DOI: 10.55643/fcaptp.2.55.2024.4281

Halyna Kryshtal
D.Sc. in Economics, Professor, Head of the Department of Finance, Banking and Insurance, Interregional Academy of Personnel Management, Kyiv, Ukraine;
e-mail: gkryshtal@ukr.net
ORCID: 0000-0003-3420-6253
(Corresponding author)

Viktoriia Tomakh
PhD in Economics, Associate Professor of the Department of Management, Logistics and Innovations, Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine;
ORCID: 0000-0002-0445-6019

Tetiana Ivanova
PhD in Economics, Associate Professor of the Department of Economic Theory, Accounting and Taxation, Kyiv National University of Construction and Architecture, Kyiv, Ukraine;
ORCID: 0000-0001-8883-7881

Volodymyr Metelytsia
D.Sc. in Economics, Senior Research Fellow, Professor
of the Department of Accounting and Consulting,
State Tax University, Irpin, Ukraine;
ORCID: 0000-0002-0795-0215

Maryna Yermolaieva
PhD in Economics, Associate Professor of the Department of Accounting and Taxation, Poltava State Agrarian University, Poltava, Ukraine;
ORCID: 0000-0003-0469-0435

Yevhen Panin
PhD Student, Cherkasy State Technological University, Cherkasy, Ukraine;
ORCID: 0000-0002-4789-5230

Received: 11/12/2023
Accepted: 10/04/2024
Published: 30/04/2024

ECO-INNOVATIVE TRANSFORMATION OF THE URBAN INFRASTRUCTURE OF UKRAINE ON THE WAY TO POST-WAR RECOVERY

ABSTRACT

The study is aimed at summarizing the processes of eco-innovative (green) transformation of urban infrastructure and researching possible prospects for the development of Ukraine in this context. In the course of the research, the possibilities of "green" transformation of urban infrastructure were considered and it was noted that the use of the principles of eco-innovative transformation in the post-war period can only take place under the condition of proper planning, state support and the creation of favourable market conditions. The authors noted that the success of such a transformation requires the establishment of green goals in all aspects of the development of Ukrainian cities. Auto-frame considered the financial possibilities of the development of urban infrastructure and proposed the location of support offices for the eco-innovative transformation of urban infrastructure at the regional level. The principles of achieving eco-innovative transformation of urban infrastructure are revealed, namely maximum energy efficiency, energy transition, "zero waste", environmental sustainability of buildings, adaptation to climate change, popularization of a green lifestyle, resource conservation, citizen involvement and circular economy. It is proposed to create a platform that would unite architects, builders, urban planners, citizens, artists and other interested persons. This platform should contribute to the search for answers to the question of how to ensure a quick, ecological, attractive and safe "green" transformation of urban infrastructure. Ukraine should cooperate with the European Union within various green platforms and networks that help cities in green transformation. All the above-mentioned tools and solutions should contribute to the creation of green, sustainable and people-oriented cities in Ukraine. The authors have considered the possibilities of financing the restoration of Ukrainian cities after the destruction in terms of the necessary financial resources, donor countries, and reconstruction expenditures.

Keywords: eco-innovative economy, eco-innovative transformation, green transformation, analysis, financial opportunities, financing, infrastructure

JEL Classification: O31, O32

INTRODUCTION

After the war, Ukraine will face the task of restoring all sectors and objects of urban infrastructure. This process will require different approaches for various objects. Two main groups of infrastructure can be distinguished: those that have suffered significant or complete destruction and those that have remained largely undamaged (Kyrylenko et al., 2023). The infrastructure that has been destroyed will require reconstruction plans. In such cases, it is important to determine which structures and parts of the infrastructure need to be restored and how resources are mobilized. Reconstruction planning should address the city's needs, interests, and opinions of local residents while ensuring the creation of a resilient and functional environment for living.

Regarding cities that have not suffered significant destruction, their development in new conditions will require transformation. This is evidenced by the review of existing development plans adapted to new needs and challenges, including ecological, economic, and social aspects. Such cities have the opportunity to rethink their identity and create a more viable and attractive environment for residents (Petrik, 2023). Regardless of the degree of damage, recovery, or development, infrastructure encompasses cross-cutting

issues that concern all cities. Human needs and opinions should be of paramount importance. A people-centric approach should be a key principle in the post-war recovery of the city and infrastructure as a whole. Cities should create comfortable conditions for a full and quality life. Planning should compensate for migration processes that have affected millions of people and ensure the resilience and stability of the local population.

In the context of infrastructure solutions related to recovery and development, these principles should also be considered. The construction and reconstruction of infrastructure should contribute to improving the quality of life for residents, providing convenient access to services, green spaces, transportation, and other essential elements of the urban environment (Perevozova et al., 2021). Moreover, it is important to use durable and environmentally friendly materials and consider opportunities for implementing innovative technologies to create resilient and energy-efficient cities. Overall, the questions of recovery and development of Ukraine's infrastructure after the war require an integrated approach that combines planning, financing, public participation, and the smart use of resources. Only by taking into account the needs and opinions of the people, preserving cultural heritage, and creating a resilient and attractive environment can we successfully rebuild and develop Ukraine's infrastructure after the war. It should be noted that in Ukraine, the process of transformation and the formation of a mechanism for financing eco-innovative (green) infrastructure transformation requires further detailed research.

LITERATURE REVIEW

The fundamental principles of developing green Smart Cities, as outlined in the scientific works of renowned researchers, define crucial aspects for creating environmentally sustainable and intelligent urban areas. Scholars such as Albino and Dangelico (2012), Bollier (1998), and Giffinger, Fertcher, and Kramar (2007) thoroughly investigate and formulate principles that contribute to the green growth of urban territories and regions. They emphasize environmental, energy, technological, and social aspects of urban development. It's important to note that these principles aim not only to ensure the sustainability of ecosystems in urban environments but also to utilize innovative technologies to enhance the quality of residents' lives. Green Smart Cities are designed with a focus on citizens' health and comfort, aiming to optimize resource usage and reduce environmental impact.

The development of these principles represents a significant step in the advancement of urban planning and construction. They take into account modern challenges related to climate change, urban resilience to stressful situations, and the development of cutting-edge technologies. Expanding upon these principles can help construct cities that effectively blend technological progress with the preservation of natural resources, fostering more resilient and livable communities.

Zhukovich (2014) delves deeply into the creation of green Smart Cities as a vital component of the "green" development concept for urban areas. He points out that green Smart Cities not only leverage advanced technologies to enhance residents' comfort and efficiency but also actively incorporate environmentally friendly approaches to urban planning and infrastructure.

The creation of green Smart Cities within the concept of "green" urban development involves the use of integrated approaches to conserve natural resources and establish a healthy living environment. The authors emphasize the importance of combining modern technologies with sustainable development strategies to achieve a balance between economic growth, social equality, and environmental sustainability. Furthermore, it is highlighted that the development of green Smart Cities under "green" development considers innovative solutions in energy efficiency, the use of renewable energy sources, efficient waste management, and other elements aimed at reducing environmental impact and improving the quality of life for residents (Bazaluk et al., 2020; Dvigun et al., 2022a, 2022b).

Researchers, including Owensby-Conte and Yepes (2012), and Koval et al. (2023) actively explore issues related to "green" construction. Their studies likely focus on technological and infrastructural innovations aimed at creating environmentally friendly and efficient urban spaces. These scholars may discuss innovative approaches to energy efficiency, construction materials, and other aspects of "green" construction in their works.

On the other hand, Hens (2010) focuses on formalizing conditions for the implementation of "green" innovations in urban planning. This may involve considering aspects such as the legislative environment, financial support, interaction with stakeholders, and other factors influencing the successful implementation of green initiatives in urban planning.

Expanding on the author's perspective, it can be noted that these studies are crucial for the development of modern cities and the enhancement of their sustainable growth. Further discussion of specific conclusions and recommendations from these researchers can deepen the understanding and significance of their contributions to the field of green urban development.

DOI: 10.55643/fcaptp.2.55.2024.4281

Researchers contribute significantly to the study of issues related to green Smart Cities by working on formalizing the transformation of models of municipal development towards green Smart Cities. Their research may include the analysis of innovative strategies and practices aimed at ensuring the ecological friendliness and sustainability of the urban environment (Zhukovych, 2014; Gaman et al., 2022; Kulikov et al., 2022; Shevchuk & Omelchuk, 2023).

