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Urbanization challenges and opportunities for sustainable development of smart regions in Ukraine

Abstract. The article examines the primary challenges of urbanization processes for the sustainable development of Ukraine's regions. Based on international programs ("Smart Specialization", "100 Climate Neutral" and "Smart Cities"), analytical reports of international organizations (UN-Habitat, OECD, World Bank), as well as national strategic documents, the study identifies specific features of urbanization processes in Ukraine, which, taking place in military conditions and in the context of uncertainty and resource constraints, have become the main challenge for sustainable development.

At the same time, it is demonstrated that urbanization can provide the basis for the formation of competitive and sustainable "smart regions" provided that technological, socio-economic, and managerial dimensions are effectively integrated, as well as ensuring spatial coherence through inter-municipal and inter-sectoral cooperation.

Using examples of successful European cases, the article shows that digitalization, environmental innovations, and e-governance increase national competitiveness, territorial cohesion, and quality of life, provided that digital, social, environmental, and infrastructure innovations are harmoniously combined.

The article formulates recommendations for Ukraine, in particular on the development of a national "smart region" strategy, investment in digital infrastructure, implementation of "green technologies", and strengthening cybersecurity potential.

To clearly reflect the regional characteristics of urbanization processes, build a roadmap, implement operational control, and assess effectiveness, which is the basis for making management decisions and the possibility of further analysis and identifying opportunities for implementing the "smart region" concept, the article uses data systematization and visualization.

This study proves the need to implement the concept of "smart regions" and adapt international experience to national realities by integrating technology, digital, social, environmental, and infrastructure innovations to improve the quality of life in communities. In addition, the implementation of operational control, reporting,

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and assessment of the effectiveness of the Roadmap directions will enable informed management decisions on implementing "smart strategies" during the urbanization of Ukraine's regions.

Methodology/Approach. The methodological basis of the study is a systematic and interdisciplinary approach that combines elements of statistical analysis, comparative research, and analytical interpretation of publications by leading scholars.

The primary sources of information include the Global Data Lab (Demographics, 2012-2023), the State Statistics Service of Ukraine (2025), as well as data from international organizations such as the United Nations -World Urbanization Prospects (Population, 2018) and the World Bank (2014-2024).

The research period spans 2014-2025 and traces the dynamics of urbanization processes in Ukraine over the past decade, with particular attention to the consequences of the COVID-19 pandemic and the introduction of martial law in 2022.

The article uses systematization and visualization of data to clearly reflect the regional characteristics of urbanization processes, build a roadmap, implement operational control, and assess effectiveness, which is the basis for making management decisions and the possibility of further analysis and identifying opportunities for implementing the concept of a "smart region".

Findings. The results obtained show that urbanization is a challenge to sustainable development both in the world and in Ukraine, causing structural, environmental, and social problems, problems associated with a decrease in the level of security in the country.

Analysis and generalization of analytical reports and national strategic documents of Ukraine, scientific literature, allowed us to determine the features of urbanization in Ukraine and the conditions in which it occurs. Among the features of urbanization are the absence of urban agglomerations of a global scale, the dominance of small and medium-sized cities, which, together with military conditions, conditions of uncertainty, and limited resources, have become a challenge for the sustainable development of Ukraine.

The opportunities opened by the concept of "smart regions" were also identified, including digitalization, environmental innovations, and electronic ordering.

This study proved the need to implement the concept of "smart regions" and adapt international experience to national realities through the integration of technologies, digital, social, environmental, and infrastructure innovations to improve the quality of life in communities. Implementation of operational control, reporting, and assessment of the effectiveness of the Roadmap areas will allow management decisions on the implementation of "smart strategies" during the urbanization of the regions of Ukraine

Keywords: digital transformation, innovation, investment, regional policy, smart economy, smart strategy, operational control, reporting and assessment of effectiveness, digitalization**,** balanced development of regions

Category: Research paper

Introduction

Urbanization is one of the key trends in modern global development. According to the World Bank, more than 56% of the world's population lives in cities, and by 2050, this figure may increase to 68% (Population..., 2018).

