INFRASTRUCTURE DETERMINANTS AND STRUCTURAL COMPONENTS OF POPULATION QUALITY-OF-LIFE RESILIENCE UNDER SUSTAINABLE DEVELOPMENT

DOI: https://doi.org/10.53486/dri2026.34
UDC: 338.49:330.59(477)

Viktoriia KHAUSTOVA
Research Center for Industrial Problems of Development of the NAS of Ukraine
Kharkiv, Ukraine
Email account: v.khaust@gmail.com
ORCID ID: 0000-0002-5895-9287
Olena RESHETNYAK
Research Center for Industrial Problems of Development of the NAS of Ukraine
Kharkiv, Ukraine
Email account: reshetele@ukr.net
ORCID ID: 0000-0002-1183-302X
Nataliia TRUSHKINA
Research Center for Industrial Problems of Development of the NAS of Ukraine
Kharkiv, Ukraine
Email account: nata_tru@ukr.net
ORCID ID: 0000-0002-6741-7738

Abstract: *The article substantiates the theoretical and applied foundations for the formation of population quality-of-life resilience under sustainable development based on the identification of infrastructure determinants and structural components ensuring the stability of socio-economic systems. It is proved that under conditions of global instability, military threats, energy crises, digital transformation, and climate challenges, infrastructure acts not only as the material basis for the functioning of territories, but also as a key prerequisite for ensuring adaptability, security, and resilience of the population's quality of life. Modern scientific approaches to the interpretation of the concepts of "resilience", "infrastructure", and "population quality of life" are generalized. The key infrastructure determinants of population quality-of-life resilience formation are identified, among which energy, transport, logistics, digital, social, коммунал, environmental, and security infrastructure have a system-forming significance. It is substantiated that the development of these infrastructure systems determines the ability of territories to maintain functional stability, ensure continuity of population life support, and adapt to crisis impacts. The structural components of ensuring population quality-of-life resilience are systematized, namely: institutional, infrastructural, social, economic, security, digital, and environmental. A conceptual model of the interrelation of structural components of resilience provision is proposed, which makes it possible to comprehensively integrate institutional, infrastructural, social, economic, digital, security, and environmental elements into a unified system for ensuring territorial resilience. The relationship between infrastructure transformation and the provision of resilient sustainable development has been established. It is proved that infrastructure modernization should be based on the principles of sustainability, resilience, inclusiveness, energy efficiency, digital integration, and environmental responsibility. Particular attention is paid to the Build Back Better concept as the basis for the formation of resilient, energy-efficient, digitally integrated, and environmentally oriented infrastructure systems in the process of Ukraine's post-war recovery. The practical significance of the obtained results lies in the possibility of their use in the formation of state regional development policy, post-war recovery strategies, modernization of critical infrastructure, and the development of mechanisms for ensuring the infrastructural resilience of territories.*

Key words: *national economy, resilience, population quality of life, infrastructure determinants, infrastructure transformation, critical infrastructure, sustainable development, infrastructural resilience, socio-economic systems, post-war recovery, energy resilience, digital infrastructure, security infrastructure, Build Back Better, territorial adaptability, infrastructure development.*

JEL: H54, I31, O18

Introduction

In the current conditions of global instability, military risks, climate change, energy crises and digital transformation, the issues of ensuring the resilience of the quality of life of the population are of particular importance. One of the key determinants of the formation of such resilience is infrastructure as the basic basis for the functioning of socio-economic systems, ensuring the vital activity of the population, the availability of public services and maintaining the continuity of economic processes.

In the international scientific discourse, infrastructure is increasingly viewed not only as a set of material and technical objects, but as a complex system of interconnected elements that ensure the resilience of territories to external and internal challenges. In this context, the issues of developing energy, transport, logistics, digital, social and communal infrastructure are of particular importance, which directly affect the level of security, availability of services, social well-being and quality of life of the population.

For Ukraine, the issue of infrastructure resilience has become particularly relevant in the context of a full-scale war, accompanied by large-scale destruction of critical facilities, disruption of logistical connections, energy instability, deterioration of the population's access to basic services, and significant socio-economic losses. According to international organizations, a significant part of the damage falls on energy, transport, housing and communal services, and social infrastructure facilities, the restoration of which is a necessary prerequisite for ensuring sustainable development and improving the quality of life of the population.

At the same time, modern approaches to building resilience in the quality of life of the population require a transition from a fragmented consideration of individual infrastructure elements to a systematic analysis of infrastructure determinants and structural components that determine the ability of territories, communities, and socio-economic systems to adapt to crisis impacts, maintain functional stability, and ensure an adequate level of life for the population.

