given the multi-vector nature of urban systems, at the first stage, the key to the introduction of smart technologies should be building partnerships in certain areas of urban activity. However, a significant challenge for the develop-

ment of Smart Cities in Ukraine and the implementation of digital transformation now lies in the area of resource limitations and the imbalance of powers that local authorities face.

5 Conclusion and limitations

The current research of public-private partnership (PPP) as a tool for infrastructural development of Ukrainian cities in the context of the “Smart city” concept emphasizes the urgent need for effective mechanisms for the restoration and modernization of urban infrastructure, especially in light of the challenges caused by Russian military aggression and the destruction that Ukrainian cities have experienced.

The key factors that contribute to the implementation of “Smart city” initiatives are highlighted, including the integration of digital technologies, the use of data, and innovative business models to optimize city functions. Having analysed various policy areas, the potential advantages of PPPs in promoting sustainable urban development, economic stability, and public welfare are emphasized.

The analysis revealed challenges in the implementation of governmental responsibilities for providing quality public services in cities, technological gaps, a deficit in budgetary expenditures for capital construction at a time when the number of deteriorating infrastructures is increasing. As cities actively seek the involvement of the private sector and investments to restore critically important infrastructure, public-private partnership emerges as a perspective for combining managerial efficiency, technical expertise, and the financial resources necessary for the realization of modern Smart Cities projects.

The study highlights the importance of strategic planning and cooperation between the public and private sectors in implementing “Smart city” projects. Using PPPs, local governments can ensure optimal value for money, reduce financial burden, attract qualified professionals, and mitigate negative impact on the environment and social sphere. In addition, PPP contributes to the provision of quality and affordable services to local residents.

The partnership between the public and private sectors plays a crucial role in the implementation of urban development initiatives focused on the “Smart City” concept. Implementation of PPP projects can make a significant contribution to the development of sustainable infrastructure, creating interconnected systems for the safe and efficient functioning of cities. By effectively taking advantage of PPPs, local governments can develop and modernize urban infrastructure, improve services, and provide a better quality of life for their citizens. To achieve the goals of the “Smart City” concept, it is important to establish close cooperation, develop strategic plans, and create a favourable political environment that encourages collaboration between the public and private sectors. Reconstructing urban environments through multifaceted collaboration and innovation provides a unique opportunity to revive the

cities of Ukraine in the post-war period based on the national digital transformation of infrastructure

Limitations. In this study, we do not seek to provide a type of PPP contract and we are not looking for an answer to how to deal with the lack of administrative capacity in Ukraine cities, the problems of corruption, the issues of Value for Money, the budgetary implications in the long run and the problems of fiscal flexibility. During the research, an answer was sought about the role of public-private partnership (PPP) as a critical tool for urban infrastructure restoration and the development of Ukrainian cities within the framework of the 'Smart city' concept.

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