Lasting Growth of Cities: Challenges of Infrastructure Rehabilitation in Ukraine

Larysa Sergiienko [1*], Liudmyla Homlia [2], Kseniia Chichulina [3], Oleh Chukhnii [4], Oleksii Mukhin [5]

[1] Département of National Security, Public Management and Administration,
Faculty of National Security, Law and International Relations,
Zhytomyr Polytechnic State University, Zhytomyr, Ukraine.
[2] Department of Botany, Ecology and Methods of Teaching Biology, Faculty of Natural Sciences and Management,
V. G. Korolenko Poltava National Pedagogical University, Poltava, Ukraine.
[3] Department of Economics, Entrepreneurship and Marketing,
National University "Yuri Kondratyuk Poltava Polytechnic", Poltava, Ukraine.
[4] Department of International Economic Relations, West Ukrainian National University, Ternopil, Ukraine.
[5] Interregional Academy of Personnel Management, Kyiv, Ukraine.
Corresponding authour : sergiienko.lv@gmail.com

OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at https://www.ssrn.com/index.cfm/en/oida-intl-journal-sustainable-dev/

Abstract: The large-scale destruction of industrial, energy and infrastructure facilities during the war has a destructive impact on social development and the progress of the business sector. The European integration concept of Ukraine's post-war recovery envisages active reconstruction of cities based on sustainable development. The article aims to analyse the scale of infrastructure destruction in Ukraine during the war and its impact on sustainable urban development. The study identifies potential risks for the urban development strategy caused by infrastructure destruction. The system of management of reconstruction projects and the state of coordination of management activities in this aspect are investigated. The need to transfer modern approaches generally accepted in the international community to upgrade local management structures for urban development is determined. The necessity of improving the regulatory framework in this aspect is substantiated. The potential of the energy security system against the background of the risks of damage to urban infrastructure is investigated. The sectoral objectives included in Goal 11 of the General Strategy for Sustainable Development - Sustainable Development of Cities and Communities - are analysed. It is established that these tasks aim to ensure the openness, safety and environmental sustainability of cities. It is proved that large-scale destruction of infrastructure, including critical infrastructure, causes instability in socio-economic development, destroys the environment, and worsens the investment climate. It is established that optimisation of the urban development strategy in wartime should aim at integration into global economic networks, transfer of the latest technologies, integration of "green" initiatives, and intensification of social participation in urban development initiatives, which has become an integral component of the process of building an adaptive and sustainable modern city.

Keywords: sustainable development, reconstruction, infrastructure facilities, investment climate, innovation, city, globalisation, economic development.

Introduction

Against the backdrop of wartime challenges in Ukraine, an effective regional policy should implement the gradual transition of cities to a resilient development trajectory. Given the socio-economic and environmental problems and large-scale infrastructure destruction, the pace of implementation of the strategy for sustainable urban development in the context of globalisation is currently slowing down significantly. In addition, the investment attractiveness of cities is declining.

The destruction of urban infrastructure leads to uneven economic development, increased social polarisation, imbalances between different districts of large cities, outflow of financial and intellectual capital, minimisation of

innovation, and increased environmental problems. These challenges require a systemic strategy for ensuring sustainability and implementing innovative solutions in all areas of city life [1]. At the same time, even in times of war, the problem does not lose its relevance, as sustainable urban development is one of the key global development goals set by the UN until 2030 [2].

Today, it seems necessary to introduce the concept of stimulating strategic decisions focused on improving urban security as a critical area of management activity. Assessing the destruction of infrastructure in Ukraine during the war will help determine the bottlenecks in the national security paradigm and formulate directions for optimising the situation based on the identified reserves.

Literature review

The issue of sustainable urban development is considered one of the most pressing topics in modern social economics and urban studies. In particular, the modern international scientific community pays much attention to this topic: scientists emphasise the need to integrate socio-economic and environmental aspects to ensure sustainable, balanced urban development [3], emphasise the interconnections between sustainable economic growth, environmental protection, social justice and improvement of the quality of life [4], analyse the concepts of forming adaptive and resilient urban systems [5].