In foreign studies, issues of infrastructure resilience are mostly analyzed through the prism of the concepts of sustainable development, climate resilience, urban resilience, smart infrastructure, critical infrastructure protection and risk-oriented management. However, the issues of comprehensive determination of infrastructure determinants and structural components of the formation of resilience of the quality of life of the population in the conditions of modern transformation processes, digitalization of the economy and post-war reconstruction of territories remain insufficiently studied.

In this regard, the purpose of the article is to substantiate the infrastructure determinants and structural components of the formation of resilience of the quality of life of the population in the conditions of sustainable development. To achieve the set goal, it is planned to: (1) summarize modern scientific approaches to the interpretation of the concepts of "resilience", "infrastructure" and "quality of life of the population"; (2) identify key infrastructure determinants of the formation of resilience; (3) systematize the structural components of ensuring resilience of the quality of life of the population; (4) substantiate the relationship between infrastructure transformation and the achievement of sustainable development goals.

Thus, the study of infrastructure determinants and structural components of the formation of resilience of the quality of life of the population has important theoretical and applied significance for ensuring sustainable development of territories, increasing the adaptability of socio-economic systems and forming effective mechanisms for the post-war recovery of Ukraine.

Basic content

In the current conditions of global instability, increased military, energy, climate and socio-economic risks, the concept of resilience has acquired special importance in the research of sustainable development, territorial security and ensuring the quality of life of the population. Transformational processes taking place in the world economy, the digitalization of society, the growth of the

interdependence of critical infrastructure and the aggravation of crisis phenomena necessitate the formation of new approaches to ensuring the stability of socio-economic systems (Holling, 1973; Walker et al., 2004; Folke, 2006). The concept of "resilience" was originally formed in ecological theory and was interpreted as the ability of a system to maintain equilibrium and restore functioning after the impact of external disturbances (Holling, 1973). Later, the concept of resilience acquired an interdisciplinary character and was extended to social, economic, managerial, urban and infrastructure systems (Walker et al., 2004; Meerow et al., 2016). In modern research, resilience is mainly considered the ability of a system to adapt to crisis impacts, maintain functional stability, minimize the negative consequences of threats and ensure recovery and further development (Folke et al., 2010).

The modern evolution of scientific approaches to the interpretation of resilience indicates a gradual transition from a narrow understanding of resilience as the ability of a system to return to its previous state to a comprehensive vision of resilience as an integrated characteristic of adaptability, flexibility, transformative ability and continuity of functioning of socio-economic systems (*Table 1*).

Table 1. Evolution of Scientific Approaches to the Interpretation of Resilience

Scientific approach	Characteristics of the approach
Ecological	Resilience is interpreted as the ability of a system to maintain equilibrium and recover after external impacts
Social	Primary attention is focused on societal adaptability, social cohesion, and the ability of the population to respond to crisis phenomena
Economic	Resilience is considered as the stability of economic systems to risks, crises, and external shocks
Urban	Emphasis is placed on the resilience of cities, territories, and population life-support systems
Infrastructural	Defined by the ability of critical infrastructure to ensure continuity of functioning and rapid recovery
Integrated	Provides for the integration of social, economic, environmental, institutional, and infrastructural components of resilience

Source: compiled by the authors based on the generalization of studies (Holling, 1973; Walker et al., 2004; Folke, 2006; Folke et al., 2010; Meerow et al., 2016; OECD, 2023).

In scientific discourse, the concept of infrastructure resilience is of particular importance, according to which infrastructure is considered a system-forming basis for ensuring the stability of territories, the security of the population and the continuity of the functioning of socio-economic systems (UNDRR, 2022). In this context, infrastructure resilience encompasses the ability of energy, transport, logistics, digital, municipal and social systems to adapt to crisis impacts, maintain functionality in emergency conditions and ensure rapid recovery from threats (Directive (EU) 2022/2557).

For Ukraine, the issue of infrastructure resilience is particularly relevant in the context of a full-scale war, accompanied by large-scale destruction of critical facilities, energy attacks, disruption of logistical communications, digital threats, and significant socio-economic losses (Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b). Under such conditions, ensuring the resilience of infrastructure systems directly affects the level of population security, availability of basic services, social stability, and the possibilities of post-war reconstruction of territories.

At the same time, the concept of "quality of life of the population" in modern research is considered a multidimensional category that characterizes the level of social well-being, accessibility of medical, educational, housing and communal, transport and digital services, safety of residence, ecological state of the environment and living conditions of the population (Cherenko et al., 2023). In this

context, it is advisable to link the resilience of the quality of life of the population not only with the level of material security, but also with the ability of the socio-economic system to maintain proper living conditions in conditions of crisis influences.