The intensive growth of the urban population creates significant challenges in the areas of infrastructure, ecology, social justice, and resource management. At the same time, urbanization presents opportunities for innovation, including the introduction of digital technologies and the development of new models of territorial governance.

In the context of sustainable development, it is important to transition from traditional models of spatial organization to the concept of "smart regions", which combine intelligent management systems, digital services, and principles of ecological balance (Komninos *et al.*, 2022). The European Union, within the framework of the "Smart Specialization" (European Commission, 2025) and "100 Climate-Neutral and Smart Cities" (European Commission, 2025) programs, defines digitalization and sustainability as interrelated areas of development policy.

Ukraine, like many other countries, faces the task of creating sustainable and effective economic development in its regions through "smart specialization" and the implementation of "smart strategies" for development.

For Ukraine, this vector is especially relevant in connection with the need to defend its right to independence, carry out post-war reconstruction, and integrate into the European economic and political space.

Despite the wide representation of research on urbanization processes in world scientific thought, Ukrainian issues remain less studied, especially in the issue of finding development opportunities based on "smart specialization" of regions in wartime conditions, conditions of uncertainty, and lack of resources.

Currently, there is a growing attention of the international and national scientific community to urbanization as a multidimensional challenge that requires the use of different approaches. The strategy of "smart regions" in this context appears as an effective tool that allows combining innovative technologies, institutional changes and orientation to social needs in order to ensure sustainable development.

This article identifies urbanization challenges and outlines the opportunities that the concept of "smart regions" opens for ensuring sustainable development of Ukraine.

This study contributes to the scientific understanding of innovative models of regional development management. It is proved that digitalization, environmental innovations, e-governance and inclusive policies can create a basis for the formation of competitive and sustainable "smart regions". It is the synergy between urban processes, digitalization and environmental policies that can become the key to sustainable development of Ukraine.

A conceptual distinction is made between approaches to understanding: urbanization as a purely demographic process and the interpretation of this process as a complex socio-economic and institutional challenge; understanding the "smart region" as a purely high-tech environment and the interpretation of the "smart region" as a territorial unit where digital, social, environmental and infrastructure innovations are integrated to improve the quality of life in communities.

The scientific novelty of this study lies in revealing the specifics of urban challenges in Ukraine within the context of a multidimensional crisis (pandemic, war, and economic instability) and the opportunities that "smart regions" offer for sustainable development.

Unlike existing approaches, this study provides a deeper understanding of urbanization challenges and new opportunities for the formation of "smart regions" in conditions of high uncertainty and limited resources.

Literature review

The issues of urbanization and urban development are constantly in the field of view of researchers from academic and industry research institutions, as well as leading higher educational institutions in Ukraine. This issue has given a prominent place on the agenda of international forums, particularly under the auspices of the United Nations, and in the review publications of international organizations (Population, 2018).

Most researchers consider urbanization as a challenge for the sustainable development of cities and regions, which causes problems of overloading of transport infrastructure, increasing environmental pollution, social inequality and cyber threats (Matern *et al*., 2019), growth of urban population while reducing the total population in countries (Karal, 2024).

The study of urbanization processes is naturally complemented by an analysis of the concept of "smart specialization" of regions, which is considered one of the promising tools for socio-economic stabilization and development of territories.

Several approaches to understanding a "smart region" can be traced in scientific publications.

Some researchers understand a "smart region" as a territorial unit based on digital technologies, big data and artificial intelligence for effective management (Behera *et al*., 2023).

Other scientists emphasize the integration of environmental and social components, which is embodied in the concept of "circular and smart city" (Mylonas *et al*., 2024). The third group of authors emphasizes that the "smart region" encompasses a broader spatial integrity and is focused on increasing competitiveness, cohesion, and quality of life in the intermunicipal and intersectoral dimension (Sutriadi, R., 2021; Artyomov & Yakushev, 2021).