In the context of military challenges in Ukraine, the issue of sustainable urban development is under active research. For example, publications by Kovalenko et al. [6], Okhrimenko and Popov [7], and Markushyn [8] analyse the consequences of military destruction, such as environmental risks, infrastructure deficits, and social problems, which are exacerbated by the trend of globalisation. The researchers study aspects of sustainable urban development strategies in the context of their adaptability to the realities of Ukrainian megacities in wartime.

Liu et al. [9] present general approaches to assessing infrastructure damage, where losses are assessed by typology. The authors focus on the role of national institutions and international organisations. Guarini et al. [10] see opportunities for post-war regeneration of urban infrastructure to increase the overall investment attractiveness, which optimises financial and credit flows and investment.

At the same time, several scholars [11, 12] identify an urgent need to upgrade the legal framework for ensuring the security of cities, stimulating their development and effective recovery. The assimilation of sustainable development, investment climate and energy security aspects is carried out by De Rosa et al. [13] and Paravantis and Kontoulis [2], who note that ensuring the overall resilience of the energy system is positioned as a driving force for optimising the investment climate of large cities, their economic development and ensuring social balance in times of instability.

Researchers Koval et al. [14] and Yermachenko et al. [15] study the potential of smart infrastructure and its innovative components, as well as the management system of this infrastructure in cities. The researchers pay special attention to the trends in the development of smart cities in the context of socio-economic consequences.

Despite the contribution of modern scholars to the state of research on the issue, aspects of large-scale infrastructure destruction's impact on sustainable urban development's possibilities remain poorly understood, making it important to conduct an extended analysis of the topic.

The article aims to analyse the scale of infrastructure destruction in Ukraine during the war and its impact on sustainable urban development.

Materials and methods

Design and scope of the study. The study focuses on the concept of sustainable urban development in the context of the large-scale destruction of infrastructure in Ukraine during the war. Particular attention is paid to ensuring the rule of law, improving the sectoral legislative framework, and implementing effective international support policies.

Data collection and sources. The study conducted a comprehensive analysis of publications, scientific articles published in various scientific sources, and statistical information on Ukraine's infrastructure destruction in wartime. The sources used include a selection of publications in recent years in industry journals, totaling about 25. In order to mitigate the internal bias of the publications used for this study, an open access and data reuse strategy was applied. It provided access to the full research data, including raw data and code, allowing for verification of results and additional analyses if necessary, reducing the impact of bias. First, primary sources were selected from publications indexed in leading databases (Scopus, Web of Science). The criteria for including and excluding publications were the spatial and temporal indicators and the level of information reliability. The works taken into account were published in the time interval between 2019 and 2024. The keywords used for the search were “sustainable

development, reconstruction, infrastructure facilities, investment climate, innovation, city, globalisation, economic development". The methods used to assess the risk of bias in the included studies include brainstorming and causal analysis.

Analytical framework and methods. Analytical approaches such as analysis, synthesis, generalisation, comparison, and abstraction were the main methods used to identify cause-and-effect relationships. Quantitative studies focus on numerical data that can be evaluated using statistical tools. Qualitative research focused on detailed data on contemporary researchers' practical experience and positions in sustainable urban development in times of crisis and instability.

Evaluation criteria. The study's limitations include the lack of access to complete and up-to-date official data and the difficulty of experimentally testing theoretical conclusions.

Results

The sustainable development strategy aims to ensure the long-term stability of the social environment, which effectively integrates economic, environmental and social aspects of life. Sustainable urban development involves the maximum harmonisation of interests in the areas of economic growth, improving the quality of life of the population, and preserving the environment.

Infrastructure is one of the sectors most affected by the ongoing war in Ukraine, including in terms of the amount of damage caused. The destruction of industrial, energy, and civilian infrastructure poses increased risks to security, logistics, investment, and society's overall development [6]. As of 2024, the direct losses caused by the destruction of Ukraine's infrastructure during the war reached USD 137 billion (Figure 1).