Taking into account the generalization of modern scientific approaches, it is advisable to understand the set of interconnected infrastructure systems, the conditions of their functioning and mechanisms for ensuring stability, which determine the ability of socio-economic systems to maintain an adequate level of living conditions of the population, adapt to crisis influences and ensure sustainable development of territories.

Unlike existing approaches, the proposed interpretation allows for a comprehensive integration of infrastructural, social, economic, security, digital and environmental aspects of ensuring the resilience of the quality of life of the population, which creates the basis for the formation of a holistic approach to studying the resilience of territories in modern conditions of global challenges.

Therefore, ensuring the resilience of the quality of life of the population requires a systematic identification of key infrastructure determinants (*Table 2*), which form the adaptive potential of territories, ensure the continuity of the functioning of critically important systems and determine the sustainability of socio-economic development in the conditions of modern transformation processes.

Table 2. Infrastructure Determinants of Population Quality-of-Life Resilience Formation

Infrastructure determinant	Impact on ensuring population quality-of-life resilience
Energy infrastructure	Ensures energy security, continuity of functioning of critical systems, and stability of population life support
Transport infrastructure	Forms population mobility, territorial accessibility, and resilience of transport and logistics connections
Logistics infrastructure	Ensures uninterrupted supply of food, medicines, humanitarian resources, and essential goods
Digital infrastructure	Promotes the development of digital services, e-governance, remote forms of interaction, and information resilience
Social infrastructure	Determines the accessibility of healthcare, educational, cultural, and social services
Utility infrastructure	Ensures proper living conditions, water and heat supply, and sanitary safety
Environmental infrastructure	Forms environmental resilience of territories and adaptability to climate change
Security infrastructure	Ensures the functioning of civil protection systems, crisis response, and minimization of emergency consequences

Source: compiled by the authors based on the generalization of studies (OECD, 2023; Gopalakrishnan & Peeta, 2010; Directive (EU) 2022/2557; Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b; Padgett et al., 2012).

As evidenced by the results of research by international organizations, it is infrastructure systems that ensure the basic resilience of territories to crisis phenomena and determine the level of social adaptability of the population (OECD, 2023; Meerow et al., 2016). At the same time, the insufficient level of infrastructure development leads to increased social vulnerability, worsening of the population's access to basic services, increasing territorial disparities and reducing the level of security of life (Lamond et al., 2015).

Energy infrastructure is of particular importance in modern conditions as a key determinant of ensuring the functional stability of socio-economic systems. Energy security directly affects the stability of medical institutions, water supply systems, transport, communications, digital services and other critically important areas of life of the population. In the context of the post-war reconstruction of Ukraine, the issues of developing distributed energy systems, smart grid

technologies, energy efficiency and decentralization of energy infrastructure are of priority importance (OECD, 2024).

At the same time, the role of digital infrastructure, which ensures the functioning of e-government, distance education, telemedicine, digital financial services and crisis information systems for the population, is growing significantly. In modern conditions, digital resilience is becoming an important component of the overall resilience of territories and socio-economic systems (World Bank, 2023).

It should be noted that infrastructure determinants are interdependent. Disruption of the functioning of one infrastructure system can cause cascading effects, i.e., cascading negative consequences for other sectors of the economy and areas of public life (European Commission, 2023). For example, damage to energy infrastructure can lead to disruptions in the operation of transport systems, water supply systems, communications, medical institutions and digital services.

In modern conditions, security infrastructure, which covers civil protection systems, crisis response, risk management and ensuring the continuity of the functioning of critical facilities (Directive (EU) 2022/2557), is also of particular importance. The growth of military, terrorist, cyber and technogenic threats necessitates the formation of a comprehensive approach to ensuring the infrastructural security of territories.

In addition, an important direction for the formation of resilience of the quality of life of the population is the development of ecological infrastructure, which ensures the adaptation of territories to climate change, the minimization of environmental risks and the creation of a safe environment for the population's life (UNEP, 2023). In this context, ecological sustainability is increasingly integrated into modern approaches to infrastructure development and territorial management.

Thus, infrastructure determinants form the system-forming basis for ensuring the resilience of the quality of life of the population and determine the ability of socio-economic systems to maintain functional stability, adaptability and security in the face of modern global challenges. At the same time, ensuring effective interaction between infrastructure, institutional, social and security elements requires the formation of a comprehensive structural model of resilience, which necessitates the identification of its key structural components.