In the domestic scientific and practical sphere, the concept of a "smart region" is most often associated with the ideas of "smart specialization" (Goncharenko & Slynko, 2020) and "smart economy" (Kudin & Fedyk, 2022), which orient regions towards innovative development and integration of science, business, and government (Slynko, 2020; Yakushev & Yakusheva, 2018).

"Smart specialization" is considered by Ukrainian authors as a key tool of innovation policy, capable not only of increasing the competitiveness of territories, but also of becoming an effective response to the urbanization challenges facing modern cities and regions.

Thus, at the present time, the international and domestic scientific community has accumulated a significant body of research devoted to urbanization challenges and the search for opportunities through the implementation of the concept of "smart region", the implementation of "smart strategies" of regional development. At the same time, Ukrainian realities, which are determined by a high level of uncertainty and limited resources, require more thorough study. We are talking about specifying the content of the concept of "smart region", assessing the level of involvement of Ukrainian regions in global processes of "smart development", as well as finding ways to adapt innovations to the conditions of resource limitation.

Materials and Methods

The methodological basis of this work is a systematic and interdisciplinary approach that combines elements of statistical analysis, comparative studies, and analytical interpretation of publications by leading authors. This approach allows us to study the dynamics of urbanization processes in Ukraine over the last decade (2014-2024), considering the consequences of the COVID-19 pandemic and martial law, as well as to identify potential opportunities for sustainable development through the implementation of the concept of a "smart region" and the implementation of "smart strategies" of regional development.

Data collection

The empirical basis of the study is made up of the following sources:

Official statistical reports and analytical studies conducted by international organizations - the UN (Population, 2018), UN-Habitat (2020), Organisation for Economic Co-operation and Development (OECD, 2020), World Bank (Ukraine country data, 2024-2024), and Global Data (Demographics, 2014–2024).

National regulatory and legal acts, official information from government portals (State Statistics Service of Ukraine (2025), Cabinet of Ministers of Ukraine.

Scientific publications of Ukrainian and international researchers on the issue of forming competitive and sustainable smart regions (6 sources, including such journals as Journal of the Knowledge Economy, European Planning Studies, Journal of Urban Technology, Sustainability, Journal of Cleaner Production).

Methods

In this study, based on the generalization of statistical data, official documents and scientific literature, an analysis of the dynamics of urban processes in Ukraine for the period 2014-2024 (during the pre-pandemic period, the pandemic phase and wartime) was conducted, the problems caused by these processes were identified and the opportunities opened up by the concept of "smart region" for ensuring the sustainable development of Ukraine were shown. Urbanization indicators were defined as the share of the population living in administratively defined urban settlements (urban settlements).

To ensure the validity and reliability of the results, the indicators were verified by comparing data from various sources (GDL, State Statistics Service, World Bank, UN-Habitat). This made it possible to obtain a generalized picture of urbanization trends, as well as identify regional features, which is the basis for analyzing opportunities, among which the concept of "smart regions" occupies a leading place.

Using analytical methods, a conceptual distinction was made between the terms "urbanization" and "smart region. When building the Roadmap for implementing "smart strategies" during the urbanization of Ukraine's regions, the synthesis method was employed. The article utilizes data systematization to clearly reflect the regional characteristics of urbanization processes, which serves as the basis for identifying opportunities and making informed management decisions regarding the formation of smart regions.

Results and discussion

Ukraine is one of the most urbanized countries: more than two-thirds of the population - 70.1% in 2023 - live in cities, which exceeds the world average (61.7%) (The Global Economy, 2024). Over the past decade, Ukraine has experienced a steady increase in the number of urban residents. For example, from 2014 to 2024, the urban population increased from 68.97% to 70.1% (Urban population, 2014-2024). However, it should be noted that this growth is not due to natural factors, but due to internal migration (movement from small towns and villages to large urban centers). At the same time, Ukraine has experienced a trend of declining total population. The significant population decline - minus 8,112,159 people compared to 2014 - is due to the combination of the latest factors: low birth rate, high emigration, and war losses (Statista, 2024). According to the World Bank, for the period from 2014 to 2024, the population decreased by approximately 8.1 million people, the share of people aged 65+ has already exceeded 17%, which significantly exceeds global indicators, and the share of children has decreased to 14% (Population in urban agglomerations, 2024).