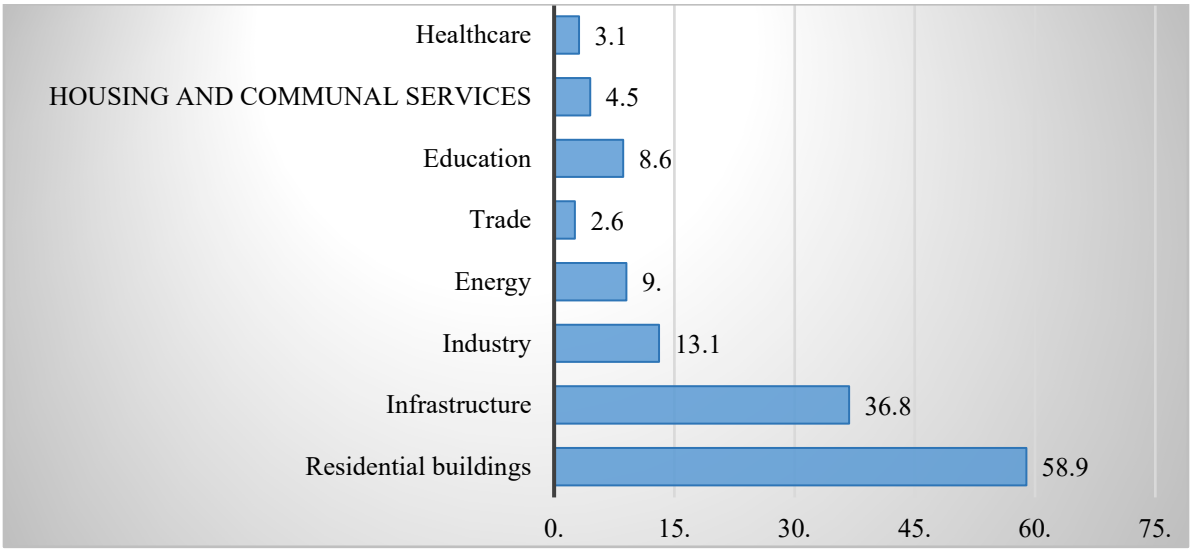

Figure 1. Losses due to infrastructure destruction by industry, as of 2024, UAH billion
Source: systematised based on [16]

As shown in Figure 1, civilian and industrial infrastructure suffered the most significant damage. This requires large-scale financial transfers and a robust security strategy to prevent recurrent destruction, which will help optimise the investment environment.

Ensuring sustainable urban development requires effective partnerships between the authorities, the public and businesses. European practice shows that such interaction optimises the cost of infrastructure projects and resource management and improves the investment climate and the balance of the socio-economic environment [10]. Public-private partnerships within sustainable urban development ensure that the adopted development models complement specific regional needs, which is the basis for forming an inclusive urban environment. In addition, this interaction impacts ensuring environmental sustainability and protection by promoting the integration of energy efficiency initiatives,

green practices, and mitigation of environmental degradation [12, 17].

In the European environment, public-private partnership models have been successfully implemented over the past decade, demonstrating steady quantitative growth despite crisis periods (Figure 2).