Taking into account the generalization of modern theoretical approaches, the author's approach to structuring the components of ensuring the resilience of the population's quality of life is proposed, which involves the integration of institutional, infrastructural, social, economic, security, digital and environmental components into a single system for ensuring the stability of territories. Unlike existing approaches, the proposed structuring allows for a comprehensive combination of infrastructural, managerial, social, security and environmental aspects of resilience formation in the context of modern global challenges, which creates the basis for the formation of a holistic mechanism for ensuring the sustainable development of territories. The main structural components of ensuring the resilience of the population's quality of life are given in *Table 3*.

Table 3. Structural Components of Ensuring Population Quality-of-Life Resilience

Structural component	Functional role in ensuring resilience
Institutional	Forms the system of public administration, legal regulation, strategic planning, and interagency coordination
Infrastructural	Ensures the functioning of critical, transport, energy, digital, social, and utility infrastructure
Social	Determines the level of social cohesion, human capital development, accessibility of social services, and population adaptability
Economic	Forms financial stability, investment potential, economic security, and resource support for development
Security	Ensures civil protection, crisis response, risk management, and minimization of threat consequences

Digital	Promotes the development of digital infrastructure, cybersecurity, digital services, and data management systems
Environmental	Ensures environmental security, adaptation to climate change, and environmental resilience of territories

Source: compiled by the authors based on the generalization of studies (Meerow et al., 2016; OECD, 2023; Gopalakrishnan & Peeta, 2010; Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b).

The key role in ensuring the resilience of the quality of life of the population is played by the institutional component, which forms the regulatory, legal and organizational and managerial basis for the functioning of the system. It is the effectiveness of public administration, intersectoral coordination, strategic planning and institutional interaction that determines the ability of territories to adapt to crisis impacts and ensure the stability of socio-economic processes (OECD, 2023). In modern conditions, the development of adaptive governance, which involves the flexibility of management decisions, a risk-oriented approach and the integration of crisis response mechanisms, is of particular importance. At the same time, the infrastructure component forms the material and technical basis for ensuring the vital activity of the population and the continuity of the functioning of critical systems. The development of resilient infrastructure involves ensuring adaptability, reliability, energy efficiency, digital integration and the ability to quickly recover from crisis impacts (UNDRR, 2022; Directive (EU) 2022/2557). It is the infrastructural sustainability that determines the capabilities of the energy supply, transport, communications, healthcare, education and housing and communal services systems.

The social component ensures the adaptability of the population to crisis situations and is directly related to the level of social cohesion, trust in society, human capital development and accessibility of basic services. Studies by international organizations show that it is the social sustainability of the population that largely determines the ability of territories to effectively respond to emergencies and maintain stable development (United Nations, 2015). In this context, the issues of developing education, healthcare, social protection and supporting vulnerable groups of the population become important.

The economic component ensures the financial sustainability of territories, investment capacity and resource provision for development. In the context of modern crises, economic sustainability determines the capabilities of maintaining the functioning of infrastructure systems, implementing programs for the restoration and modernization of territories. Diversification of funding sources, the development of public-private partnerships and the attraction of international financial support are of particular importance.

The security component covers civil protection, crisis response, risk management and mitigation of the consequences of emergencies. Military actions, energy attacks, terrorist threats and cyber risks significantly increase the importance of the security component in shaping the resilience of territories (European Commission, 2023). In this context, ensuring the security of critical infrastructure, developing early response systems and forming mechanisms for interdepartmental coordination are of priority importance.

The digital component ensures the information stability of socio-economic systems, the continuity of digital services and the adaptability of management processes in the face of crisis impacts. The development of digital platforms, e-governance, information and communication technologies and cybersecurity systems contributes to increasing the efficiency of territorial management and expanding the population's access to services (World Bank, 2023). In modern conditions, digital stability is increasingly seen as one of the key prerequisites for ensuring the functional continuity of territories.

At the same time, the ecological component reflects the level of ecological safety, adaptation of territories to climate change and ecological sustainability of the living environment of the population.

The growth of the scale of natural disasters, climate risks and man-made threats necessitates the integration of ecological principles into the processes of infrastructure planning and territorial development. In this context, ecological sustainability is increasingly integrated into modern models of ensuring the resilience of territories. Given the interdependence of structural components of ensuring the resilience of the quality of life of the population, it is advisable to form a conceptual model that reflects the systemic nature of the interaction of institutional, infrastructural, social, economic, security, digital and environmental components (*Fig.*).

The proposed conceptual model demonstrates that the resilience of the quality of life of the population is formed as a result of the complex interaction of institutional, infrastructural, social, economic, security, digital and environmental components. At the same time, the institutional and infrastructural components create the basic conditions for the functioning of the system, the social and economic ones ensure the adaptability and sustainability of development, and the digital, environmental and security components form mechanisms for responding to modern global challenges. The combined interaction of these components ensures the formation of resilience of the quality of life of the population as the basis for sustainable development of territories.