It's also worth highlighting the work of Sokolovska (2014), who investigates modern information and communication technologies in green municipalities. Her research may involve analyzing the application of digital tools and the Internet of Things (IoT) to enhance the efficiency and environmental friendliness of urban management.

Expanding on the author's perspective, it can be said that such research is essential for understanding and implementing innovations in municipal management aimed at creating environmentally friendly and technologically advanced cities.

Researchers (Zvonar, 2017; Bobrovsky, 2014; Pobochenko and Shvayuk, 2016; Kyrylenko et al., 2022; Semenets-Orlova et al., 2022b; Chukurna et al., 2022) made a significant contribution to studying the creation of Smart Cities based on the concept of sustainable development. They actively analyze and assess various aspects of the transformation of urban development, particularly focusing on the ecological and social aspects of this process.

The pieces of research by Zvonar (2017) and Semenets-Orlova et al. (2022a) are highly significant for scholarly thought as they involve the analysis of innovative approaches to sustainable urban development and their impact on the quality of life for residents. Bobrovsky (2014) explores the concept of a green Smart-City in his works as a distinct social dimension, taking into account both ecological and technological innovations.

Pobochenko and Shvayuk (2016) and Mironova et al. (2022) assess the energy and environmental advantages of Smart-City by investigating technological solutions aimed at improving resource efficiency and reducing environmental impact.

Today, cities are key factors in the economic development of countries and are increasingly becoming independent participants in the international arena. A special position in the country's economy is occupied by the capital, which acts as a financial and investment centre. For example, Kyiv, as the capital of Ukraine, is equipped with exceptional economic potential. The location of 6% of the country's population in Kyiv has a huge impact on the economic landscape. The city generates about 19% of GDP, is the centre of retail trade (18%) and performs 23% of all construction work.

More than 60% of financial sector assets are concentrated in Kyiv, marking its key role in the country's financial stability. This status of the capital not only emphasizes its importance for the economy but also defines it as a strategic participant in national and international economic development (Khaietska et al., 2023).

The problems of urban development and financing were studied by Geraimovich (2013) and Averkina (2012), who in their works draw attention to the low levels of wages, social benefits, and other incomes, which are the reason for the low solvency of Ukrainian citizens. Only 5-8% of residents can provide housing for themselves. The scientist sees the development and implementation of effective housing financing mechanisms that would significantly increase housing affordability for the vast majority of the population as one of the priority tasks of state policy.

According to Geraimovich (2013), two ways of solving the above-mentioned problems can be outlined: 1) to improve the implementation mechanism of this program by improving its information transparency, increasing the amount of funding of the program, expanding the circle of citizens who can use the program, and reducing the price the value of real estate objects included in the program, etc., or 2) close the "Affordable Housing" program due to its low efficiency and lack of targeted funding in the declared volumes.

Expanding on the author's perspective, it is important to emphasize that these studies constitute a significant contribution to the understanding and development of concepts related to sustainable urban development and the creation of Smart-City based on ecological and social responsibility.

AIMS AND OBJECTIVES

The purpose of the work is to synthesize the processes of eco-innovative green transformation of infrastructure and explore possible development prospects for Ukraine.

The research aims to achieve the following objectives:

- explore the possibilities of green infrastructure transformation;
- elaborate on the principles of achieving eco-innovative transformation of infrastructure;

- explore the possibilities of financing the restoration of Ukrainian cities after the destruction, considering the necessary financial resources, donor countries, and reconstruction expenditures;
- propose tools and solutions that will contribute to the creation of green, sustainable, and human-oriented cities in Ukraine.

METHODS

During the scientific research of eco-innovative (green) infrastructure transformation, various methods of cognition were applied using systematic analysis and scientific processing of the obtained results. Some of the methods include:

1. Logical generalization: this method enabled the systematic organization and generalization of the structural components of eco-innovative (green) transformational infrastructure, modifying the relationships between them, and identifying key factors influencing the success of such processes.
2. Quantitative and qualitative comparisons: these methods allowed for a comparative analysis of different approaches, strategies, and practices of eco-innovative (green) infrastructure transformation in various contexts. They helped identify the advantages, disadvantages, and risks associated with the implementation of various measures and initiatives.
3. Scientific abstraction and systematization: these methods systematically described and classified various aspects of eco-innovative (green) infrastructure transformation, created conceptual models, identified key success factors, and developed proposals for improving regulatory and support directions for such processes.

All these mentioned methods facilitated a scientific analysis and synthesis of the research results on eco-innovative (green) infrastructure transformation, contributing to the subsequent step of the methodology in terms of developing scientifically grounded strategies and recommendations for development.

RESULTS

Eco-innovative (green) infrastructure transformation entails a shift towards sustainable and environmentally friendly infrastructure that reduces environmental impact and promotes sustainable development. This includes the development of green infrastructure, such as energy-efficient buildings, the utilization of renewable energy sources, the creation of eco-friendly transportation systems, water resources and waste management, and the integration of natural elements into urban planning, among others.

In the context of Ukraine's development, the analysis and synthesis of eco-innovative (green) infrastructure transformation processes may serve as a basis for determining pathways for the country's development, considering stability and ecological requirements. This may involve developing strategies for the advancement of green technologies, fostering innovative enterprises, implementing energy-efficient technologies in construction and transportation systems, supporting environmental initiatives, and attracting investments in green infrastructure (Mulska et al., 2022; Lupenko et al., 2022; Rodchenko, 2022; Buryachenko, 2012).

Analyzing and synthesizing such processes can contribute to the development of perspectives for Ukraine in the context of eco-innovative (green) infrastructure transformation, fostering sustainable development, environmental preservation, and improving the quality of citizens' lives.

The innovative model of green Smart Cities, based on the digitization of municipal development, is becoming increasingly popular worldwide. The European Union stands as a major initiator of transforming conventional cities into green Smart Cities. In these "green" cities, digital technologies are employed to enhance the well-being and quality of life for residents, as well as to improve environmental safety and energy efficiency. The key characteristics of Smart Cities are outlined in Table 1.

DOI: 10.55643/fcaptp.2.55.2024.4281

Table 1. Key characteristics of Smart Cities. *(Source: Marciniak, 2013)*

Characteristics of Smart Cities	Sphere of manifestation
Smart Environment	▪ Energy Efficiency ▪ Resource Management ▪ Environmental Protection
Smart Governance	▪ Open Data ▪ Government and Social Services ▪ E-Government
Smart Mobility	▪ Traffic Management ▪ Logistics ▪ Electric Vehicles
Smart Economy	▪ Enterprise and Innovation ▪ Productivity ▪ Labor Market Flexibility
Smart People	▪ Urban Life Management ▪ Inclusive Society ▪ Education
Smart Living	▪ Health and Life ▪ Recreation Technology ▪ Accessibility Security

The formulated characteristics are as follows:

1. Smart Environment: Closely related to the rational use of resources, primarily energy. Considering the limited resources and their high costs, the main emphasis is on implementing energy efficiency principles and reducing greenhouse gas emissions. This characteristic involves the development of "smart energy" through the introduction of closed energy networks, pollution level control and monitoring systems, the construction of energy-efficient buildings, and the use of innovative and cost-effective biomass, solar, and wind energy. An important aspect is waste management, including control over waste accumulation, transportation, and efficient disposal. All of this is aimed at creating a sustainable and environmentally friendly environment for city residents.
2. Smart Governance: Directed towards interactive governance at the local level, creating conditions for the effective functioning of the city. The idea is to use advanced technologies to optimize management processes and ensure interaction between the government and citizens.
3. Smart Mobility: Involves increasing the use of transport and logistics systems based on information and communication technologies. This may include optimizing the transport network for convenient movement between any points in the city.
4. Smart Economy: Oriented towards the development of electronic commerce and business, increasing labour productivity, and a high level of innovation in the technological production of goods and services.
5. Smart People: Aimed at developing IT skills, increasing education levels, and computer literacy, as well as enhancing qualifications, stimulating creativity, and fostering innovation.
6. Smart Living: Envisages the implementation of ICT in the organization of life, changes in people's behaviour, and models of consumption of goods and resources. The goal is to improve health and develop a cultural environment.

In summary, the Smart-City model, consisting of these six main components, is proposed to be represented in Figure 1.