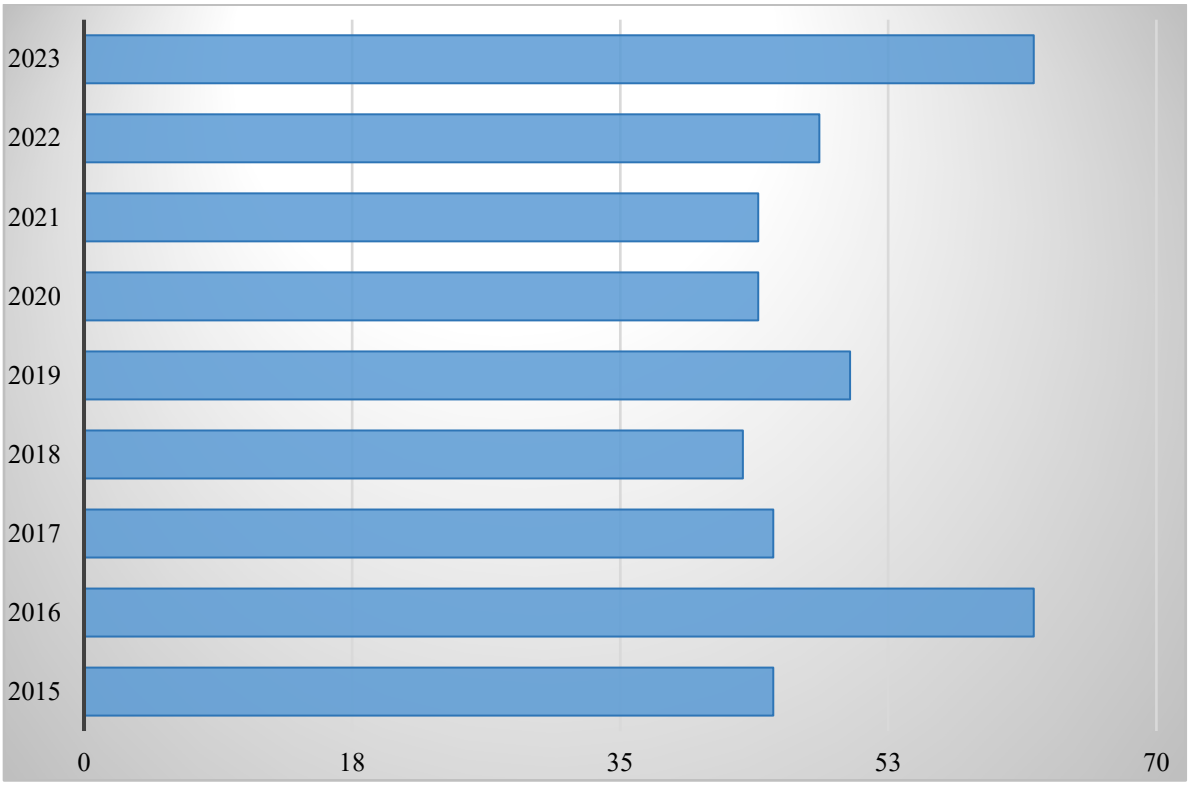

Figure 2. Number of public-private partnership projects in the European Union in 2015–2023
Source: systematised based on [18]

Sustainable development generally implies a balance between meeting human needs and a safe environment, excluding the dominance of any one area – economic, social, or environmental. In this context, investing in the restoration of destroyed and damaged infrastructure is of particular importance in times of war and prospective post-war recovery. At the same time, local governments should actively use credit and financial instruments and partnership opportunities with the business sector based on transparency and openness of the process.

In particular, the experience of Iraq's post-war reconstruction is illustrative. In line with the main trends in investment in the country, public-private partnership projects focused on the reconstruction and rehabilitation of infrastructure projects. At the same time, the active involvement of the public sector and businesses in local development projects was envisaged. Reconstruction models for infrastructure projects in Iraq describe the state directly in public-private partnership projects and include criteria for privatisation and investment policy, legal and political factors, financial and commercial, administrative and organisational, as well as social and environmental impacts and government guarantees [19].

The investment process faces additional difficulties due to the problem of guaranteeing returns amid the risks of war. Therefore, the state should facilitate these activities by integrating relevant legal changes, which will undoubtedly affect the pace of urban development towards sustainability and stability. Thus, an influential decision in this context was creating the innovative electronic platform Advantage Ukraine, which is positioned as a hub for investment projects, including those related to the direct development of cities. The platform has accumulated over five hundred investment projects in various sectors of the economy [20]. In addition, Advantage Ukraine plans to expand the scope of investment design in electronic communications, energy-efficient construction, green equipment, and critical infrastructure restoration systems.

To effectively support the investment policy to restore urban infrastructure, state institutions have introduced war risk insurance for investment projects in priority sectors as part of the Ukraine Recovery Project. In addition, priority areas for stimulating sustainable urban development amid the destruction of Ukraine's infrastructure should be highlighted:

– interest-free lending for projects to regenerate destroyed or damaged infrastructure;

– partial or complete compensation of interest on investment loans;

– support for industrial and infrastructure investment projects;

– financial incentives for the transfer of green technologies and industrial parks;

– stimulating innovative urban development projects and start-ups, digital business transformation, and the development of international partnerships.

Developing a network of industrial parks is seen as an innovative solution to effectively and quickly restore the infrastructure destroyed in Ukrainian cities, contributing to sustainable development. This will help to relocate production, ensure a favourable investment climate, and increase budget revenues at the local level. In order to attract large-scale investment, Ukraine should develop the processes of decentralisation, deregulation, and restoration of privatisation, as well as encourage the implementation of priority public-private partnerships at the city level, such as cooperation and leasing.