The Ukrainian urbanization model can be characterized as polycentric with a dominance of medium and small cities. Thus, unlike many countries where there are several powerful urban agglomerations, medium and small European cities dominate in Ukraine, while megacities of a global scale are almost absent. Only ~14.7% of the population lives in urban agglomerations with a population of over 1 million - this indicates the expansion of medium and small cities (compared to megacities) (Population total, 2024). This is due to a structural imbalance: large cities are growing and facing infrastructure overload, while small and medium-sized cities are experiencing depopulation, staff outflow and population aging. This creates pressure on the labor market and reduces the development potential of small and medium-sized cities. Small city networks are not adapted to digital challenges, green transformation, innovative technologies, and often have limited financial and managerial resources to implement digital transformations and implement innovative practices. At the same time, they are key centers of regional development and maintaining the country's socio-economic balance, therefore, when searching for development strategies in Ukraine, the need to integrate medium-sized and small cities into a single digital ecosystem should be retained, which will ensure balanced and sustainable development of the territory (Urban development data, 2024).

All these circumstances form specific urbanization challenges characteristic of Ukraine. In the world's scientific and practical literature, the following key urban challenges are usually distinguished: infrastructure, environmental, social, and security aspects. Considering this, to gain a deeper understanding of the potential of applying the "smart region" strategy as a tool for ensuring sustainable development, it is advisable to conduct a detailed analysis of the current situation in Ukraine.

The infrastructure of Ukrainian cities was significantly worn out even before the war began: according to data for 2014, more than 60% of water supply and sewage networks were in critical

condition, the level of energy efficiency in housing and communal services systems remained low, and the condition of roads did not meet the mobility needs of the population and business. (Modernizing..., 2014). After 2024, the situation was complicated by direct destruction: according to RDNA4 estimates (Updated Ukraine recovery..., 2024), the total damage to Ukraine's infrastructure reached $176 billion (Direct damage, 2024). According to the World Bank, approximately 13% of the country's housing stock was destroyed or damaged, about 236 thousand houses (private, apartment buildings, dormitories) (World Bank..., 2024).

Transport infrastructure was also damaged: over 26,000 km of roads were damaged or destroyed; losses in the transport sector ~ $38.5 billion. (Direct damage..., 2024).

War significantly complicates spatial development planning and infrastructure restoration, making long-term planning impossible. Restoration of damaged networks and infrastructure projects requires rapid but balanced prioritization of costs. This creates the need not only for restoration, but also for modernization of infrastructure systems based on "smart" technologies.

Urbanization processes are accompanied by high levels of air pollution in large cities, such as Kyiv, Dnipro, and Kryvyi Rih, significant energy losses due to low building efficiency, and a lack of sustainable waste management systems. In addition, military actions create new environmental risks, including soil and water pollution, destruction of industrial facilities, and increased CO_2 emissions resulting from restoration processes (Ukraine Emergency, 2024).

Threats also arise from climate change, including more frequent extreme weather events, changes in forest states, erosion, and soil degradation. Forest fires have become a serious challenge. For example, over 965,000 hectares were burned in 2024 due to fires and forest/agricultural fires (Reuters, 2024).

In addition, reconstruction after destruction is often done quickly and with cheap materials, which may contradict the goals of climate neutrality and long-term environmental sustainability.

The social sphere of Ukraine is under significant pressure due to the combination of demographic crisis, economic imbalance and the consequences of the war. One of the most noticeable phenomena is the depopulation of small towns, caused by the outflow of the working-age population to large urban centers and abroad. According to UNHCR / UN Refugee Agency (2025) as of February 2025: 6.9 million Ukrainians have received refugee status or other forms of protection abroad. There are 3.7 million internally displaced people in Ukraine. Approximately 12.7 million people need humanitarian assistance in 2025, including nearly 2 million children. This leads to the decline of local economies, degradation of infrastructure and a decrease in the quality of life (Listening to citizens..., 2024).