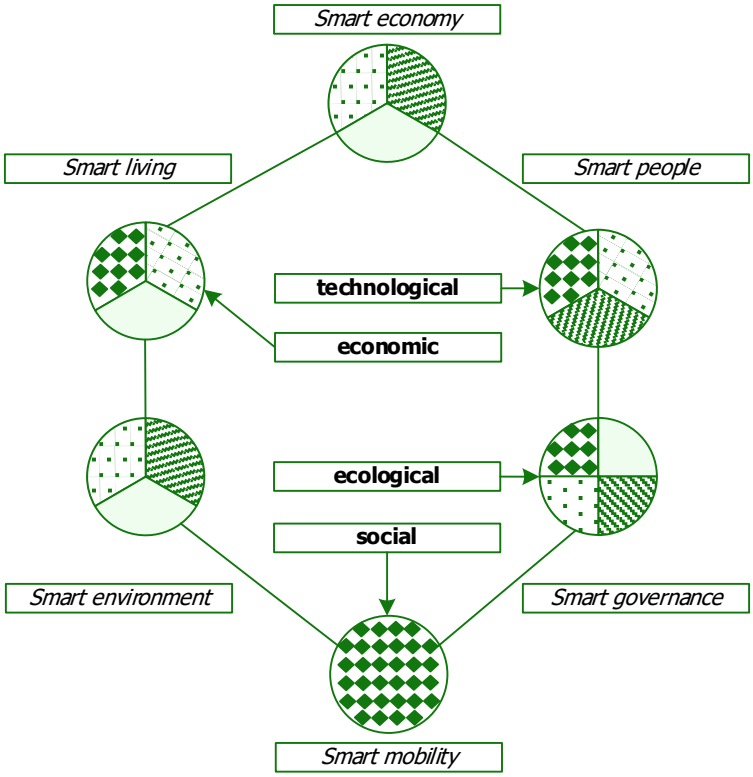

Figure 1. The Smart-City model is presented in the form of six components. *(Source: Marciniak, 2013)*

The task of the near future is to create conditions for the high quality of society's life through the use of advanced technologies aimed at the safe, economical, and ecological functioning of all subsystems of urban life. To achieve the status of a smart city, systemic reforms are needed in sectors such as public services, transportation, construction, utilities, energy, healthcare, trade, social support, security, finance, and others. In practice, the concept of a smart city includes the application of cutting-edge technologies in construction and infrastructure projects, the use of innovative materials, the transformation of city management methodologies and processes, as well as the application of modern information technologies to enhance the efficiency of local authorities (Shevchuk, 2022; Sumets et al., 2022).

An integral step in implementing the Smart-City concept is identifying areas that require modernization and justifying the necessary tools to achieve the planned goals. It is important to analyze the specific characteristics of the city and the needs of its residents.

Furthermore, it is crucial to identify the tools that will be implemented to achieve the strategic goals of a smart city. These may include information and communication technologies, monitoring and management systems, and innovative solutions in energy, transportation, healthcare, and more. The justification and effectiveness of choosing these tools will determine the success of the concept's implementation.

Implementing reforms in the city's development management system is a key step in ensuring coordination, efficiency, and transparency in the implementation of Smart-City.

This includes not only technical aspects but also socio-economic and legal aspects of urban development management. An optimized management system will enable efficient responses to changes, the implementation of innovative approaches, and the provision of quality services to the city's residents (Sytnyk et al., 2022; Oliinyk et al., 2021).

The development of Smart-City services will expedite decision-making, save budget costs, and improve the provision of information services to citizens and businesses. Let's consider electronic services that can contribute to the development of Smart-City (Table 1).

DOI: 10.55643/fcaptp.2.55.2024.4281

Table 2. Electronic Smart Services for Individuals and Legal Entities. *(Source: Zvonar, 2017)*

Sector	Service Name	Service Description
Transportation	Waze	A web service for monitoring the road situation in the city is an innovative tool that helps users identify the optimal route and overcome traffic challenges most efficiently. This online application interacts with real-time data on the condition of roads, enabling drivers and passengers to plan their journeys more quickly and effectively. The application not only simplifies navigation through the city but also contributes to improving overall traffic flow, making it smoother and more tailored to the needs of each user.
	EasyWay	An online platform for real-time tracking of public transportation movements and access to its schedule has become a necessity for city residents. This innovative service allows users to conveniently and efficiently plan their trips by providing up-to-date information on the location of transportation vehicles and the estimated time of their arrival at a stop. This service becomes a vital tool for city dwellers, assisting them in using public transportation conveniently and efficiently in their daily mobile lives.
	Parking Inspectors Service	Ensuring order in the parking sector in the city has become more efficient thanks to innovative online services. Now, residents and drivers can easily voice their complaints about parking violations through a dedicated online interface. This provides citizens with the opportunity to actively participate in maintaining order on the streets and parking lots of the city. Such innovations in the parking sector contribute to the creation of safe and organized public spaces, as well as improve the interaction between municipal services and residents to ensure convenience and compliance with rules in the urban environment.
Housing and Utilities Sector	Urban Contact Center	The online interface allows city residents not only to submit inquiries but also to track their status in real time. This creates a transparent and open mechanism of interaction, where citizens can see at which stage their inquiry is being processed or addressed. Such an approach makes the interaction between the urban population and municipal services more transparent, efficient, and open, contributing to problem resolution and improving the quality of municipal services in the city.
	Personal Resident Account	The Personal Resident Account is an innovative electronic service that serves as a vital communicator between utility service providers and municipal services on one side and city residents on the other. This service is designed to simplify and optimize the interaction between various stakeholders to ensure the more effective functioning of municipal infrastructure.
	Safe City	This tool enables quick and efficient access to information for city management and security services, facilitating prompt intervention when necessary. Such a service is a crucial step towards ensuring safety and monitoring events in the city through the use of modern technologies and open communication.
	Shelters	Creating a website with an interactive map that marks all the shelters in the city during emergencies is a crucial element of the city's security and preparedness system for various hazards. This tool provides citizens with access to essential information in crisis situations. This interactive tool can be integrated into the city's portal or mobile application system to ensure maximum accessibility and convenience for city residents.
Health and Medicine	Helsi	Online doctor appointment scheduling.
Cultural and Entertainment	Tourism Portal	Creating a website with all the tourist infrastructure is an important step in attracting tourists and providing them with conveniences during their visit to the city. Such a resource can contain a wide range of information to facilitate the travel and entertainment of tourists.
	Cultura	Event Portal Creating a website with current city events is an important step in promoting the cultural and social life of residents and visitors. Such a resource can provide a wide range of information about various events taking place in the city. Key elements of such a website may include: 1. Event Calendar: A convenient calendar displaying all upcoming and future events in the city. 2. Concerts and Performances: Information about music concerts, theatrical performances, opera nights, and other performances. 3. Exhibitions and Fairs: Schedule of art exhibitions, craft fairs, and other thematic events. 4. Sports Events: Information about sports competitions, tournaments, and other sporting events. 5. Cultural Festivals: Overviews of festivals in various fields – from cinema and music to gastronomic fests. 6. Reviews and Critiques: Reviews of past events and critiques to help users make informed choices. 7. This website can become an integral part of the city's cultural life, assisting people in choosing and planning their leisure and entertainment activities.
	Sports Portal	Creating a website with sports events and achievements of city residents can significantly enrich the city's informational environment and support the development of sports culture. The main components of such a website may include: 1. Sports Event Calendar: Schedule and information about all sports events, such as competitions, tournaments, marathons, etc. 2. News and Press Releases: Reviews and news about the sports achievements of teams and individual athletes in the city. 3. Athlete Profiles: Information about outstanding athletes in the city, their achievements, biographies, and interviews. 4. Rankings and Statistics: Tables and graphs displaying rankings of teams and athletes. 5. Sports Clubs and Associations: Information about various sports associations and clubs in the city. 6. Photo and Video Materials: Galleries of images and videos from sports events. 7. Information about Sports Infrastructure: Addresses and overviews of sports grounds, stadiums, and other facilities. Such a website can bring together the sports community of the city, inspiring and supporting athletes on their path to achievements.