Discussion

Sustainable urban development against the backdrop of large-scale infrastructure destruction requires the development of new approaches to damage assessment, stimulating the recovery process and attracting investment capacity. This is reflected in the publications of leading scholars. In particular, Thaler and Hofmann [21] analyse the impact of crisis socio-political processes and sustainable growth, while Mykytenko [22] and Shpatakova et al. [23] focus on the dynamics of investment in infrastructure reconstruction, expanding the scope of traditional tools for attracting investors. Exploring strategies for financing the reconstruction process, the authors emphasise the need to coordinate public-private cooperation in the context of sustainable socio-economic progress and the priority of critical and industrial infrastructure. In continuation, Ukrainian scholars Lobunets and Honchar [24] study the peculiarities of business investment in wartime. The authors propose modern strategies for supporting investment projects to rebuild infrastructure in Ukraine by international organisations through the participation of business representatives in various international programmes and projects.

Kosse [25] notes that 46% of Ukraine's population lives in urban areas. Therefore, the infrastructure sector requires significant funding, prioritisation and effective international coordination based on adaptability, multimodality and sustainable urban development. Also, as Kosse [25] argues, Ukraine's domestic infrastructure policy on post-war reconstruction should be combined with the infrastructure initiatives of the European community.

In the international academic field, the issue of wartime infrastructure damage has been addressed in recent publications by Pacek and Pacek [26] and Gunawan and Pane [1]. Pacek and Pacek [26] pay particular attention to the goals and scope of Russian attacks on critical infrastructure, including medical and energy, by examining the precedent of Russian aggression in an evolutionary context since 2014. The authors note that the main goal is often to make life difficult for the civilian community, likely to generate signs of discontent and resistance to the Ukrainian authorities. Pacek and Pacek [26] identify the principal risks of infrastructure destruction and point out the need to strengthen society's resilience for uninterrupted functioning. At the same time, Gunawan and Pane [1] consider the problem from the perspective of legal protection, which would allow for assessing and recovering damages from the party responsible for the destruction of infrastructure. The authors emphasise the lack of the necessary institutional support in Ukraine and the ineffectiveness of international regulation.

The scientific developments of Guarini et al. [10] and De Rosa et al. [13] correlate with this study's findings on the priority of investment processes in the restoration of war-damaged infrastructure. Most authors position investment instruments as the basis for successful recovery and emphasise the need for security guarantees for critical infrastructure as the basis for business functioning.

Grum and Grum [27] continue the issue of sustainable urban development in Ukraine, linking the risks of urban sustainability to sustainable development. Kucher et al. [28], using water resources as an example, propose ways to strengthen the economic mechanism of sustainable management at the regional level to increase resilience to the risks and challenges of crisis socio-political conditions.

The work of Shmatkovska et al. [29] is valuable, where the issue of regulating the socio-economic security of regions is relevant. The authors propose that it is mandatory to consider indicators of social tension and the level of socio-economic security for the formation and implementation of sustainable development programmes. In continuation, Dulko [30] defines the role of urban planning in post-war Ukraine, identifying the main priorities, means and tools for achieving sustainability in urban development amidst infrastructure destruction.

At the same time, increasing Ukraine's resource potential and investment attractiveness for effective urban recovery and development in times of war remains a pressing problem, given the geopolitical dynamics and the complications of intergovernmental support.

Conclusion

Ukraine's European integration strategy envisages active urban development based on sustainable development goals. The large-scale destruction of infrastructure during the war caused instability in socio-economic development, had a destructive impact on the environment, and worsened the investment climate. There is an urgent need to transfer modern management approaches that are generally accepted in the international community and adapt the relevant regulatory framework.

The main challenges of sustainable urban development are ensuring agglomerations' openness, security, resilience and environmental sustainability. The destruction of critical industrial and civilian infrastructure causes instability in socio-economic development, has a destructive impact on the environment, and worsens the investment climate. The strategy for urban development in times of war should be based on integrating into global economic networks, transferring the latest technologies, implementing green initiatives, and increasing public and business participation in public-private partnership projects.

