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Smart Development of Cities: Ukrainian Experience, Trends and Prospects

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ABSTRACT

Smart city development has emerged as a key concept of modern urban studies, aimed at ensuring sustainable economic growth, improving residents' quality of life, and enhancing the competitiveness of local economies. The Ukrainian context of this idea reflects global trends while also demonstrating national specificities shaped by economic, social, and geopolitical challenges. The aim of the article is to identify the key trends in smart city development based on the Ukraine's experience. To determine the results, a sociological survey was conducted among representatives of local authorities. The article analyzes the current state of smart city initiatives in Ukraine, with particular emphasis on the role of digitalization, innovation ecosystems, and public-private partnerships as fundamental drivers of urban modernization. Special attention is given to the interaction between local self-government bodies, businesses, and civil society in the implementation of projects related to digital governance, smart infrastructure, and sustainable mobility. The experience of selected cities (Kyiv, Lviv, Kharkiv, Dnipro) illustrates positive cases of smart solutions integration, though the overall level of adoption remains uneven and fragmented. Key trends include the growing influence of large industrial enterprises in shaping strategic urban programs, the gradual involvement of small and medium-sized businesses, and the emergence of socially oriented initiatives, such as veterans' support projects. At the same time, the development of smart technologies is constrained by limited financial resources, insufficient institutional capacity, and a lack of policy coherence at the municipal level. Prospects for advancing smart cities in Ukraine are associated with strengthening partnerships among stakeholders, fostering innovation clusters, and aligning local strategies with European integration processes. The study concludes that successful implementation of smart development requires a systemic approach that combines technological progress with inclusive governance and the priorities of sustainable development.

1. INTRODUCTION

Modern cities face numerous challenges: population growth, exacerbating environmental risks, the need to address complex social issues, energy efficiency and security issues, ageing municipal infrastructure and worsening urban traffic, and many others. The spread of the latest ICTs in all spheres of public life has become an important tool for solving these problems, leading to the emergence of the phenomenon of smart cities. Smart cities are identified not only with the unprecedented spread of digital technologies, but, first and foremost, with the fact that they enable the transition to green standards and the fulfilment of social requirements. Within individual localities, smart cities are able to implement all these processes together, as it is the use of the latest digital technologies that allows for a comprehensive approach to energy efficiency, traffic management and the transition to environmentally friendly modes of transport, inclusiveness and accessibility, the transition to e-governance, etc. In recent decades, the number of smart cities has been growing, and their practices have been enriched.

Since clear criteria for classifying a city as a 'smart city' have not yet been developed, the number of such cities can vary greatly depending on the source. There are not many smart cities in the pure sense of the word; rather, we can talk about a smart development vector that cities choose when implementing comprehensive smart initiatives. The general trend of their growth is obvious. More and more cities in different countries and regions are joining smart initiatives, implementing comprehensive digital solutions for urban development management based on sustainable, green development and resilience. According to Fortune Business

Insight, the global smart city market was valued at $623.90 billion in 2023 and is projected to grow to $4,647.63 billion by 2032, with an average annual growth rate of 25.2% [1].

The development of smart cities is receiving additional impetus with the spread of artificial intelligence technologies. The path to a smart city often begins with the implementation of individual solutions, which quite often remain fragmented. Artificial intelligence technologies make it possible to combine all these individual solutions into more complex systems and approaches. It is artificial intelligence (AI) that allows cities to cope with huge amounts of data, respond faster, plan smarter and, ultimately, achieve better results for communities [2].

The technologies are used in real-time video surveillance and analytics systems, transport and mobility management, energy systems, public safety, etc. Hybrid artificial intelligence platforms are being developed and are ready for scaling, enabling real-time operation of smart cities, industrial automation, and intelligent government services using scalable infrastructure [3].

This trend is also important for Ukrainian cities, which, despite the complexity of the current situation, are also trying to move in a smart direction. Even before the war, many digital solutions had been implemented in Kyiv, Kharkiv, Dnipro, Odesa, and other cities. According to forecasts, the smart cities market in Ukraine will reach US$104.50 million in 2025, and with an annual growth rate (CAGR 2025-2029) of 7.13%, it will grow to US$137.66 million in 2029 [4].

2. THEORETICAL BACKGROUND

Since the emergence of smart cities, this issue has become very relevant in scientific research. The essence, structure, and evolution of smart cities are studied by Giffinger et al. [5]; Greenfield [6]; Kumar and Bharat [7]; Pozdniakova [8] and many others. Giffinger [9] has been researching the understandings of the Smart City, its evolution, and its meaning for sustainable and resilient urban development. Greenfield [6] emphasizes a broad approach to understanding the smart city, one that takes into account the complex, interconnected, imperfect, and very human realities of urban existence [10]. Sterling [11] and Pikulski [12] share the same opinion. Indian researchers led by Kumar and Bharat [7] are conducting in-depth research into the nature and structure of the smart city phenomenon.