Thus, the resilience of the quality of life of the population is formed under the influence of interconnected structural components, the effective interaction of which ensures the stability, adaptability, security and ability of socio-economic systems to recover in the conditions of modern global challenges. At the same time, the development of structural components of resilience requires the integration of the principles of infrastructure modernization, digital transformation, environmental sustainability and security management, which creates the basis for ensuring sustainable development of territories.

It should be noted that infrastructure transformation is of particular importance in the context of achieving the UN Sustainable Development Goals (SDGs), since infrastructure development directly affects economic well-being, accessibility of basic services, energy security, environmental sustainability and social inclusion (United Nations, 2024).

In this context, the following are of key importance: SDG 3 "Good health and well-being"; SDG 7 "Affordable and clean energy"; SDG 9 "Industry, innovation and infrastructure"; SDG 11 "Sustainable cities and communities"; SDG 13 "Climate change mitigation" (United Nations, 2024)

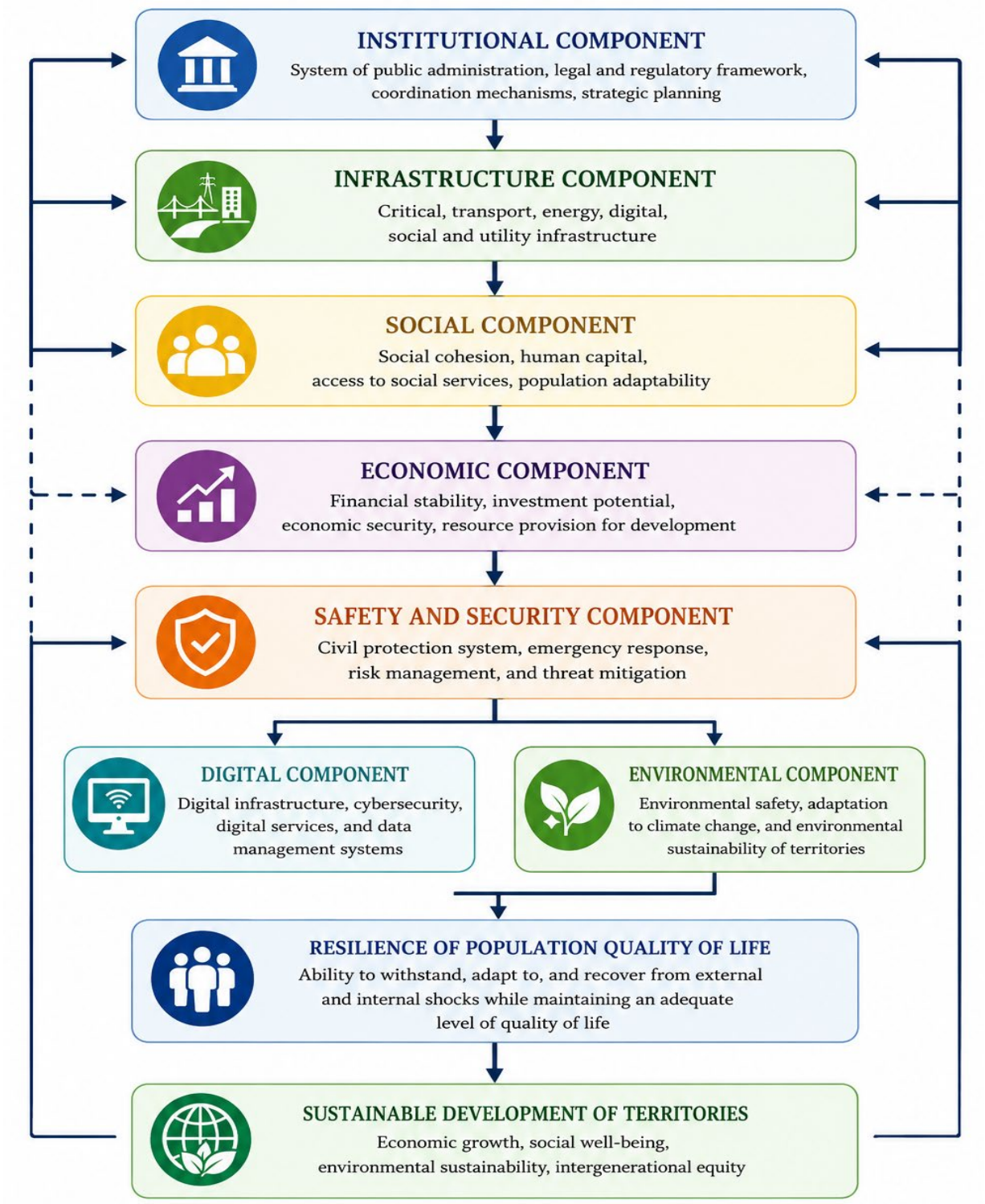

Figure. Conceptual Model of the Interrelation of Structural Components for Ensuring Population Quality-of-Life Resilience

Source: developed by the authors based on (Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b).