The findings were obtained with prior mitigation of bias, which was achieved through an open access and data reuse strategy.

References

[1] Gunawan, Y., & Pane, Mhd. E. R. (2024). Responsibility for Excessive Infrastructure Damage in Attacks: Analysing Russia's Attack in Ukraine. *PETITA, 9,* 212. https://doi.org/10.22373/petita.v9i1.213

[2] Paravantis, J. A., & Kontoulis, N. (2020). Energy security and renewable energy: a geopolitical perspective. In: *Renewable energy-resources, challenges and applications*. IntechOpen. https://doi.org/10.5772/intechopen.91848

[3] Shevchenko, S. O., & Kukurudz, O. M. (2024). Strategies for financing post-war reconstruction: challenges and prospects for Ukraine. *Academic Visions, 28*. https://academy-vision.org/index.php/av/article/view/914

[4] Havrysh, O., Yukhnov, B., & Suray, A. (2024). Development of public-private partnership in the process of post-war reconstruction of Ukraine: analysis of legislative initiatives. *Adaptive management: theory and practice. Series Economics, 18*(36). https://doi.org/10.33296/2707-0654-18(36)-02

[5] Esposito, P., & Dicorato, S. (2020). Sustainable Development, Governance and Performance Measurement in Public Private Partnerships (PPPs): A Methodological Proposal. *Sustainability, 12*(14), 5696. https://doi.org/10.3390/su12145696

[6] Kovalenko, Y., Lazarenko, D., & Marchenko, O. (2024). Energy security of the country during the war: barriers and prospects for overcoming. *Herald of Khmelnytskyi National University. Economic sciences, 326*(1), 262–266. https://doi.org/10.31891/2307-5740-2024-326-41

[7] Okhrimenko, O., & Popov, R. (2022). Post-war reconstruction of Ukraine: potential and strategy of transformations. *Economy and Society, (45*). https://doi.org/10.32782/2524-0072/2022-45-7

[8] Markushyn, O. G. (2023). Reconstruction of urban infrastructure in the post-war period: foreign experience. *Investitsii, 3,* 114–119.. https://dspace.chmnu.edu.ua/jspui/handle/123456789/2268

[9] Liu, H., Yao, P., Latif, S., Aslam, S., & Iqbal, N. (2022). Impact of Green financing, FinTech, and financial inclusion on energy efficiency. *Environmental Science and Pollution Research, 29,* 1–12. https://doi.org/10.1007/s11356-021-16949-x

[10] Guarini, E., Mori, E., & Zuffada, E. (2021). New development: embedding the SDGs into city strategic planning. *Public Money and Management, 41*(6), 494–497. https://doi.org/10.1080/09540962.2021.1885820

[11] Suprun, N. V., & Yatsenko, N. O. (2022). Risk insurance in the process of post-war recovery of Ukraine. In: *Modern instruments of corporate finance management: collection of materials of the VI All-Ukrainian scientific and practical Internet conference of students, postgraduates and young scientists.* (pp. 519–522). Kyiv: KNEU. https://ir.kneu.edu.ua/handle/2010/39242

[12] Dankevych, V. E., Dankevych, E. M., Dankevych, A. E., & Naumchuk, V. V. (2023). Economic, food and environmental security in the context of post-war reconstruction: international experience. *Modern Economics, 41,* 45–53. https://doi.org/10.31521/modecon.V41(2023)-07

[13] De Rosa, M., Gainsford, K., Pallonetto, F., & Finn, D. P. (2022). Diversification, concentration and renewability of the energy supply in the European Union. *Energy, 253,* 124097. https://doi.org/10.1016/j.energy.2022.124097

[14] Koval, V., Mikhno, I., & Tamosiuniene, R. (2023). Ensuring sustainable consumption behaviours in circular economy engagement. *Transformations in Business and Economics, 22*(2), 161–177. https://etalpykla.vilniustech.lt/handle/123456789/115576

[15] Yermachenko, V., Bondarenko, D., Akimova, L., Karpa, M., Akimov, O., & Kalashnyk, N. (2023). Theory and practice of public management of smart infrastructure in the conditions of the digital society' development: Socio-economic aspects. *Economic Affairs (New Delhi), 68*(1), 617–633. https://doi.org/10.46852/0424-2513.1.2023.29