A topical issue in scientific research is the analysis of the factors contributing to the success of smart cities. Thus, Lombardi et al. [13] analyze the interrelations between smart city components connecting the cornerstones of the triple helix. Nam and Pardo [14] offer strategic principles aligning with the three main dimensions (technology, people, and institutions) of smart city: integration of infrastructures and technology-mediated services, social learning for strengthening human infrastructure, and governance for institutional improvement and citizen engagement. Sureshchandra et al. [15] systematize key success factors of smart cities based on literature analysis the scientific publications. Many researchers focus on studying the role of the technological component in implementing the concept of a smart city [8] [16].

In the 2020s, the spread of the latest digital technologies is gaining momentum, with big data analytics and artificial intelligence bringing new opportunities. The dynamic integration of digital technologies into urban life is driving the further development of smart cities, which is the subject of research in many works. Smart cities are studied through the prism of systems thinking and complex systems by Ammara et al. [17], defining them as “complex adaptive systems in which there is a high degree of interdependence and interaction between different stakeholders, components, and subsystems.” He explores the evolution of the concept of smart cities, considering them a utopia, a brilliant image of the city of the future. Boulanger [18] deepens the understanding of smart city discourse [19]. He is also working on defining smart cities, their advantages, disadvantages, implementation challenges, financing, implementation methods, quantitative analysis methods, and prioritization indicators [20]. Mupfumira et al. [21] analyze the main elements of a smart city structure, perform a SWOT analysis of existing structures, and identify four categories: human-centered, technology-centered, integrated human-technology-centered, and environmentally-oriented structures. Ziosi et al. [22] examine definitions related to the concept of smart cities and identify the ethical implications of smart cities.

There is a growing number of works devoted to assessing the effectiveness of smart cities. For example, Lacson et al. [23] systematize literature on smart city assessment (SCA), especially in the context of developing countries. A. Samarakkody et al. [24] raise the question of the criteria for “smart” cities, emphasizing that the characteristics of a smart city (smartness requirements) are vague, and different smart cities develop their own criteria for smartness. Shi and Shi [25] conduct a comprehensive analysis and comparative assessment of 33 recently introduced or withdrawn assessment systems.

da Silva Tomadon et al. [26] conduct a bibliometric review of literature on smart city and sustainable development (SSCI) indicators from 2015 to 2022. The study shows a sharp increase in publications (by 288% from 2015 to 2022) and confirms China's leading position.

One of the most pressing issues in scientific research in the field of smart cities is the study of the changes and opportunities brought about by the latest technologies. Karri et al. [27] characterize five key technologies for smart and/or safe cities (intelligent traffic management systems, information and communication technologies, blockchain technology, re-identification, and the Internet of Things). The issue of improving the sustainability, fairness, and performance of transport systems is explored by Khanmohammadi and Guerrieri [28]. Kim et al. [29] explore next-generation, sixth-generation (6G) communication systems that will play a crucial role in improving the efficiency of urban operations and services (non-terrestrial networks, advanced mobile edge computing, vision-based wireless communication, artificial intelligence (AI)-based wireless communication, and integrated sensing and communication), key technical challenges, and potential benefits.

The impact of artificial intelligence on the development of the digital community and its capabilities in identifying and predicting the needs of individuals and population groups, as well as in developing plans for the effective use of municipal resources [30]. Okonta and Vukovic [31] explore how ICT integration can contribute to sustainable urban development and improve citizens' quality of life. Qayyum et al. [32] explore the integration of energy management systems into smart residential buildings, which serve as key nodes in a smart city network. Szpilko et al. [33] emphasize the

importance of technologies that can improve energy efficiency in cities, contributing to their sustainable development (smart energy networks, energy storage, integration of renewable energy sources, Internet of Things, 5G/6G, artificial intelligence, blockchain, digital twins).

Scientific views on smart-oriented development and partnership between business and local governments consider a large number of theoretical aspects and practical implementation, however, Ukraine is in conditions of active military operations and, accordingly, needs rapid mechanisms for the restoration of economic activity and the search for methods of active cooperation and the development of public-private partnership. Analyzing scientific works, key criteria for assessing the activities of smart cities were identified and based on this, a questionnaire was constructed, the main purpose of which was to determine the potential and prospects for post-war urban reconstruction.

Thus, the issue of smart cities is being studied in many aspects and very broadly, which confirms its relevance. The phenomenon of smart cities is developing rapidly, providing many examples of successful implementation in various aspects. This leaves many questions for further research concerning the success of smart cities, the interaction of partners in the urban environment, the application of the latest ICT, etc.