Taking into account modern approaches, it is advisable to determine the main directions of the impact of infrastructure transformation on ensuring resilient sustainable development of territories (*Table 4*).

Table 4. Impact of Infrastructure Transformation on Ensuring Resilient Sustainable Development

Direction of infrastructure transformation	Result for resilient sustainable development
Modernization of energy infrastructure	Enhancement of energy security, decarbonization of the economy, and ensuring the energy resilience of territories
Development of digital infrastructure	Ensuring digital resilience, development of e-governance, and improvement of service accessibility
Transformation of transport and logistics infrastructure	Increasing population mobility, territorial integration, and ensuring the resilience of logistics connections
Development of social infrastructure	Improving access to healthcare, educational, and social services, as well as enhancing social adaptability
Implementation of smart infrastructure	Increasing the efficiency of resource management, territorial adaptability, and responsiveness of crisis management
Development of environmental infrastructure	Reducing environmental pressure, adapting to climate change, and ensuring environmental resilience
Formation of secure infrastructure	Increasing the resilience of territories to military, technological, and crisis threats

Source: compiled by the authors based on the generalization of studies (United Nations, 2015, 2024; Directive (EU) 2022/2557; Meerow et al., 2016; Gopalakrishnan & Peeta, 2010; World Bank, 2023; European Commission, 2023).

According to the results of research by international organizations, the development of modern infrastructure is a basic condition for ensuring economic competitiveness, the investment attractiveness of territories and long-term social stability (OECD, 2023). At the same time, an insufficient level of infrastructure development leads to an increase in socio-economic disparities, territorial inequality and infrastructure vulnerability.

In the international practice of post-crisis recovery, the Build Back Better concept is of particular importance, which involves the transformation of the traditional recovery model towards the formation of resilient, energy-efficient, digitally integrated and environmentally oriented infrastructure systems (OECD, 2024). In modern conditions, this concept becomes the basis for the formation of a new model of territorial development of Ukraine, focused on the long-term sustainability of socio-economic systems.

In the context of the post-war recovery of Ukraine, the implementation of the Build Back Better concept should include:

- modernization of critical infrastructure;
- development of distributed energy systems;
- digital transformation of territories;
- greening of infrastructure solutions;
- integration of climate adaptation principles;
- formation of a safe and inclusive living environment for the population (Batty et al., 2012).

Therefore, infrastructure transformation is a strategic prerequisite for ensuring resilient sustainable development and forming a sustainable quality of life for the population. In modern conditions, infrastructure development should be based on the integration of economic, social, environmental, digital and security priorities, which will ensure increased adaptability of socio-economic systems to modern global challenges and create a basis for long-term sustainable development of territories.

Conclusions

As a result of the conducted research, the theoretical and applied principles of forming the resilience of the quality of life of the population in the conditions of sustainable development were substantiated

based on the definition of infrastructure determinants and structural components of ensuring the stability of socio-economic systems. It was proved that in modern conditions of global instability, military threats, energy crises, digital transformation and climate challenges, infrastructure acts not only as a material basis for the functioning of territories, but also as a key determinant of ensuring adaptability, security and stability of the quality of life of the population.

The conducted research allowed us to establish that the resilience of the quality of life of the population should be considered as an integral ability of the socio-economic system, infrastructure environment and institutional mechanisms to ensure the continuity of the population's vital activities, maintain the availability of basic services, adapt to crisis impacts and ensure the restoration of territories in compliance with the principles of sustainable development.

The study identified key infrastructure determinants of the resilience of the quality of life of the population, among which energy, transport, logistics, digital, social, communal, environmental and security infrastructure are of systemic importance. It is substantiated that it is the level of development of these infrastructure systems that determines the ability of territories to ensure the stability of socio-economic processes, support the functioning of critically important facilities and minimize the negative consequences of modern crisis impacts.

It was established that in the conditions of modern transformation processes, the development of distributed energy systems, the implementation of smart grid technologies, the digitalization of infrastructure systems, the modernization of transport and logistics infrastructure, the development of crisis response systems and the formation of environmentally oriented energy-efficient infrastructure are of priority importance. It is proven that the decentralization of infrastructure systems and the implementation of digital technologies contribute to increasing the adaptability of territories and reducing their vulnerability to crisis and military threats.