Economic difficulties are exacerbated by high inflation and rising living costs. According to national methodology, about 29–37% of Ukraine's population lived below the poverty line in 2023–2024, while about 8.8% were on the verge of physiological survival (World Bank..., 2024).

A significant problem is the growth of social inequality. Access to basic services - electricity and water supply, healthcare, and education - varies significantly between relatively safe regions and areas affected by hostilities. The level of income inequality has also increased: the Gini coefficient in 2023–2024 exceeded 0.40 (for comparison, in 2021 it was ~0.25) (Listening to citizens..., 2024).

Large-scale internal migration creates an additional challenge: millions of citizens remain internally displaced people (IDPs), which creates a need for temporary housing and increases the burden on the social infrastructure of host cities. At the same time, the most significant losses are suffered by vulnerable groups of the population - pensioners, people with disabilities, and residents of frontline areas, who have limited access to protection and assistance (Listening to citizens..., 2025).

The social challenges of urbanization in Ukraine are complex and multidimensional. They combine not only the problems of depopulation and inequality, but also the issues of adapting infrastructure to the conditions of mass migration, war destruction and threats. These factors

necessitate the integration of modern technological solutions and "smart region" strategies to increase community resilience and reduce socio-economic disparities.

In a military context, the security dimension of urbanization becomes particularly important: the need to form crisis-resistant communities, develop civil protection systems, and integrate security monitoring technologies is growing.

Military threats remain the most obvious, including active hostilities, missiles and drone strike on urban infrastructure, and shelling of civilian and industrial facilities. A significant part of critical energy and housing systems have been destroyed or damaged, which limits the ability to provide basic needs for the population.

An equally important dimension is cyber threats, which have significantly increased in 2022–2024. They include massive cyberattacks on telecommunications systems, state registries, and business structures.

In response to these challenges, attention is being paid to the crisis resilience of urban systems. This includes the introduction of backup mechanisms, such as alternative energy sources, redundant communication lines, early warning systems for the population, evacuation plans, and protocols for restoring critical infrastructure. The mass introduction of generators, energy storage systems, and modular solutions ensures a minimum level of community functioning even under systemic attacks.

Assessments by international organizations confirm the scale of the challenges. According to the World Bank and the United Nations Development Program (United Nations..., 2024), Ukraine's needs for recovery and reconstruction over the next decade are estimated at approximately $ 524 billion.

Thus, Ukraine faces the following urbanization challenges: rapid population growth in large cities and increased pressure on infrastructure, infrastructure destruction, shortage of affordable housing, growing socio-economic inequality, unequal access to digital services, as well as climate risks (formation of "heat islands", threat of floods, deterioration of air quality), military and cyber threats, etc.

But despite the large-scale threats, the current stage of urbanization development also opens new opportunities. This creates the need to find comprehensive solutions that would combine reconstruction, innovative technologies and strategies for the development of "smart regions".

Despite the scale of the challenges, Ukraine's urbanization experience is special and specific, but not unique - many European countries have also faced the problems of restoring infrastructure, ensuring energy security, overcoming social imbalances and forming crisis-resistant urban systems. In several EU countries, both successful and less successful models of integration of "smart city" and "smart region" technologies have already been developed, which have allowed to increase the efficiency of management, reduce the vulnerability of communities to crises and strengthen the innovative potential of regions, or for several reasons have not achieved the desired results.

Addressing these cases is important for Ukraine, as it provides an opportunity not only to adapt foreign practices to its own context, but also to develop a strategic vision of post-war development. Table 1 provides examples of international experience, key practices and achievements, and highlights elements that may have practical value for Ukraine.

Table 1. International Experience, Results and Opportunities for Ukraine

Country	Key practices	Results (before/	Results/after results)	What can be adapted in Ukraine
Estonia	e-Government (99% public services online) Smart transport solutions	2002: GDP per capita ≈ $3 134	2022: ≈ $28 247 (+800%) 2024: 100% of the services are available online, ~14,000 users daily	A unified digital ecosystem for the state and regions Automation of municipal services Smart mobility in cities

Continued Table 3.