3. METHODOLOGY

To determine the results, a sociological survey was conducted among representatives of local authorities. The research methodology included the following stages:

1) developing a list of questions for a questionnaire on the implementation of smart initiatives in cities, key successes and obstacles;

2) conducting a survey by the consulting company Aktiv-Group based on a combined study. The methods of collecting primary information included: a quantitative component (self-completion of questionnaires using the CAWI method) and a qualitative component (in-depth interviews with representatives of local self-government bodies). A total of 111 respondents local government bodies were surveyed throughout the country (representatives of local authorities in Ukrainian cities), except for the occupied part. The structure of the cities surveyed was as follows: cities with a population of up to 10,000-14.41%, 10,000-50,000-23.42%, 50,000-100,000-4.50%, 100,000-200,000-2.70%, 200-500 thousand-28.83%, 500-700 thousand-2.70%, 700-900 thousand-9.01%, more than 1 million-14.41%. Generalised groups: up to 100 thousand-42.3%, 100-500-31.6%, 500-over 1 million-26.1%.

3) summarising the data set obtained and formulating conclusions on the dynamics of smart development processes in Ukrainian cities, the main barriers, trends and prospects.

4. RESULTS

Choosing the path of smart development for each city begins with specific decisions on the more active use of digital technologies to solve sustainable urban development problems. Global experience shows that there is no single standard approach to the formation of smart cities, the stages of its development, sectors or the choice of technologies. Nevertheless, the most common initiatives are the following: electronic management of public utilities, intelligent transport systems, air and water quality monitoring systems, e-government, video surveillance and security, and many others. This is confirmed by a sociological survey in Ukrainian cities on the main directions of smart city development and its key components. Thus, in various cities of Ukraine, digital services for citizens, security and video surveillance systems, and infrastructure for electric transport have become the most widespread (Figure 1). These main areas were detailed in more specific solutions and presented to cities to answer the question 'Which components of a smart city have already been implemented in your city?' (It was necessary to select 5 from the proposed list.)

The results show that more than half of all cities have implemented digital services for the population (53.2%), video surveillance systems (45.9%), charging stations for electric transport (34.2%), electronic tickets (28.8%), smart lighting (25.2%), and electronic utility management (25.2%). Ukrainian smart cities are currently focusing primarily on the implementation of basic digital services, such as electronic services for citizens, an automated e-ticket system for public transport, and video surveillance networks aimed at ensuring security. Particular attention is also being paid to the development of electric transport infrastructure, which has the potential to reduce emissions and promote efficient mobility.

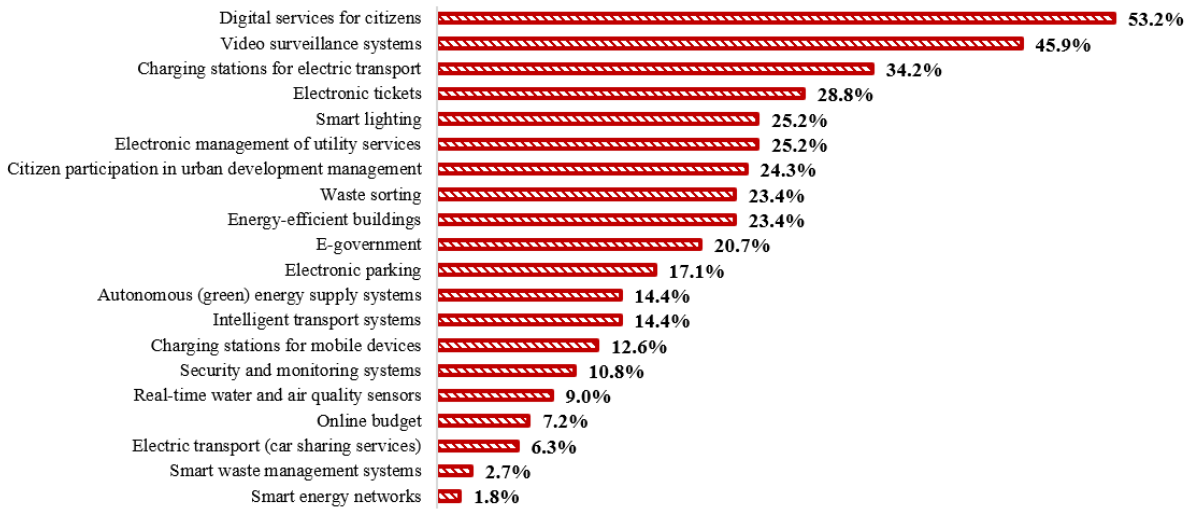

Figure 1. Most common smart technologies implemented in Ukrainian cities, 2025

It should be noted that the areas that will actually determine the future of smart cities remain on the periphery of attention for now. These include energy sustainability, waste management, the introduction of green technologies, and the development of smart grid systems to optimise energy consumption. Despite the importance of these areas, the key priority today remains ensuring digital security and improving the level of comfort for city residents. This reflects the pressing tasks of local administrations, but there is a noticeable trend towards a gap between local initiatives and global trends. In global practice, the focus is increasingly shifting to aspects such as energy efficiency, climate neutrality and the creation of sustainable urbanisation systems that respond to the challenges of the current environmental crisis.