As a result of the study, the structural components of ensuring the resilience of the quality of life of the population were systematized, namely, institutional, infrastructural, social, economic, security, digital and environmental. It was proven that the effective interaction of these components forms a holistic system of ensuring the resilience of territories and the adaptability of socio-economic systems to modern global challenges. The proposed conceptual model of the relationship of structural components allows for the comprehensive integration of institutional, infrastructural, social, economic, security, digital and environmental components into a single system of ensuring the resilience of the quality of life of the population.

Based on the analysis, the relationship between infrastructural transformation and ensuring resilient sustainable development of territories was established. It was substantiated that infrastructure modernization should be carried out on the principles of sustainability, resilience, inclusiveness, energy efficiency, digital integration and environmental responsibility. It is proven that modern infrastructure transformation should be considered not only as a process of technical renewal of infrastructure systems, but as a comprehensive mechanism for the formation of sustainable, adaptive and safe models of territorial development.

Of particular importance in modern conditions is the implementation of the Build Back Better concept, which involves the transition from the traditional model of post-crisis recovery to the formation of resilient, energy-efficient, digitally integrated and environmentally oriented infrastructure systems. In the context of the post-war recovery of Ukraine, this creates the basis for the formation of a new model of territorial development, focused on the long-term sustainability and security of socio-economic systems.

The scientific novelty of the study lies in the substantiation of the infrastructural determinants of the formation of resilience of the quality of life of the population, the systematization of the structural components of ensuring resilience and the development of a conceptual model of the relationship between institutional, infrastructural, social, economic, digital, security and environmental components in the context of ensuring sustainable development of territories.

The practical significance of the results obtained lies in the possibility of their use:

- by state authorities – in the formation of state regional development policy, post-war recovery programs and strategies for ensuring infrastructure resilience;
- by local governments – in the development of development plans for territorial communities, modernization of critical infrastructure and implementation of crisis response mechanisms;
- by critical infrastructure entities – to improve risk management systems, ensure continuity of operation and increase the adaptability of infrastructure systems;
- in the energy sector – in the development of distributed energy systems, smart-grid solutions and energy-efficient infrastructure;
- in the process of digital transformation of territories – for the development of e-governance, digital management platforms and cybersecurity systems;
- in scientific and analytical activities – as a theoretical and methodological basis for further assessment of the level of resilience of the quality of life of the population.

Taking into account the results obtained, it is advisable to recommend:
1) integrate the principles of infrastructure resilience into the state policy of regional development and post-war reconstruction of Ukraine;
2) activate the development of distributed energy systems and local energy networks to increase the energy sustainability of territorial communities;
3) ensure the digitalization of infrastructure management systems and the implementation of smart infrastructure technologies;
4) strengthen the mechanisms of public-private partnership in the field of modernization of critical infrastructure;
5) develop a system for monitoring and assessing the level of infrastructure resilience of territories using integral indicators;
6) ensure the integration of environmental, climate and security criteria into infrastructure planning processes.

Prospects for further research are to develop a methodological approach to assessing the level of resilience of the quality of life of the population based on a system of indicators and theoretical and methodological substantiation of the integral index of infrastructure resilience of territories. Separate scientific study is required on the issues of digital resilience of communities, assessment of cascading effects and adaptation of infrastructure systems to climate and military threats.

Thus, ensuring the resilience of the quality of life of the population should be considered a strategic priority of state policy and territorial development, the implementation of which requires a comprehensive infrastructure transformation, integration of the principles of sustainable development and the formation of adaptive mechanisms for responding to modern global challenges.

References

1. Batty, M. et al., 2012. Smart cities of the future. *European Physical Journal Special Topics*, 214, pp. 481–518. https://doi.org/10.1140/epjst/e2012-01703-3.
2. Cherenko, L. M. et al., 2023. Quality of life of the population of Ukraine and the first consequences of the war: monograph. Kyiv: Institute of Demography and Social Research named after M. V. Ptukha NAS of Ukraine. [in Ukrainian]
3. Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the resilience of critical entities and repealing Council Directive 2008/114/EC (Text with EEA relevance), 2022. *Official Journal of the European Union*, December 27. URL: https://eur-lex.europa.eu/eli/dir/2022/2557/oj.
4. European Commission, 2023. Enhancing EU resilience: A step forward to identify critical entities for key sectors. URL: https://ec.europa.eu/commission/presscorner/detail/it/ip_23_3992.
5. Folke, C., 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), pp. 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002.
6. Folke, C. et al., 2010. Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4), Article 20. https://doi.org/10.5751/ES-03610-150420.