Country	Key practices	Results (before/	Results/after results)	What can be adapted in Ukraine
Finland	Smart City as a Service (integrated data) The goal is climate neutrality 2030	Helsinki emissions ↓ on 45% (1990 – 2023)	Per capita emissions ↓ by 60% 2025: Closure of the last coal-fired power plant → emissions reduction by 50%	Renewable Energy in Urban Systems Green Urban Regeneration Standards Using Digital Platforms for Infrastructure
Poland	Smart Cities (Warsaw, Krakow, Wroclaw) EU funds for digitalization and transport	2020: eGovernment digitalization of public services - 55	Growth in digitalization of public services by 14 points (2020–2023). - 69	Using EU grants and funds for smart projects Development of sustainable mobility (electric vehicles, bicycles) Pilot projects in regional centers

Source: compiled by the authors based on (ITIF, 2024; Notes from Poland, 2024; My Helsinki, 2025)

Analysis of international experiences shows that implementing "smart strategies" yields tangible results in the short and medium term. Estonia has proven that the digitalization of public services can increase the efficiency of management and stimulate economic growth (GDP per capita has increased by more than eight times in two decades). Finland has confirmed that systemic environmental policy and digital city management platforms reduce CO_2 emissions (minus 45% total and minus 60% per capita). Poland has shown that even a country with a transition economy can quickly improve digitalization using EU resources (+14 points in the eGovernment rating in just three years). For Ukraine, these examples are significant: in the post-war period, the key task will be not only reconstruction, but also the transition to more sustainable and competitive development models, where digitalization, energy modernization, and integration into European programs will play a decisive role.

For Ukraine, international experience shows the importance of:

- developing regional "smart specialization" strategies, coordinated with local resources;
- participating in international EU programs, in particular Horizon Europe and Green Deal;
- developing pilot projects of "smart regions" that could combine digitalization, energy efficiency and climate neutrality;
- ensuring broad public participation in the formation and implementation of innovation strategies.

The formation of "smart regions" allows solving problems simultaneously: from logistics to healthcare, "startup specialization" can create paths to local development without being tied to centralization. Moreover, certain steps have already been taken in Ukraine on this path.

In 2017, the Ministry of Economy announced the launch of pilot projects on smart specialization of industry in three regions of Ukraine and a focus on innovation and clusters. It enables the adaptation of the "smart specialization" methodology to regional conditions, stimulates industrial innovation, supports local industry, and attracts investments in manufacturing enterprises (Press Service of the Ministry of Economy, Environment, and Agriculture of Ukraine, 2017).

The successes of Kyiv, Dnipropetrovsk, Poltava, Ternopil, and Lviv regions in implementing "smart specialization" strategies show that this approach has practical effectiveness and is not limited to theoretical developments. An essential element of success was the local study of the resource potential of the regions, the assessment of their scientific

and technical level, and the active involvement of local stakeholders in the process of forming and implementing strategies.

In 2025, Ukraine is among the leaders in Central and Eastern Europe in the number of startups at the early stage of development (313 companies) and the number of "unicorns" (8 companies). Despite the high level of relocation (90% against the regional average of 48%), the Ukrainian technology sector demonstrated resilience even in war conditions. This confirms its potential to be one of the key areas of smart specialization and the driving force of post-war recovery (Money and Career, 2025).

Thus, the peculiarity of smart regions lies in the combination of scientific concepts of smart specialization with practical projects of digital transformation at the regional level. The analysis conducted allows us to identify key factors that contribute to or, conversely, complicate the implementation of the concept of "smart regions" (Table 2).