(continued on next page)

Table 2. Continued

Sector	Service Name	Service Description
Transparent	Budget	The creation of a website that displays information about the revenues and expenditures of the local budget can make financial processes more transparent and accessible to the city's residents. The key functionalities of such a website may include: 32. Revenue Dynamics: Charts and diagrams illustrating the dynamics of revenue to the local budget from various sources, such as taxes, fees, financial assistance, etc. 33. Expenditure Structure: Breakdown of expenditures into different sectors of the economy, such as education, healthcare, municipal services, culture, social programs, etc. 34. Projects and Initiatives: Information about specific projects and initiatives funded by the local budget, along with reports on their outcomes. 35. Budget Reports: Regular publication of budget reports that provide detailed descriptions of revenues and expenditures for a specific period. 36. Community Participation: An opportunity for residents to leave comments, express their opinions on the allocation of budget funds, and make suggestions. 37. Interactivity: Use of visualizations, interactive maps, and other tools to present information in an understandable manner. The creation of such a website would promote openness and interaction between government authorities and the community, facilitating more effective use of budgetary funds.
Administrative and Social Services	Government Directional Services Portal	The creation of such a website with online forms, registries, and services can significantly facilitate the interaction of citizens with government agencies and social services. Key elements and functionalities of such a website may include: Online Forms and Templates: ▪ centralized access to all necessary forms and templates for various types of declarations, applications, registries, etc.; ▪ interactive online forms with the ability to fill out and electronically sign. Service Catalog: ▪ categorized catalogue of services provided to citizens, businesses, and other entities. Registries and Databases: ▪ convenient access to registries and databases, such as business registries, real estate records, social services, etc. Social Services: ▪ a dedicated section for inquiries regarding social services, adoption, or guardianship of children; ▪ information about requirements and procedures for different types of social support. Online Communication: ▪ convenient communication tools with representatives of social services for consultations and assistance; ▪ interactive chats or ticketing systems to address questions and issues. Inquiry Monitoring: ▪ tracking history and status of inquiries so that citizens can monitor their progress; ▪ creating such an interactive and information-functional resource will contribute to increased accessibility and efficiency of government and social services for citizens.

In recent years, the population of cities in Ukraine has been steadily increasing, leading to the need for the improvement of electronic services to ensure the effective functioning of cities and enhance the quality of life for citizens. The analysis of open data becomes a key element in this process, aiding the government, businesses, and non-governmental organizations in making informed decisions.

The concept of a Smart City serves as an innovative system that utilizes advanced technologies such as sensors, the Internet of Things (IoT), networks, and big data analytics to enhance the competitiveness and efficiency of urban services. The core principles of Smart Cities include sustainable development that considers economic, social, and environmental aspects, catering to the needs of current and future generations.

The development of Smart Cities involves the integration and coordination of various services in cities, fostering opportunities for citizens' remote participation in governance processes. This entails creating conditions for active citizen involvement in urban management, promoting increased interaction and openness in city governance.

Research indicates that city management systems often insufficiently consider factors such as the movement, storage, distribution of goods, transportation, and hazardous waste disposal. These factors adversely affect the city's ecosystem and are not aligned with the principles of sustainable development.

City management systems often lack a logistic approach, which ensures optimal management of economic flows and resources to achieve goals with minimal costs. Logistics is closely related to the architecture, urban planning, and ecology of the city. Given the need to minimize pollution and optimize resource utilization, the application of eco-innovative (green) transformation principles to city management systems becomes increasingly important.

DOI: 10.55643/fcaptp.2.55.2024.4281

Eco-innovative (green) transformation of infrastructure is a tool that supports environmental safety and economic growth. The implementation of eco-innovative (green) transformation principles in city management systems requires active participation from local authorities and other economic entities in shaping new institutional foundations for city development, where economic, social, and environmental factors converge. The areas of infrastructure activation are outlined in Table 3.

Table 3. Areas of Activation of Eco-Innovative Infrastructure. *(Source: Zvonar, 2017)*

Innovative economy	Urban infrastructure	Management
Innovations in industries, clusters, and city districts	Transportation	Administrative services for citizens
Knowledge workforce: education and employment	Energy / Utilities	Direct democracy
Establishment of knowledge-based companies	Environmental protection / Safety	Citizen services: quality of life

There are several key approaches to implementing the Smart City concept. One such approach is actively used by IT companies to deploy their products at the local level for the automation of various urban life spheres. The "smart" infrastructure of the city combines physical and digital components. Physical infrastructure covers areas such as transportation, energy, water supply, telecommunications, and waste management. While digital infrastructure includes sensors, the Internet of Things (IoT), networks, big data, and other technological solutions. However, it is important to note that Smart City not only aims for automation but also for improving the quality of life for residents and ensuring sustainable urban development.

Assessing the impact of economic activities on the environmental state of the city is an aspect of production and should be statistical when developing logistical solutions. Various logistic approaches already exist globally to address air pollution, transport network overload, and consumer spending. Applying the principles of "green" infrastructure transformation in the city management system is necessary to achieve environmental safety and sustainable development. This requires cooperation between local authorities with open interests and the formation of new models of city development that ensure a harmonious combination of economic, social, and environmental factors.

The military events with Russia have led to extensive destruction in many cities of Ukraine. Disruptions to the sustainable functioning of populated areas, notably in Mariupol, where over a third of buildings have undergone significant destruction or serious damage, have become a distressing reality. Even larger cities, such as Kharkiv, Zaporizhzhia, and Severodonetsk, have also suffered substantial destruction caused by the military conflict.

These catastrophic events have resulted in various forms of devastation, and the ultimate consequences remain uncertain. Parts of cities have been transformed into ruins, and their restoration poses a significant challenge for Ukrainian society. In this challenging time, efforts need to be directed towards reconstruction, recovery, and support for those who have suffered from these devastating events.

Rebuilding cities after the war is a crucial task, and initiatives involving foreign countries are a positive step towards the recovery of Ukrainian regions and cities affected by the war. With financial support from the Ministry of Foreign Affairs of the Czech Republic under the Transition Promotion Program, a special project for the reconstruction of cities affected by Russian aggression is being implemented. Additionally, the Association of European Cities Eurosities plans to unite over 200 major cities in Europe to implement reconstruction projects for Ukrainian cities. A memorandum of cooperation in this direction has been signed.

The first stage of recovery involves crucial measures such as clearing debris and restoring infrastructure. This phase requires active participation from the government and planners, who play a key role in adjusting city planning, including the design of transportation networks, highways, main and side streets, as well as suburban railway systems. An important task is the restoration of public facilities, such as schools, parks, administrative buildings, hospitals, and others.

In the next stage, the laying of engineering communications, such as water supply, gas pipelines, and sewage systems, takes place. Approximately half of urban territories are used for public needs, and the location of these objects, including transportation, determines the direction of private investments.

All these measures are not only aimed at restoring physical infrastructure but also hold significant importance for economic revitalization and social recovery of the affected cities. As of May 10, 2023, the total documented damages in the infrastructure exceeded USD 94.3 billion or almost UAH 2.8 trillion. Due to the war, Ukraine lost 23% of its railway network, including the loss of 6.3 thousand km of main tracks, damage to 23,573 km of roads, and the impairment of 289 automobiles and 41 railway bridges.

Estimates indicate that the war resulted in the destruction or damage of 35.2 million square meters of residential buildings, amounting to USD 31 billion. Cities like Mariupol, Kharkiv, Chernihiv, Sumy, and Rubizhne suffered the most significant losses in the housing sector. The number of damaged or destroyed educational institutions has reached almost a thousand, with estimated losses of USD 1.3 billion.

The reconstruction and recovery of Ukraine after the war will require substantial investments amounting to USD 411 billion, surpassing the country's expected GDP in 2022 by nearly 2.6 times. This determination arises from a study conducted by the World Bank, the United Nations, the European Commission, and the government of Ukraine. According to the bank's instructions, the total amount of necessary funds has sharply increased compared to the previous estimate of USD 349 billion, which was disclosed in September of the previous year.

For critical and priority investments in reconstruction and recovery, Ukraine currently needs USD 14 billion. To achieve this, an additional USD 11 billion in financing will be required, in addition to what is already planned in the Ukrainian budget for 2024.

Approximately 22% of expenditures are planned for the restoration of transportation infrastructure, 17% for the housing and utilities sector, 11% for the energy complex, and 7% for agricultural development.

Observations from the World Bank indicate that the most significant expenses will be required in the energy sector, where the level of losses has increased more than fivefold compared to the previous year. It is also worth noting that the most significant growth in necessary funds for recovery is observed in the front-line regions, such as Donetsk, Kharkiv, Luhansk, and Kherson oblasts, which have been subjected to extensive rocket attacks from Russia since October.