In-depth interviews confirm these trends with real examples of digital transformation of the urban environment, particularly in the areas of transport, medicine, energy, security, ecology, and public participation. Most of the solutions have already been implemented or are in the process of being implemented in cooperation with international partners. For example, Zaporizhia has introduced electronic accounting and GPS tracking of public transport, allowing residents to track routes in real time. Many responses mention electronic medical records, online doctor appointment systems and electronic queues, which indicates the deep penetration of digital services into the healthcare sector. However, it should be noted that healthcare initiatives are nationwide. Vinnytsia has charging stations for electric transport and solar-powered traffic lights as elements of sustainable urban energy. In 2024, the city also began cooperating with the Swedish WM4U project in the field of waste management. There are plans to create a cluster model of waste management, transferring the experience of Stockholm. Informants emphasise that city residents have access to electronic petitions, opportunities to influence through online participation tools, and public control over the budget.

An analysis of the development of smart technologies in cities in terms of priorities indicates that digital services and citizen involvement in governance are the most developed, with these areas predominating in small cities. Large cities are characterised by video surveillance systems, charging stations for electric transport, energy-efficient buildings, waste sorting, real-time water and air quality sensors, electronic parking, etc. For cities with a population of up to 10,000, the priorities are: digital services for citizens (56.25%), citizen participation in urban development management (18.75%) and smart lighting (18.75%). For cities with a population of 10,000 to 50,000, the priorities are digital services for citizens (48.15%), waste sorting (33.33%) and citizen participation in urban development management (33.33%). In cities with a population of 50,000 to 100,000, the priorities were: video surveillance systems (80%), waste sorting (60%), digital services for citizens (40.0%), and citizen participation in urban development management (40.0%). In cities with a population of 100,000 to 200,000, the priorities were charging stations for electric transport, energy-efficient buildings, waste sorting, and real-time water and air quality sensors (66.67%) (Table 1).

Thus, it can be seen that as cities grow, so do the opportunities for implementing more intelligent and advanced smart city tools. Overall, we can note the significant potential for the development of smart cities. At the same time, additional efforts are needed to implement intelligent transport systems and energy networks, electric transport (car-sharing services), autonomous (green) energy supply systems, the spread of energy-efficient buildings, smart waste management and sorting systems, security and monitoring systems, real-time water and air quality sensors, etc.

The next important question is what cities are planning, what technologies and directions they see as promising for themselves. Based on the survey, the following most promising areas for the development of smart cities were identified: energy-efficient construction, waste management, etc. (Figure 2).

Ukraine is actively focusing its efforts on implementing energy-efficient technologies and environmentally friendly approaches, covering a wide range of solutions: from modernising buildings and waste collection and processing systems to strengthening the role of renewable energy. These areas define the fundamental aspects of the smart city concept, enabling the creation of a more comfortable and environmentally responsible urban environment. The digitalisation of services and security remains important components, but their perception has now shifted towards basic elements of development, where they are no longer considered innovations, but rather standards of modern urban life. This rethinking makes it possible to focus on less developed areas, such as smart grids, transparent management of city finances through online budgets, and car sharing, which have significant potential and meet the high requirements of European standards for sustainable urban development.

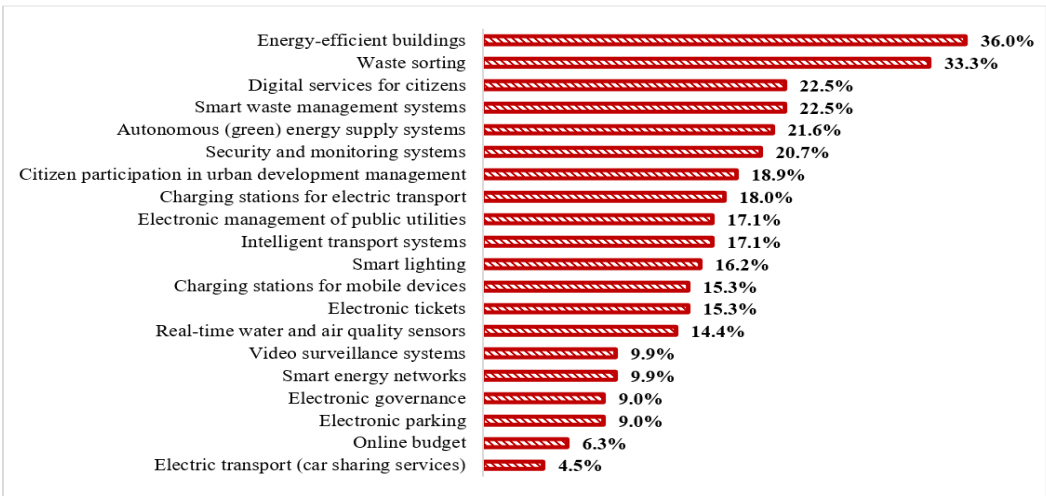

Figure 2. Promising areas for the development of smart cities in Ukraine, 2025

Table 1. Key priorities for the development of smart technologies in cities, depending on population size, %, 2025