Table 2. Factors of implementation of "smart regions" in Ukraine

Category of factors	Predisposing factors	Adverse factors
Economic	Support for international donors and grant programs	Limited funding from the state and local budgets High cost of technological solutions Low investment attractiveness of certain territories
Institutional	Smart specialization strategies in regions Experience in decentralization	Fragmentation of regional politics Lack of coordination between state and local authorities Corruption risks
Technological	Development of the IT sector in the regions • Active development of digital services ("Diia", e-services) • Spread of mobile Internet and 4G/5G • Partnerships with IT companies	Uneven access to digital infrastructure between cities and villages Dependence on imported technologies Cyber vulnerability in wartime
Social	High level of digital literacy of young people Civil society activity Growing Demand of the Population for Quality Public Services	Demographic losses due to war and migration Low digital competence in older age groups Socio-economic inequality between regions

Source: summarized by the authors

Therefore, these factors provide an opportunity to critically assess the Ukrainian reality and consider both positive and negative factors that may act as a deterrent in the implementation of innovative, climate-oriented, and sustainable models of urban and regional development. Awareness of these factors is necessary for Ukraine to transform urbanization processes into a source of sustainable economic growth and social cohesion, rather than merely responding to crises. At the same time, awareness of the challenges and potential advantages creates space for the formulation of practical steps and strategic decisions. In this context, it is appropriate to outline proposals for Ukraine aimed at the effective implementation of the concept of "smart regions" and adapting international experience to national realities. At the same time, special importance should be placed on operational control, reporting, and assessment of the effectiveness of these components. Table 3 presents the Roadmap, which systematizes directions and enables informed management decisions regarding the implementation of "smart strategies" during the urbanization of Ukraine's regions.

Table 3. Roadmap for the introduction and implementation of "smart strategies" during the urbanization of the regions of Ukraine

Direction	Characteristics	Features of operational control
Development of regional smart specialization strategies	Each macro-region of Ukraine (North, South, East, West, Center) must determine its own development priorities (IT, agribusiness, energy, creative industries), integrating universities, business and local authorities.	Requires the implementation of a system of operational control of costs and results to ensure a transparent assessment of the efficiency of resource use and an audit of the feasibility of implementing investments in identified development priorities.
Launch of pilot "smart regions"	Selection of several regions for testing integrated development models (digital economy + green energy + climate neutrality), with the possibility of scaling to other regions	Requires the introduction of accounting mechanisms and analytical control of the results of pilot programs to assess financial risks, costs and economic efficiency in terms of the feasibility of scaling
Introduction of energy-efficient and "green" technologies	Adaptation of the principles of the European Green Deal to modernize municipal infrastructure, develop renewable energy sources and transition to a circular economy	Requires the implementation of control over modernization costs and assessment of the economic effect of energy-saving measures. Through systematic audits, monitor the effectiveness of investments, generate reporting for donors, regulators and stakeholders
Digitalization of management and public services	Creation of unified digital platforms for municipal management, transport logistics, e-health and e-education to ensure transparency and accessibility of services	Requires the implementation of electronic accounting systems and automated control of financial flows to ensure transparency of budget expenditures and audit
Development of sustainable mobility	Investments in public electric transport, infrastructure for bicycles and pedestrians, creation of integrated transport systems in cities and suburban areas	Investments in transport infrastructure need to be supported by operational financial monitoring and a management accounting system to assess costs, determine efficiency and payback period
Attracting international programs and funding	Participation in EU programs ("Horizon Europe", "100 Climate-Neutral and Smart Cities", "Green Deal"), the World Bank and UN-Habitat to receive grants, investments and expert support	Participation in international grant and loan programs requires compliance with requirements for financial reporting, audit of expenses and control over the use of funds
Inclusivity and citizen participation	Ensuring broad citizen involvement in project planning and implementation through electronic platforms, public councils, and local initiatives	Transparency of citizen involvement in planning and implementation of initiatives requires accessible financial reports, independent audit mechanisms, and control over the effectiveness of the use of funds at the level of local projects

Source: summarized by the authors

Conclusions

This study examines urbanization processes in Ukraine as a multidimensional phenomenon that combines both challenges and opportunities for sustainable development. Particular attention is paid to the analysis of the specific conditions in Ukraine, which are shaped by military risks, the need to restore critical infrastructure, the growth of regional imbalances, and the necessity of developing competitive governance models.