Key priorities include the restoration of critical infrastructure, residential buildings, as well as essential social and transportation facilities. It is also crucial to focus on the recovery of the industrial sector, the development of the agricultural sphere, the IT industry, and other sectors. One of the ambitious goals is to achieve GDP figures of USD 500 billion within ten years, contrasting with the less than USD 160 billion estimated at the end of 2022.

In an effort to attract financial resources for the reconstruction of Ukraine after the war, the government is directing its efforts towards utilizing the online platform United24 (U24). Funds collected on this platform are allocated across three key directions: defence and demining, humanitarian and medical assistance, and the country's rebuilding. This global initiative has garnered support from residents of nearly 90 countries, raising contributions to over USD 147 million in charitable donations by July 26. It is noteworthy that almost USD 900,000 is earmarked for reconstruction. However, as of today, these funds are still being accumulated, as they are insufficient to commence the restoration of a specific community, as reported on the U24 platform.

This initiative serves as an example of collective efforts from citizens worldwide to aid those affected by the conflict in Ukraine. The online platform provides an opportunity for active participation in the country's recovery and addressing urgent defence, humanitarian, and medical needs.

Certain countries and cities have already taken responsibility for the reconstruction of infrastructure damaged by Russian terrorists. It has been revealed that some have taken sponsorship of individual cities, while others have taken charge of regions or specific sectors of the economy.

During the conference in Lugano, a map of city reconstruction was presented, marking a crucial step in defining priorities for rebuilding. Representatives from over 40 countries and approximately 20 international organizations endorsed a Declaration, pledging support to Ukraine in this critical process.

For instance, France, including both its national and local government bodies, is actively focusing its efforts on providing assistance to the Chernihiv region. The partnership between Chortkiv and the city of Beziers signifies a successful start to new initiatives and collaboration between Ukrainian and foreign partners.

Distant Taiwan has also expressed readiness to contribute around USD 4 million for the restoration of Ukrainian cities. These funds are distributed with half designated for the restoration of Kharkiv, and USD 500,000 each for Chernihiv, Mykolaiv, Sumy, and Zaporizhia. These financial resources will be directed towards rebuilding educational institutions and critical infrastructure.

Additionally, two significant companies, "Ukrenergo" and "Ukrzaliznytsia," have already received financial assistance from international partners for reconstruction. In particular, "Ukrzaliznytsia" is undertaking the restoration of a damaged station and station square in Trostianets using its own funds.

DOI: 10.55643/fcaptp.2.55.2024.4281

These initiatives and commitments from international partners demonstrate a readiness to collaboratively assist Ukraine in its efforts towards recovery and support for the affected regions.

One strategic direction for Ukraine's recovery involves implementing regional plans. According to this initiative, partner countries, sister cities, and foreign corporations' direct financial resources to support specific cities or regions that have been particularly affected by the war.

This plan involves direct interaction between communities and their foreign counterparts, allowing each community to actively collaborate and exchange experiences with partners from other countries. The Association of Ukrainian Cities and the Congress of Local and Regional Authorities of the Council of Europe have affirmed this cooperation by signing a Declaration of shared responsibility for the country's recovery.

Partner cities have undertaken specific commitments. For example, Malaga and Plotsk express their readiness to provide assistance to Zhytomyr and Borodianka, respectively, setting an exemplary model of cooperation and solidarity. International donor cities, such as Bonn and Irpin, or New York and Kharkiv, actively collaborate for mutual success in the recovery process.

Denmark has developed a specific aid package of EUR 13.5 million to support the recovery of Mykolaiv. Estonia has taken the initiative to restore a kindergarten in Ovruch, Zhytomyr Oblast, demonstrating additional support and care. These collective efforts on the international level signify the global community's readiness to unite in supporting Ukraine during this challenging period of recovery.

Consider the financial costs of construction in Ukraine. From Table 4, we can see that in 2020, the volume of construction financing in Ukraine decreased. In 2021, the volume of construction financing recovered, this was a favourable response to the gradual recovery of Ukraine's economy and increased demand for housing and commercial real estate. In 2022, the volume of construction financing dropped significantly by 30.9%, the main reason being the war in Ukraine. This conflict led to a halt in investment activity and significant destruction of infrastructure.

Table 4. Dynamics of construction financing in Ukraine. *(Source: Witer et al., 2023)*

Year	The volume of financing, UAH billion	Growth rate, %
2019	222.2	10.0
2020	201.3	-9
2021	229.2	12.3
2022	161.3	-30.9
2023	176.7	9.4

In 2023, there was a certain recovery, the growth of the volume of construction financing amounted to 9.4% compared to 2022. This is due to the signs of recovery of economic activity in Ukraine and the beginning of international aid for the restoration of damaged infrastructure. This indicates a certain optimism and desire to restore economic stability after the difficulties associated with the military conflict.

According to estimates, the implementation of key infrastructure projects in the capital of Ukraine may require about EUR 4 billion. At the same time, it is assumed that approximately EUR 3 billion should be directed to the development of transport infrastructure, and the remaining funds to the improvement of living conditions and communal services, as well as to the development of the city's housing stock (Table 5).

Table 5. Volumes of necessary investments in the infrastructure of the city of Kyiv. *(Source: Witer et al., 2023)*

Type of infrastructure	The required amount of investments, EUR million
Housing fund and elevator management	224
Thermal and electrical economy	1720
Sewage management	810
Transport infrastructure (key projects)	1152
Transport infrastructure (remaining desired projects)	2101
Total	6007

At the same time, investments in the development of housing and communal services can be aimed at the modernization of communal infrastructure, the introduction of ecological technologies and the improvement of the quality of services for residents.

Given the context of Ukraine, where there are certain economic challenges and the need for reconstruction after the military conflict, investment in infrastructure can be considered as a strategic step to stimulate economic development and improve the quality of life of citizens.

It is clear that providing the necessary resources for the modernization and construction of new infrastructure exclusively at the expense of budget funds becomes a difficult task. Therefore, it is important to implement alternative financing schemes to attract the necessary resources. Such schemes may include:

1. Involvement of external financing mechanisms: Cooperation with international financial institutions, such as the World Bank or the International Monetary Fund, can provide access to additional financial resources for infrastructure projects.
2. Public-private partnership: Attracting private investment capital through public-private partnership can be an effective mechanism for financing. The private sector can participate in the financing, construction and operation of infrastructure facilities.
3. International organizations: Cooperation with international organizations, such as the European Bank for Reconstruction and Development, can provide financing and technical support for infrastructure initiatives.

The implementation of such schemes will expand financial opportunities and attract various sources of investment for the successful implementation of infrastructure projects in the city.

Additionally, the European Alliance of Cities and Regions for the Reconstruction of Ukraine and the platform Cities4Cities under the patronage of the Congress of Local and Regional Authorities contribute to coordinating efforts in the reconstruction of cities.

These initiatives play a vital role in restoring the cities and regions of Ukraine affected by the war. They provide support in terms of funding and expert assistance from other countries, facilitating a quick and efficient recovery process and strengthening solidarity and collaboration between Ukrainian and foreign cities.

Reconstruction of cities after war destruction really requires solving many complex issues and taking into account the context. One of the key aspects is human capital and the issue of returning residents. People who evacuated from the destroyed cities can have a settled life in other regions or countries, and schoolchildren and students can already study in other places. However, when planning the city's recovery, it is necessary to fulfil their expectations and plans for their return.

Creating new job opportunities is another crucial aspect. Large cities can serve as hubs for development, education, entrepreneurship, etc., making them attractive for residents' return. However, small towns may face challenges in offering sufficient job opportunities and prospects for their residents. Therefore, it is essential for small towns to develop new strategies and identity to attract and retain the population.

In rebuilding city infrastructure, it is also crucial to incorporate modern principles such as energy efficiency and people-centricity. Investments in road infrastructure can address issues of bike mobility, the use of renewable energy sources, and energy efficiency in housing. Having a vision for the future functioning of the city and region is crucial.

Extraordinary circumstances, such as armed conflicts, can pose additional challenges in city reconstruction. There is often a dilemma between quick and cost-effective reconstruction and a more prolonged and expensive but higher-quality approach. Resolving this dilemma may require complex engineering, urban planning, and architectural solutions.

Rebuilding cities after war is a complex and multifaceted process that requires attention to various factors. There is no one-size-fits-all solution, but it is crucial to worsen the current context, consider residents' needs, and focus on the long-term development perspective of the city.