Urban Population	The Three Main Priorities Implemented	Three Main Promising Priorities
Up to 10 thousand	digital services for citizens (56.25%), citizen participation in urban development management (18.75%) smart lighting (18.75%)	Security and monitoring systems (43.75%) Video surveillance systems (37.5%) Waste sorting (37.5%)
10-50 thousand	digital services for citizens (56.25%), citizen participation in urban development management (18.75%) smart lighting (18.75%)	Energy-efficient buildings (55.56%) Waste sorting (48.15%) Autonomous (green) energy supply systems (37.04%)
50-100	video surveillance systems (80%), waste sorting (60%), digital services for citizens (40.0%), citizen participation in urban development management (40.0%)	Energy-efficient buildings (60.0%) Autonomous (green) energy supply systems (60.0%) Intelligent transport systems (40%) Smart waste management systems (40%) Security and monitoring systems (40%) Charging stations for mobile devices (40%)
100-200	Charging stations for electric transport (66.67%), Energy-efficient buildings (66.67%), Waste sorting (66.67%), Real-time water and air quality sensors (66.67%)	Intelligent transport systems (66.67%) Intelligent energy networks (66.67%) Electronic tickets (33.33%) Electronic management of utilities (33.33%) Smart waste management systems (33.33%) Smart lighting (33.33%) Security and monitoring systems (33.33%) Waste sorting (34.38%)
200-500	Digital services for citizens (62.50%) Charging stations for electric transport (59.38%) Video surveillance systems (50.0%)	Digital services for citizens (31.25%) Intelligent transport systems (31.25%) Electronic tickets (31.25%) Energy-efficient buildings (31.25%)
500-700	Intelligent transport systems (66.67%) Digital services for citizens (66.67%)	Intelligent transport systems (66.67%) Smart waste management systems (66.67%) Charging stations for electric transport (33.33%) Energy-efficient buildings (33.33%) Electronic management of public utilities (33.33%) Intelligent energy networks (33.33%) Citizen participation in urban development management (33.33%)
700-900	Electronic parking (80.0%) Electronic management of utilities (60.0%) Video surveillance systems (50.0%)	Smart energy networks (50%) Digital services for citizens (40%) Waste sorting (30%)
More than 1 million	Electronic tickets (68.75%) Digital services for citizens (62.25%) Charging stations for electric transport (56.25%)	Charging stations for electric vehicles (31.25%) Energy-efficient buildings (31.25%) Waste sorting (31.25%)

At the same time, the survey results indicate that there is no universal priority. Interview participants believe that the relevance of smart solutions depends on specific needs and user groups, and that it is subjective — for some, charging stations are important, while for others, medical services or digital communications are more important. At the same time, respondents identify a number of areas that are most important in the context of post-war recovery, energy efficiency, safety, and quality of life.

It is interesting to compare the priorities for cities of different sizes. Large cities have a wider range of technologies, but small cities are much more focused on environmental and energy efficiency issues. Megacities, on the other hand, focus on transport infrastructure and digital management solutions. For medium and large cities with a population of 100,000 to 700,000, the development of transport and mobility is key. Energy efficiency and green energy are most common in small and medium-sized cities with populations of 10,000 to 100,000. Digital services for the population and e-government systems are more common in cities with populations of over one million. At the same time, waste sorting and effective waste management are common priorities for all city groups, indicating a general trend towards greening. Table 1 presents the three main priorities (already implemented and promising) in cities of different sizes (Table 1).

Among those planned, the most frequently mentioned are electronic tickets for transport (planned for implementation), smart stops with waiting boards, and GPS monitoring of route traffic. These solutions directly affect the convenience of moving around the city and are in high demand among residents. Respondents highly appreciate the programmes for insulating residential buildings, implemented through partnerships between the city and condominium associations. Smart street lighting, which saves resources in conditions of unstable energy supply, is mentioned separately. There are proposals to expand the functionality of electronic interaction between citizens and the authorities: electronic resident accounts, online meetings with deputies, interactive services for appeals and decisions. The existing mechanism of the Community Budget is mentioned as a form of citizen participation in urban development. Also mentioned are open Wi-Fi zones and phone charging points in public places, which improve digital accessibility in everyday life.

In the context of accelerating the smart transformation of Ukrainian cities, it is important to identify the real obstacles. The survey revealed that there are multiple barriers to smart development. Obstacles to the implementation of smart solutions include both objective factors (the consequences of war and limited resources) and subjective factors (the level of interest among authorities and citizens). Unfortunately, the

survey also revealed weak citizen engagement in digital transformation, low public awareness, and passivity on the part of local authorities. The responses also indicate a certain resistance on the part of the authorities. Smart approaches require data openness and accountability, which may be perceived as a threat to the current management system. It should also be noted that the full-scale war has shifted the focus of resources to security needs. The ability of municipalities to invest in innovation has been significantly limited. In such conditions, public attitudes are also changing, with survival taking precedence over development.