Based on international experience (EU, OECD, UN-Habitat, World Bank), it has been proven that digitalization, environmental policy, and innovative management practices can form the basis for transforming Ukrainian regions into "smart regions".

The potential of utilizing smart specialization tools and digital strategies to enhance the competitiveness of the national economy, foster human capital development, and promote spatial cohesion is examined.

This study made a clear conceptual distinction between the concepts of "smart city" and "smart region". While the "smart city" focuses on the modernization of urbanized areas, the "smart region" covers a broader spatial and managerial level, requiring integration between municipalities, economic sectors, and rural and urban areas. This approach allows us to overcome fragmentation and create a holistic development model.

This study shows that the formation of pilot "smart regions" can become a key catalyst for the recovery of post-war Ukraine and a demonstration site for testing new approaches in the areas of digital infrastructure, energy efficiency, mobility, and inclusion. This study confirms that only a comprehensive integration of digital, social, environmental, and infrastructure innovations creates the conditions for sustainable economic growth and social cohesion. The formed Roadmap systematized the directions for implementing "smart strategies" during the urbanization of the regions of Ukraine and will allow us to make management decisions based on operational control, reporting, and assessment of the effectiveness of these components in the future.

The prospect of further research is to predict economic recovery, reduce regional disparities, and form the foundation for a new development model, where urbanization processes are transformed into a source of long-term sustainability. Ukraine will be able to use international practices and its own potential to form smart regions that will ensure integration into the European space, improve the quality of life of the population, and resilience to global and domestic challenges.

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Conflict of interest

None.

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Проблеми та можливості урбанізації для сталого розвитку розумних регіонів в Україні

Анотація. У статті аналізуються ключові виклики процесів урбанізації для сталого розвитку регіонів України. Спираючись на міжнародні програми («Смарт спеціалізація», «100 кліматично нейтральних» та «Смарт міст»), аналітичні звіти міжнародних організацій (UN-Habitat, OECD, Світовий Банк), а також національні стратегічні документи, дослідження визначає специфічні особливості процесів урбанізації в Україні, які, відбуваючись у військових умовах та в контексті невизначеності та обмеженості ресурсів, стали головним викликом для сталого розвитку.

Водночас демонструється, що урбанізація може забезпечити основу для формування конкурентоспроможних та стійких «розумних регіонів» за умови ефективної інтеграції технологічних, соціально-економічних та управлінських вимірів, а також забезпечення просторової узгодженості шляхом міжмуніципальної та міжгалузевої співпраці.

На прикладах успішних європейських кейсів у статті показано, що цифровізація, екологічні інновації та електронне урядування підвищують національну конкурентоспроможність, територіальну згуртованість та якість життя за умови гармонійного поєднання цифрових, соціальних, екологічних та інфраструктурних інновацій.

У статті сформульовано рекомендації для України, зокрема щодо розробки національної стратегії «розумного регіону», інвестування в цифрову інфраструктуру, впровадження «зелених» технологій та зміцнення потенціалу кібербезпеки.

Для чіткого відображення регіональних особливостей процесів урбанізації, побудови дорожньої карти, впровадження оперативного контролю та оцінки ефективності, що є основою для прийняття управлінських рішень та можливості подальшого аналізу та визначення можливостей для реалізації концепції «розумного регіону» у статті використовується систематизація та візуалізація даних.

Дане дослідження доводить необхідність впровадження концепції «розумних регіонів» та адаптації міжнародного досвіду до національних реалій шляхом інтеграції технологій, цифрових, соціальних, екологічних та інфраструктурних інновацій для покращення якості життя в громадах. Крім того, впровадження оперативного контролю, звітності та оцінки ефективності напрямків Дорожньої карти дозволить приймати управлінські рішення щодо впровадження «розумних стратегій» під час урбанізації регіонів України

Ключові слова: цифрова трансформація, інновації, інвестиції, регіональна політика, розумна економіка, розумна стратегія, оперативний контроль, звітність та оцінка ефективності, цифровізація, збалансований розвиток регіонів