7. Gopalakrishnan, K., and Peeta, S., 2010. Sustainable and resilient critical infrastructure systems: Simulation, modeling, and intelligent engineering. New York: Springer. https://doi.org/10.1007/978-3-642-11405-2.
8. Holling, C. S., 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4, pp. 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245.
9. Khaustova, V. Ye., Kyzym, M. O., Reshetniak, O. I., and Trushkina, N. V., 2025a. Identification of infrastructure threats in the context of ensuring the resilience of the population's quality of life: Foreign and domestic experience. *Investytsii: praktyka ta dosvid*, 23, pp. 41–53. https://doi.org/10.32702/2306-6814.2025.23.41. [in Ukrainian]
10. Khaustova, V. Ye., and Trushkina, N. V., 2025b. The theoretical approaches to the essence of the concept of "critical infrastructure": International, spatial, and resilience dimensions. *The Problems of Economy*, 4, pp. 336–351. https://doi.org/10.32983/2222-0712-2025-4-336-351. [in Ukrainian]
11. Kyzym, M. O., Khaustova, V. Ye., Reshetniak, O. I., and Trushkina, N. V., 2025a. Impact of structural infrastructure changes on ensuring the resilience of the population's quality of life: Theoretical aspects. *Efektyvna ekonomika*, 12. https://doi.org/10.32702/2307-2105.2025.12.12. [in Ukrainian]
12. Kyzym, M. O., Khaustova, V. Ye., Reshetniak, O. I., Popovych, M. V., and Yudenko, Ye. V., 2025b. The concept of "resilience of the population's quality of life": Essential content and components. *The Problems of Economy*, 3, pp. 235–254. https://doi.org/10.32983/2222-0712-2025-3-235-254. [in Ukrainian]
13. Lamond, J. E., Rose, C. B., and Booth, C. A., 2015. Evidence for improved urban flood resilience by sustainable drainage retrofit. *Proceedings of the Institution of Civil Engineers – Urban Design and Planning*, 168(2), pp. 101–111. https://doi.org/10.1680/udap.13.00022.
14. Meerow, S., Newell, J. P., and Stults, M., 2016. Defining urban resilience: A review. *Landscape and Urban Planning*, 147, pp. 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011.
15. OECD, 2023. OECD Infrastructure Governance Indicators: Conceptual framework, design, methodology and preliminary results. Paris: OECD Publishing. URL: https://www.oecd.org/content/dam/oecd/en/publications/reports/ 2023/06/oecd-infrastructure-governance-indicators_3c046ecb/95c2cef2-en.pdf.
16. OECD, 2024. Infrastructure for a climate-resilient future. Paris: OECD Publishing. URL: https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/04/infrastructure-for-a-climate-resilient-future_c6c0dc64/a74a45b0-en.pdf.
17. Padgett, J. E., Ghosh, J., and Dennemann, K., 2012. Sustainable infrastructure subjected to multiple threats. *TCLEE 2009: Lifeline Earthquake Engineering in a Multihazard Environment*, pp. 67–76. https://doi.org/10.1061/41050(357)67.
18. UNDRR, 2022. Principles for resilient infrastructure. Geneva: United Nations Office for Disaster Risk Reduction. URL: https://www.undrr.org/media/78694/download?startDownload=20260517.
19. United Nations, 2015. Transforming our world: The 2030 agenda for sustainable development. URL: https://sdgs.un.org/2030agenda.
20. United Nations, 2024. The Sustainable Development Goals Report 2024. New York: United Nations. URL: https://unstats.un.org/sdgs/report/2024/The-Sustainable-Development-Goals-Report-2024.pdf.
21. United Nations Environment Programme, 2023. Adaptation Gap Report 2023. Nairobi: UNEP. URL: https://www.unep.org/resources/adaptation-gap-report-2023.
22. United Nations Office for Disaster Risk Reduction, 2017. Build back better in recovery, rehabilitation and reconstruction. Geneva: UNDRR. URL: https://www.unisdr.org/files/53213_bbb.pdf.
23. Ukraine, 2025. Rapid damage and needs assessment (RDNA4). February 2022 – December 2024. Washington, DC: World Bank. URL: https://openknowledge.worldbank.org/server/api/core/bitstreams/96bd9c94-c327-49b4-8aff-fe125686f04e/content.
24. Walker, B., Holling, C. S., Carpenter, S. R., and Kinzig, A., 2004. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, 9(2), 5. URL: http://www.ecologyandsociety.org/vol9/iss2/art5/.
25. World Bank, 2023. Digital Development Partnership Annual Review 2023: Transitioning Towards Scale. Washington, D.C.: World Bank Group. URL: http://documents.worldbank.org/curated/en/099810207152431146.