Nevertheless, in the context of smart development, we consider it necessary to study the level of cooperation and interaction between local authorities, businesses and educational institutions. These are the main stakeholders that shape the urban ecosystem. The success of urban development is largely determined by their innovativeness, focus on promising technologies and productive collaboration.

Cooperation between local authorities and educational institutions on the development of smart cities in Ukraine is showing positive signs of progress, but it is not yet systematic. When asked, 'Do you cooperate with higher education institutions in implementing urban development goals?', 44.2% of local government representatives surveyed responded positively, 30.6% plan to do so in the future, while 25.2% indicated that there is no such cooperation. The survey results revealed a low level of cooperation between government agencies and higher education institutions in the field of smart technology development. More than half of the respondents (55.9%) indicated that there is no such interaction, which indicates weak integration of educational and scientific potential into the processes of digital transformation. Only 17.1% of respondents confirmed the existence of effective partnerships, while 27.0% noted the existence of only isolated, non-systematic forms of cooperation. This state of affairs demonstrates the fragmentation of communication between government structures and universities, as well as the insufficient development of institutional mechanisms for interaction. This reduces the possibilities for using research results to solve practical problems in the field of smart urbanisation and reduces the effectiveness of digital development policies.

Some informants point to the existence of formalised interaction between HEIs and local authorities in the context of smart development, mainly through expert and analytical participation in working groups. Representatives of higher education are members of working groups involved in strategic city planning. Universities serve as platforms for the implementation of practical initiatives. Such cooperation does not always take the form of full-fledged partnerships or long-term programmes, but it allows the intellectual potential of the academic environment to be integrated into municipal processes. This involves engaging academics in consultations, scenario analysis or the development of applied solutions in the fields of digitalisation, energy efficiency or urban planning. For example, a co-working and consulting centre for energy efficiency has been established at the National University of Water Management with the participation of the city council. This demonstrates the possibility of effective interaction between educational institutions and other sectors to solve practical urban management tasks. In general, there is no mention of institutional partnerships or joint development centres, which may indicate the limited scale of such initiatives, which are usually initiated by the authorities rather than being the result of strategic dialogue with universities.

Respondents emphasise the lack of initiative on the part of universities, even when the authorities are open to cooperation. One respondent notes that the authorities' activity in this area often boils down to PR rather than systematic work, which can undermine HEIs' trust in such cooperation. In a number of cases, there is a structural disconnect between educational programmes and municipal priorities, with the exception of specific collaborations (e.g., with the University of Water Management), which limit the possibilities for cross-sectoral partnerships. According to local government representatives, the main obstacles to cooperation with educational and scientific institutions are as in Figure 3.

In summary, the obstacles to the development of cooperation between HEIs and the authorities lie in a combination of external circumstances (war), financial constraints, professional incompatibility, lack of initiative on the part of universities, the political nature of local initiatives, and, as a result, mistrust of state structures, lack of relevant areas of cooperation, and lack of real interest on the part of the authorities. This creates a situation where even existing opportunities are not realised in full-fledged long-term partnerships.

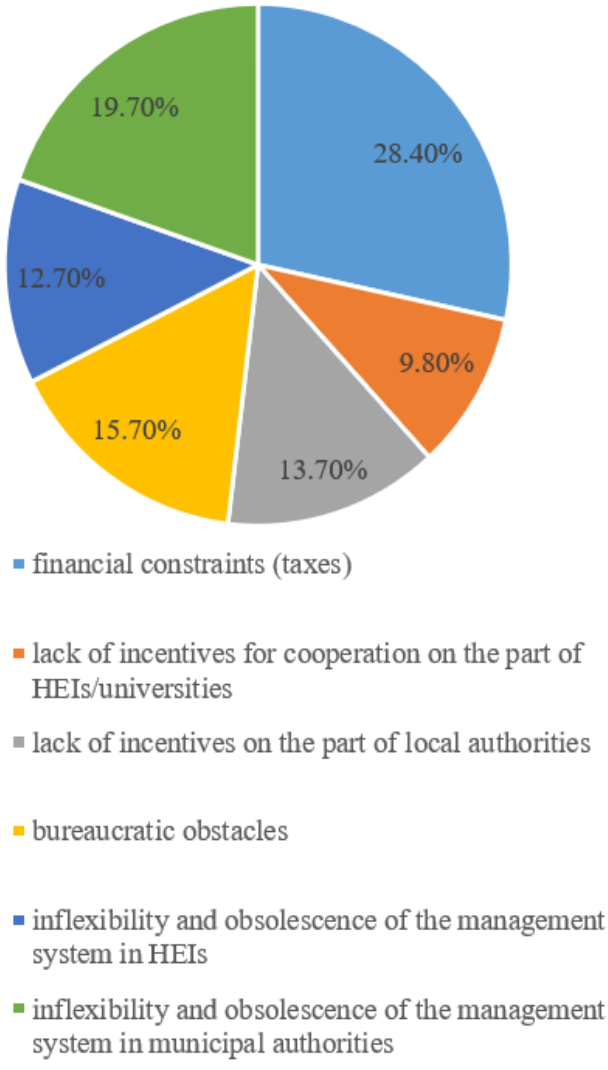

Figure 3. Main obstacles to cooperation between local authorities and educational and scientific institutions