To build the city of the future, we must embrace new approaches and develop unique solutions for the specific challenges arising after Russian aggression and extensive destruction. Developing standardized solutions can significantly facilitate the reconstruction process, especially during periods of conflict. These types of city recovery plans for neighbourhoods and building structures can be fast and effective if integrated into legislative and administrative procedures that do not require additional expertise.

DOI: 10.55643/fcaptp.2.55.2024.4281

However, communities must have the ability to develop individualized solutions that align with their unique needs, development vision, and community requirements. This encourages the emergence of commercial services for planning and implementing these initiatives without complicating the planning process.

The state should provide clear strategic frameworks for city reconstruction. It is essential to define the principles of reconstruction that go beyond the simple "rebuild better than before." These principles must be detailed and align with a modern vision shared for both the restoration of ruined cities and the transformation of others. A green development model can serve as the foundation for such a vision.

In summary, to rebuild cities of the future, it is necessary to combine standardized solutions that simplify the recovery process with the ability of cities and communities to develop individual approaches. The state should create favourable conditions for implementing such initiatives and establish clear strategic frameworks that promote sustainable development for both cities and communities.

During the post-war recovery process, support should be provided to cities that did not suffer significant damage or were only minimally affected. These cities also need incentives and development support, including plans for sustainable energy development and climate change mitigation.

Often, the attention of donors and the international community is focused on cities that have experienced substantial losses. However, cities that manage to avoid significant destruction also require incentives and support for development, including plans for sustainable energy development and climate change adaptation.

An important role in this process is partnership with other European cities, learning from their experiences, and networking. Ukrainian cities can join existing European networks, including initiatives implemented within the European Green Deal, UN, and OECD, such as the European Climate Pact, New Bauhaus, European Covenant of Mayors, and others. Programs that were effective in previous years should also be reinstated and continued.

A positive example of progress is the revival of the European Bank for Reconstruction and Development's "Green City" program, which has already resumed its activities in Khmelnytsky. Cities that already have ambitious and approved green transformation plans, such as Vinnytsia with its Green Course, should receive support today.

Unfortunately, the situation with development planning in many cities and infrastructure, in general, is indeed problematic. Many cities, especially those participating in the Covenant of Mayors, require support in implementing their sustainable energy and climate plans. Developing and implementing such plans is a step toward ensuring the country's energy security, reducing the social consequences of war, and ensuring even development after the conflict.

State support for eco-innovative (green) infrastructure transformation should be grounded in their own development plans. These plans should be realistic, with a step-by-step definition of all stages and funding needs. The presence of strategic documents on green transformation allows for defining "red lines" in the recovery process and preventing inappropriate decisions that could have a negative environmental impact.

One of the crucial aspects is the issue of autonomy in "green" infrastructure transformation, especially in military conditions. Eco-innovative (green) infrastructure transformation should have the ability to provide itself with water, electricity, and heat, even in the event of damage to centralized systems. European examples show that urban agglomerations can create partnerships with adjacent territories and secure themselves with 100% renewable energy sources.

However, it is worth considering that complete autonomy of cities and infrastructure may have negative consequences. For instance, it could jeopardize the creation of centralized systems that require significant funding to operate in backup mode. Therefore, decentralizing energy production is a more realistic alternative to the idea of energy autonomy for cities.

Market conditions, particularly energy carriers, which determine "green" infrastructure transformation, are also an essential aspect. The absence of stable market conditions can affect municipal and private investments in the city. After the end of hostilities, market conditions will be crucial for attracting investments and implementing "green" infrastructure transformation plans.

Therefore, eco-innovative (green) infrastructure transformation after wartime can only occur with proper planning, state support, and the creation of favourable market conditions. The success of such transformation requires the interaction of these three factors and the establishment of green goals in all aspects of the development of Ukrainian cities.

Institutional capacity is indeed a key aspect of green reconstruction and city transformation. The lack of qualified personnel and effective institutional mechanisms complicates the city's ability to independently develop and implement ambitious green transformation plans, making them dependent on decisions and directives from higher levels of government.

One solution to this problem could be establishing infrastructure transformation support offices at the regional level. These offices provide cities with access to most specialists and knowledge available to all cities within the region. They also contribute to accumulating experience and exchanging best practices. Implementing such a mechanism requires state support.

Furthermore, cities can enhance their favorability toward eco-innovative (green) infrastructure transformation by supporting grassroots initiatives and developing a culture of informal self-organization at various levels, such as streets, yards, and others. This culture of self-organization can significantly strengthen the transformation process, involving the population's potential and ensuring institutional memory and process sustainability. Local initiatives are stable and independent of changes in city leadership or policies at the local or state government levels.

These measures contribute to improving the institutional efficiency of the city, which is a factor in the successful green reconstruction and transformation.

Planning post-war recovery in Ukraine remains at the first and second stages - identifying problems and developing options for their solutions. Due to constant destruction and changes in occupiers' goals, the process returns to the beginning.

One of the apparent problems is the insufficient foresight in planning the future socio-economic development of territories such as cities, regions, and villages. Ukraine needs experience in forming new agglomerations and creating industrial and economic zones, but currently, such experience is lacking. Post-war recovery supports such capacity. In this context, the National Recovery Council of Ukraine is just the initial planning stage. Recovery projects require further development and iterations.

For the effective continuation of the process, the National Council should have a clear mandate and tasks. Developing a project for eco-innovative (green) infrastructure transformation in the post-war recovery period of Ukraine can be a task that aligns priorities of security and social justice. To achieve eco-innovative (green) infrastructure transformation, principles such as maximum energy efficiency, energy transition, "zero waste," environmental friendliness of buildings, climate change adaptation, promotion of a green lifestyle, resource conservation, citizen involvement, and circular economy can be considered.

Unfortunately, cities were not involved in the development of the National Recovery Plan, and local government representatives were not informed about its content. Active participation of cities in planning and project development is essential for successful recovery.

The second tool that can be used in the recovery planning process is the method of urban design and community participation. Urban design includes design analysis of the urban environment, conceptual development, planning, and implementation of infrastructure projects. It can be used to create green, sustainable cities, taking into account the needs and desires of local residents.

Community participation is an integral part of the urban design process, involving community organizations, residents, and stakeholders in decision-making regarding city development. This can take place through public consultations, forums, working groups, and other interaction formats. Community participation allows capturing the diverse needs and beliefs of local residents, contributing to the creation of more balanced and accepted decisions.

Planning eco-innovative (green) infrastructure transformation in post-war recovery should include these tools, as well as the development of other methods to address the country's other challenges. It is crucial to create a conducive platform for exchanging experiences, collaboration among experts, and engaging the public in the decision-making process. Only through such a collective approach can answers to complex challenges be found and ensure a sustainable and "green" infrastructure recovery.

DISCUSSION

We agree with the opinions of Albino and Dangelico (2012), Bollier (1998), Giffinger, Fertcher and Kramar (2007), who emphasize environmental, energy, technological and social aspects of urban development. At the same time, we propose to deepen the study of Hens (2010), which is generally focused on the formalization of the conditions for the implementation of "green" innovations in urban planning. This position of the scientist, of course, can include consideration of the legislative environment, financial support, interaction with interested parties and other factors that affect the successful implementation of green initiatives in urban planning.

DOI: 10.55643/fcaptp.2.55.2024.4281

In addition, we believe that the proposals of scientists Zvonar (2017), Bobrovsky (2014), Pobochenko and Shvayuk (2016), Kyrylenko et al. (2022), who consider the issue of creating a Smart City solely on the basis of the concept, are not sufficiently deep. sustainable development. They actively analyze and evaluate various aspects of the transformation of urban development, in particular, pay attention to the ecological and social aspects of this process, but do not take into account the specifics of implementation in military conditions.

The trajectory of infrastructure recovery and development in Ukraine is currently turbulent due to the ongoing military actions on the country's territory by an aggressor nation. Therefore, the role of analyzing the feasibility of implementing eco-innovative (green) infrastructure transformation is one of the key aspects of post-war recovery for the state.

Eco-innovative infrastructure transformation aims to implement environmentally friendly and sustainable technologies, contributing to reducing ecological burdens and improving environmental quality. Green energy, efficient resource utilization, green construction, and other aspects of green infrastructure may become essential elements of the recovery process.