[16] State Statistics Service of Ukraine (2024). https://www.ukrstat.gov.ua

[17] Chmyr, Y., Nekryach, A., Kochybei, L., Dakal, A., & Strelbytska, L. (2023). Postindustrial Society and Global Informational Space as Infrastructure Medium and Factor for Actualization of the State Informational Security. *Contributions to Political Science, 1367,* 61–73. https://doi.org/10.1007/978-3-031-33724-6_4

[18] European Investment Bank (2024). *Market update. Review of the European public-private partnership market in 2023*. https://www.ppplietuva.lt/uploads/documents/files/20240030_epec_market_update_2023_en.pdf

[19] Alsaffar, A., & Altaie, M. (2014). Paving the Way for PPPs to Infrastructure Projects in Iraq. *Journal of Engineering, 20*(12), 32–60. https://doi.org/10.31026/j.eng.2014.12.03

[20] Ministry of Economy of Ukraine (2024). *Investments in Ukraine and economic recovery.* https://www.me.gov.ua/Documents/Detail?lang=uk-UA&id=62bfd716-8665-4a4c-9e2d-6325ba53b3c8&title=InvestitsiiVUkrainuTaVidnovlenniaEkonomiki&isSpecial=true

[21] Thaler, P., & Hofmann, B. (2022). The impossible energy trinity: Energy security, sustainability, and sovereignty in cross-border electricity systems. *Political Geography, 94,* 102579. https://doi.org/10.1016/j.polgeo.2021.102579

[22] Mykytenko, V. V. (2023). Post-war restoration and development of critical infrastructure of Ukraine. *Bulletin of Economic Science of Ukraine, 1*(44), 124–138. https://doi.org/10.37405/1729-7206.2023.1(44).124-138.

[23] Shpatakova, O., Ivanenko, R., & Pogrebytskyi, M. (2022). Prospects for the restoration of critical infrastructure in the de-occupied territories of Ukraine. *Economy and Society, 40*. https://doi.org/10.32782/2524-0072/2022-40-5

[24] Lobunets, T., & Honchar, H. (2022). Features of business investment in wartime. *Scientific Perspectives, 8*(26), 155–164. https://doi.org/10.52058/2708-7530-2022-8(26)-155-164

[25] Kosse, I. (2023). Rebuilding Ukraine's infrastructure after the war. *Policy Notes and Reports, 72*, 1–22. https://wiiw.ac.at/rebuilding-ukraine-s-infrastructure-after-the-war-dlp-6621.pdf

[26] Pacek, B., & Pacek, P. (2023). Russia's devastating impact on critical infrastructure during the hybrid war in Ukraine. *Security. Theory and Practice, 2*, 11–27. https://www.ceeol.com/search/article-detail?id=1169528

[27] Grum, B., & Grum, K. D. (2023). Urban resilience and sustainability in the perspective of global consequences of COVID-19 pandemic and war in Ukraine: A systematic review. *Sustainability, 15*(2), 1459. https://doi.org/10.3390/su15021459

[28] Kucher, A., Krupin, V., Rudenko, D., Kucher, L., Serbov, M., & Gradziuk, P. (2023). Sustainable and efficient water management for resilient regional development: the case of Ukraine. *Agriculture, 13*(7), 1367. https://doi.org/10.3390/agriculture13071367

[29] Shmatkovska, T., Shubalyi, O., Rogach, S., Kupyra, M., Dobryanskyy, O., Shved, A., & Voichuk, M. (2023). In the conditions of sustainable development: a case study of Ukraine. *Management, Economic Engineering in Agriculture and Rural Development, 23*(1), 709–718. https://www.cabidigitallibrary.org/doi/full/10.5555/20230166280

[30] Dulko, I. (2023). *Rebuilding Narratives: The Role of Urban Planning in Post-War Ukraine. Master's thesis.* University of Illinois at Chicago. https://www.proquest.com/openview/9ed1d11b02d84b0e9c0e3da29c269ce0/1?pq-origsite=gscholar&cbl=18750&diss=y