In the near future, the key focus should be on removing

barriers for the 25.2% of sectors where there is no cooperation and on activating 30.6% of potential partners. An extremely important task is to create models of public-private partnerships that provide for the establishment of innovation laboratories, joint research and development centres, scientific research commissioned by the city, and the active involvement of students and teachers in the implementation of municipal projects. This approach will contribute to the growth of cities' competitiveness and provide a scientifically sound basis for the implementation of smart solutions in Ukraine's post-war economy. An example of the potential for smart development is the IT cluster in Vinnytsia, which brings together representatives of local authorities, businesses and universities. Such an organisation could become the basis for the implementation of joint digital and innovative solutions aimed at developing local infrastructure.

As for cooperation between local authorities and business structures in achieving urban development goals, more than half of respondents report that such cooperation exists: 54.1% cooperate, 31.5% plan to cooperate in the future, and 14.4% do not cooperate. At the same time, the scale of cooperation, the involvement of different sectors, and consistency vary. The main formats of interaction take place in two areas: through institutionalised councils and business support programmes, as well as through the implementation of individual joint events or initiatives. There is cooperation with industrial giants such as Zaporizhstal and Motor Sich. On the other hand, small businesses are underrepresented in urban development processes, due to both the low initiative of the entrepreneurs themselves and the lack of focus on the part of the authorities.

When it comes to local authorities working with businesses on urban development, things are even worse. Only 32.4% of local government respondents said they were working with businesses on smart development, while 64.0% clearly said they weren't. Thus, there is a lack of consistent or systematic examples of joint projects with businesses in the context of smart or sustainable development. At the same time, there is an almost complete lack of information on the participation of small businesses. This indicates the low visibility or documentation of such interaction, as well as the probable absence of a system for recording or communicating such projects at the government level.

An interesting question is who initiated the joint projects that were ultimately implemented. The leaders are business (27.8%) and the public (27.8%), whose initiatives form the basis for transformation, based on two key motivators: business is focused on improving efficiency and strengthening competitive positions through the implementation of modern smart solutions; the public seeks to improve the quality of life, in particular through environmental development and the creation of comfortable conditions. Local authorities, which account for 25% of activity, also play an important role, although their contribution is inferior to that of business and the civil sector. This may be due to limited resources or a conservative approach to management. Higher education institutions, with a score of only 8.2%, show the lowest level of initiative among national players. Despite their status as knowledge generators, their contribution to the implementation of practical projects remains underdeveloped. International organisations and other entities (5.6% each) are not leading forces, but they perform a strategically important function by providing external support for the development of smart urbanisation in Ukraine (Figure 4).

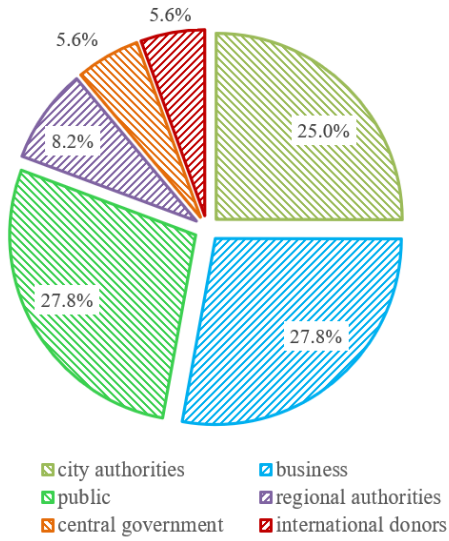

Figure 4. Initiators of joint projects for sustainable or smart development in cities, 2025

However, it should be noted that neither side — neither local authorities nor businesses — is taking a systematic leadership role in establishing partnerships, even in areas that are potentially mutually beneficial (technological solutions, spatial development, green transformation, etc.). Responses from local government representatives regarding the key obstacles to their cooperation with business indicate the following: in first place is the lack of incentives from local authorities (29.7%), followed by financial constraints (21.6%), bureaucratic barriers (15.3%), inflexibility and obsolescence of the management system in city authorities (13.5%), lack of incentives for cooperation on the part of business (9.0%), business focus on short-term rather than strategic goals (6.3%), and other (4.5%).

The experts' responses reveal the main barriers hindering the development of partnerships between business and government in the implementation of local development initiatives, particularly in smart or sustainable formats, including low levels of trust between business and government and competition within the business environment. Despite declarations and isolated attempts at cooperation, the vast majority of businesses refrain from active participation due to mistrust of the sincerity or transparency of local government intentions. This creates a passive business position in the field of social partnership and partially hinders the implementation of joint development projects. At the same time, there are internal contradictions within the business environment itself, in particular competition for customers, resources and influence. In such conditions, the need for joint coordination or participation in common projects is perceived as a potential risk of losing market position. At the same time, there are opinions that the absence of obstacles is possible if businesses realise the specific benefits, which points to the need to develop communication mechanisms and a transparent partnership model in order to transform latent readiness into real projects.