However, implementing eco-innovations in wartime conditions requires special attention and consideration. Resource shortages, destroyed facilities, and an unstable regional situation create challenges and limitations for the implementation of ecological projects. Discussion points may also include ensuring ecological standards during wartime and how international partnerships can contribute to green reconstruction.

Green infrastructure transformation can also help address socio-economic issues by creating new employment opportunities, improving the standard of living, and facilitating integration into the international economic system.

Therefore, despite existing challenges and limitations, green transformation remains a crucial tool for the stable recovery and sustainable development of Ukraine after the wartime conflict.

CONCLUSIONS

Ukrainian cities critically need to culturally develop and be oriented towards the needs of the people. They must efficiently and economically utilize resources and incorporate the use of secondary materials. The green transformation of a city should encompass all stages of the life cycle of construction and infrastructure. Various tools can be employed to achieve these goals.

Firstly, it is essential to create a platform that brings together architects, builders, urban planners, citizens, artists, and other stakeholders. This platform should facilitate finding answers to questions on how to ensure a fast, ecological, attractive, and safe "green" transformation of infrastructure.

Secondly, Ukraine should collaborate with the European Union through various green platforms and networks that assist cities in green transformation. Initiatives aimed at transitioning to a circular economy in cities are also important.

Moreover, cities and their residents can participate in the European Climate Pact, a long-term EU initiative that creates a space for exchanging ideas, debates, and actions on climate change. This can contribute to shaping a new climate consciousness in society.

To support cities in their participation in EU green programs such as LIFE and Horizon, there needs to be a conducive environment for cities to develop and implement projects, as well as opportunities to secure funding.

Critical and priority investments for the reconstruction and recovery of Ukraine currently require USD 14 billion. To achieve this, an additional USD 11 billion in financing needs to be attracted, beyond what is already allocated in Ukraine's budget for 2024. Approximately 22% of planned expenditures are allocated for the restoration of transport infrastructure, 17% for the housing and communal sector, 11% for the energy complex, and 7% for the development of agriculture.

World Bank data indicates that the most significant expenses will be necessary in the energy sector, where the size of losses has increased more than fivefold compared to the previous year. According to calculations from World Bank experts and the domestic Ministry of Economy, the minimum estimated amount required for post-war recovery in Ukraine is at least USD 411 billion. Key priorities include the restoration of critical infrastructure, housing stock, as well as key social and transportation facilities. It is also crucial to focus on the recovery of the industrial sector, the development of the agricultural sphere, the IT industry, and other sectors. One ambitious goal is to achieve GDP figures at the level of USD 500 billion, compared to the previously estimated less than USD 160 billion by the end of 2022.

To attract financial resources for Ukraine's recovery after the war, the government is directing its efforts towards using the online platform United24 (U24). Funds collected on this platform are distributed across three key directions: defence

and demining, humanitarian and medical assistance, and country reconstruction. This global initiative has garnered support from residents across virtually the entire world, drawing contributions from approximately 90 countries. The U24 platform has successfully gathered over USD 147 million in charitable donations as of July 26. It's worth noting that almost USD 900,000 is designated for recovery. However, these funds are still being collected as they are currently insufficient to commence the restoration of a specific community, as reported on the U24 platform.

However, engagement in these initiatives requires new legislative frameworks. Current efforts by the government and the Verkhovna Rada of Ukraine to simplify and regulate the construction process need to be adapted or new measures introduced. It is crucial to understand that finding solutions requires changes to legislation to implement these solutions in practice. All the aforementioned tools and solutions should contribute to the creation of green, resilient, and people-centric cities in Ukraine.

Our further research will be aimed at 1) analysis of the results of green transformations, their impact on environmental sustainability and meeting the needs of residents; 2) research on the impact of the participation of Ukrainian cities in the European Climate Pact on changes in climate awareness and the implementation of environmental measures.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

FUNDING

The Authors received no funding for this research.

CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

REFERENCES

1. Albino, V., & Dangelico, R.M. (2012). *Green Cities into Practice. The Economy of Green Cities: A World Compendium on the Green Urban Economy.* https://www.researchgate.net/publication/303655370_Green_Cities_into_Practice
2. Averkina, M.F. (2012). Sustainable development of the city on the basis of "green logistics". *Efficient economy, 8*. http://www.economy.nayka.com.ua/?op=1&z=1314.
3. Bazaluk, O., Yatsenko, O., Zakharchuk, O., Ovcharenko, A., Khrystenko, O., & Nitsenko, V. (2020). Dynamic development of the global organic food market and opportunities for Ukraine. *Sustainability, 12*(17) https://doi.org/10.3390/SU12176963
4. Bobrovsky, O. (2014). "Smart cities" and "smart societies": collisions of formation in the information and communication space. *Scientific notes of the National University "Ostroh Academy"*, *16*, 138-141. http://eprints.oa.edu.ua/3874/1/27.pdf
5. Bollier, D. (1998). *How Smart Growth Can Stop Sprawl: A Fledgling Citizen Movement Expands*. Washington: D.C., Essential Books/Sprawl Watch Clearinghouse.
6. Buryachenko, A. (2012). Use of foreign experience in financing local infrastructure. *Scientific notes: coll. of science Ave.*, *14*(1), 218—224. http://iepjournal.com/journals/20/2014_6_Buriachenko_Geraymovych.pdf
7. Chukurna, O., Nitsenko, V., Tyukhtenko, N., Lomonosova, O., Zhartay, Z., & Dobrovolskyi, V. (2022). Substantiation of the green approach in the formation of a sustainable system of ecological logistics. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, *1*, 76-82. https://doi.org/10.33271/nvngu/2022-1/076
8. Dvigun, A. O., Datsii, O. I., Levchenko, N. M., Shyshkanova, G. A., & Dmytrenko, R. M. (2022a). Rational Use of Fresh Water As A Guarantee Of Agribusiness Development In The Context Of The Exacerbated Climate Crisis. *Science and Innovation*, *18*(2), 85-99. https://doi.org/10.15407/scine18.02.085
9. Dvigun, A., Datsii, O., Levchenko, N., Shyshkanova, G., Platonov, O., & Zaliznіuk, V. (2022b). Increasing Ambition to Reduce The Carbon Trace Of Multimodal Transportation In The Conditions Of Ukraine's Economy Transformation Towards Climate Neutrality. *Science and Innovation*, *18*(1), 96-111. https://doi.org/10.15407/scine18.01.096
10. Gaman, P., Yarovoi, T., Shestakovska, T., Akimov, O., & Akimova, L. (2022). Institutional platform to ensure the interaction between the subjects of combating medical and biological emergencies mechanism. *Economic Affairs*, *67*(4), 765-775. https://doi.org/10.46852/0424-2513.4s.2022.10
11. Geraimovich, L. (2013, April 11–16). State program "Affordable housing": implementation progress and implementation defects. Socio-economic prospects of

DOI: 10.55643/fcaptp.2.55.2024.4281

Ukraine in the 21st century: collection of the 80th scientific student conference of KNEU students.