When assessing the overall obstacles to implementing the concept of smart development in the city, representatives of local self-government bodies gave the following answers. Respondents could give up to three answers to the question «What obstacles do you see to implementing the concept of smart development in your city/region? (Figure 5).

Figure 5. Main obstacles to implementing the concept of smart development in a city/region

Among the identified resources that can contribute to urban development and the implementation of economic recovery projects, experts highlight three key types of resources without which the implementation of reconstruction and economic initiatives will be difficult. Financial and export resources are considered the most influential, as the need for investment remains an unavoidable condition for launching new economic projects. The second most important resource is the availability of appropriate human resources, both professionals capable of leading projects in the fields of culture, architecture and tourism, and workers requiring specialist skills, such as fitters, electricians, operators, etc. Thirdly, the need for political support and communication was mentioned. Respondents emphasise the importance of state policy, the availability of state orders and strategic interaction with the central government and international donors. Effective promotion of the city's interests and 'soft lobbying' play an important role in this. Thus, the economic revival of the city requires not only financial injections, but also systematic strengthening of human resources and institutional cooperation, which allows for integration into state and international reconstruction processes.

One way to overcome difficulties and promote economic development is to involve the public in the activities of government bodies, given the importance of transparent communication, which requires the development of effective tools for civic participation and motivational mechanisms for business as the main ways to actively involve various social groups in the reconstruction process. It has been noted that only clear public information about projects and results can make people feel involved. In this context, public discussions, surveys, public hearings, and regular updates for residents about city plans and projects are proposed.

It is also important to create special conditions for business, including preferential taxation and guaranteed access to young personnel, which is not only financial but also systemic support at the recovery stage. It should be noted that all respondents emphasise that without honest and active communication, neither businesses nor citizens will feel like they are part of the reconstruction process. In this context, it should be noted that effective involvement in reconstruction requires systematic, transparent communication, the restoration of participation tools and the stimulation of business through specific support mechanisms.

There is a need for flexible government programmes that stimulate the development of clusters and support industrial parks, but do not hinder local initiatives with excessive regulation, reporting and bureaucracy. There are requests to create special conditions for frontline regions. Initiatives such as preferential tax zones are mentioned as tools for increasing the investment attractiveness of areas close to the front line. Infrastructure co-financing and government procurement are also considered important. In this context, the state is expected to participate in the financing of large-scale urban projects that are beyond the means of the local budget alone. The need for access to innovation and finance is also outlined, but respondents also emphasise the need for the community itself to work on promoting the city. An important mechanism in this context is the practice of interacting with European cities with which exchanges, visits and consultations have been established. Such contacts are seen as an effective format for mutual enrichment and financial support.

5. CONCLUSIONS

There is no doubt that the development of smart cities should become a key direction for Ukraine's successful post-war recovery, as it corresponds to the main trends in global development. The study confirmed that Ukrainian cities are definitely moving in this direction. The activity of this movement is influenced by both external factors (related to military aggression) and numerous internal factors, which are often influenced by them. The lack of investment resources in the context of external aggression is a significant factor in the insufficiently dynamic smart development of cities, as confirmed by the survey. However, these are not the only influential factors. In general, it can be concluded that the barriers to smart development are complex in nature. They are not limited to a lack of resources, but also include cultural, communication, management and strategic factors.

There is an urgent need to intensify the smart trend in urban development, which will involve revising strategic priorities for smart infrastructure development, shifting the focus towards the implementation of smart energy networks, expanding environmental projects, and creating sustainable and adaptive urban solutions. This approach will not only be in line with current European practices in economic and

technological development, but will also contribute to Ukraine's deeper integration into the pan-European context of digital and green transformation. In the context of the country's post-war recovery, a balanced approach that combines infrastructure solutions, such as improving energy efficiency or waste management systems, with the active use of digital platforms seems particularly promising. The latter will encourage citizens to get involved in city management processes and ensure their participation in important decision-making. Such synergy will be key to creating a sustainable urban landscape and integrating Ukraine into the best practices of modern urban development.

In general, we can note that cooperation with business is more developed and promising than with educational institutions. There is a lack of systematic models of partnership with higher education institutions, which causes a gap between scientific developments and the practical needs of cities. In this context, the institutionalisation of trilateral cooperation (government-business-higher education institutions) is a key task for the formation of an effective smart city ecosystem in post-war Ukraine, primarily through the development of public-private-education partnership programmes, the creation of innovation hubs and laboratories in municipalities with the participation of businesses and universities, the involvement of students and researchers in smart city pilot projects to combine theoretical knowledge with practice, and the use of international experience in integrating science, government and business into urban management.

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