12. Giffinger, R. Fertcher, C., & Kramar, H. (2007). Smart Cities – Ranking of European Medium-size Cities. Final Report. October. https://www.researchgate.net/publication/261367640_Smart_cities_-_Ranking_of_European_medium-sized_cities
13. Hens, L. (2010). The challenge of the sustainable city. *Environment, Development and Sustainability*, *12*(6), 875–876. http://dx.doi.org/10.1007/s10668-010-9259-3
14. Khaietska, O., Holovnia, O., Pavlyuk, T., & Osipova, L. (2023). Branch Structure of the National Economy and Directions of Its Optimization in the Post-War Period. *Economics. Ecology. Socium*, *7*(3), 1-12. https://doi.org/10.31520/2616-7107/2023.7.3-1
15. Koval, V., Mikhno, I., Zharikova, O., Tsvirko, O., Metil, T., & Nitsenko, V. (2023). Investment management and financial development in infrastructure renovation of a sustainable-built environment. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, *2*, 91-97. https://doi.org/10.33271/nvngu/2023-2/091
16. Kulikov, P., Aziukovskyi, O., Vahonova, O., Bondar, O., Akimova, L., & Akimov, O. (2022). Post-war economy of Ukraine: Innovation and investment development project. *Economic Affairs*, *67*(5), 943-959. https://doi.org/10.46852/0424-2513.5.2022.30
17. Kyrylenko, V., Halaburda, M., Fedorenko, T., & Lisniak, I. (2023). Economics and Morality Conflicts in the Public Goods Using. *Economics. Ecology. Socium*, *7*(1), 26-34. https://doi.org/10.31520/2616-7107/2022.7.3-1
18. Kyrylenko, Y., Kameneva, I., Popov, O., Iatsyshyn, A., Artemchuk, V., & Kovach, V. (2022). Actual Issues on Radiological Assessment for Events with Liquid Radioactive Materials Spills. In: *Zaporozhets, A. (eds) Systems, Decision and Control in Energy III. Studies in Systems, Decision and Control*, vol 399. Springer, Cham. https://doi.org/10.1007/978-3-030-87675-3_8
19. Lupenko, Y., Viatkina, T., Gordienko, L., Pasichnyk, Y., & Grzebyk, M. (2022). The Impact of Selected Budget Expenditures on Personal Income in the EU and Ukraine. *Scientific Horizons*, *1*(42), 218–225. https://doi.org/10.55643/fcaptp.1.42.2022.3564
20. Marciniak, K., & Owoc, M. (2023). Applying knowledge grid models in smart city concepts. *Proceedings of the 6th Knowledge Cities World Summit*, KCWS, Lookus Scientific, 238–244. http://dx.doi.org/10.13140/RG.2.1.2060.7525
21. Mironova, N., Koptieva, H., Liganenko, I., Sakun, A., & Chernyak, D. (2022). Modeling the selection of innovative strategy for development of industrial enterprises. *WSEAS Transactions on Business and Economics*, *19*, 278-291. https://doi.org/10.37394/23207.2022.19.26
22. Mulska, O., Vasyltsiv, T., Shushkova, Y., Kloba, L., & Parfenyuk, Y. (2022). Assessment of the Population's Social Resilience Environment (The Case of the Carpathian Region Of Ukraine). *Problems and Perspectives in Management*, *20*(1), 407-421. https://doi.org/10.21511/ppm.20(1).2022.33
23. Oliinyk, O., Bilan, Y., Mishchuk, H., Akimov, O., & Vasa, L. (2021). The impact of migration of highly skilled workers on the country's competitiveness and economic growth. *Montenegrin Journal of Economics*, *17*(3), 7-19. https://doi.org/10.14254/1800-5845/2021.17-3.1
24. Owensby-Conte, D., & Yepes, V. (2012). Green Buildings: Analysis of State of Knowledge. *International Journal of Construction Engineering and Management*, 3(1), 27-32. https://doi.org/10.5923/j.ijcem.20120103.03
25. Perevozova, I., Horal, L., Daliak, N., Chekmasova, I., & Shyiko, V. (2021). Experimental management of ecological security of territorial facilities for forecasting the developing economy dynamics. *IOP Conference Series: Earth and Environmental Science*, 628, 012022. https://doi.org/10.1088/1755-1315/628/1/012022
26. Petrik, D. (2023). Exploring the Determinants of Partner Management in IIoT Platform Ecosystems. *European Journal of Management Issues*, *31*(2), 79-92. https://doi.org/10.15421/192307
27. Pobochenko, L. M., & Shvayuk, Yu. E. (2016). "Smart city" ("smart house") and its energy component: world experience. *Development strategy of Ukraine, 1*, 141-145. http://nbuv.gov.ua/UJRN/sru_2016_1_27.
28. Semenets-Orlova, I., Rodchenko, L., Chernenko, I., Druz, O., Rudenko, M., & Poliuliakh, R. (2022a). Requests For Public Information In The State Administration In Situations Of Military Operations. *Anuario De La Facultad De Derecho.Universidad De Extremadura*, *38*, 249-270. https://doi.org/10.17398/2695-7728.38.249
29. Semenets-Orlova, I., Shevchuk, R., Plish, B., Moshnin, A., Chmyr, Y., & Poliuliakh, R. (2022b). Human-centered approach in new development tendencies of value-oriented public administration: Potential of education. *Economic Affairs*, *67*(5), 899-906. https://doi.org/10.46852/0424-2513.5.2022.25
30. Shevchuk, I., & Omelchuk, L. (2023). Systematic analysis of the sphere of economic security of ukraine in conditions of limited resources in the context of the policy of sustainable development. *Socio-Economic Relations in the Digital Society, 3*(49), 40-50. https://doi.org/10.55643/ser.3.49.2023.507
31. Sokolovska, O.O. (2014). Smart City: the use of information and communication technologies in local self-government. *Aspects of public administration*, *11-12*, 77-85. http://nbuv.gov.ua/UJRN/aplup_2014_11-12_12
32. Sumets, A., Tyrkalo, Y., Popovych, N., Poliakova, J., & Krupin, V. (2022). Modeling of the Environmental Risk Management System of Agroholdings Considering the Sustainable Development Values. *Agricultural and Resource Economics*, *8*(4), 244-265. https://doi.org/10.51599/are.2022.08.04.11
33. Sytnyk, H. P., Zubchyk, O. A., & Orel, M. H. (2022). Conceptual Understanding of the Peculiarities of Managing Innovation-Driven Development of the State in the Current Conditions. *Science and Innovation*, *18*(2), 3-15. https://doi.org/10.15407/scine18.02.003

34. Witer, O., Kylin, O., & Martin, O. (2023). World experience of post-war economic recovery: An example for Ukraine. In Theoretical and practical aspects of modern scientific research. *European Scientific Platform*. https://doi.org/10.36074/logos-28.04.2023.02

35. Zhukovych, I.A. (2014). Smart-misto yak novyi obiekt statystychnykh doslidzhen: deiaki kontseptualni aspekty. *Statystyka v Ukraini*, *2*, 69-73. http://irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?C21COM=2&I21DBN=UJRN&P21DBN=UJRN&IMAGE_FILE_DOWNLOAD=1&Image_file_name=PDF/su_2015_1_4.pdf

36. Zvonar, V.P. (2017). Smart community as a socio-economic phenomenon. *Demography and social economy*, *3*(31), 76–88. https://dse.org.ua/archcive/31/6.pdf

Кришталь Г., Томах В., Іванова Т., Метелиця В., Єрмолаєва М., Панін Є.

ЕКОІННОВАЦІЙНА ТРАНСФОРМАЦІЯ МІСЬКОЇ ІНФРАСТРУКТУРИ УКРАЇНИ НА ШЛЯХУ ДО ПОВОЄННОГО ВІДНОВЛЕННЯ

Дослідження спрямоване на узагальнення процесів екоінноваційної (зеленої) трансформації міської інфраструктури та вивчення можливих перспектив розвитку України в цьому контексті. У процесі дослідження розглянуто можливості зеленої трансформації міської інфраструктури та зазначено, що використання принципів екоінноваційної трансформації в повоєнний період може відбуватися лише за умови належного планування, державної підтримки та створення сприятливих ринкових умов. Автори відзначають, що успіх такої трансформації вимагає встановлення зелених цілей у всіх аспектах розвитку міст України. Автори розглянули фінансові можливості розвитку міської інфраструктури та запропонували розміщення офісів підтримки екоінноваційної трансформації міської інфраструктури на обласному рівні. Розкрито принципи досягнення екоінноваційної трансформації міської інфраструктури, а саме: максимальна енергоефективність, енергетичний перехід, «нуль відходів», екологічність будівель, адаптація до змін клімату, популяризація зеленого способу життя, ресурсозбереження, залучення громадян та циркулярна економіка. Запропоновано створити платформу, яка б об'єднала архітекторів, будівельників, містопланувальників, громадян, митців та інших зацікавлених осіб. Ця платформа має сприяти пошукові відповідей на питання, як забезпечити швидку, екологічну, привабливу та безпечну зелену трансформацію міської інфраструктури. Україна має співпрацювати з Європейським Союзом у межах різних зелених платформ і мереж, які допомагають містам у зеленій трансформації. Усі вищезгадані інструменти та рішення мають сприяти створенню зелених, стійких та людиноорієнтованих міст в Україні. Автори розлянули можливості фінасування відновлення українських міст після руйнування в частині необхідних фінансових ресурсів, країн донорів та видатків на відбудову.

Ключові слова: екоінноваційна економіка, екоінноваційна трансформація, зелена трансформація, фінансові можливості, фінансування, інфраструктура

JEL Класифікація: O31, O32

DOI: 10.55643/fcaptp.2.55.2024.4281