

Mishenina Halyna

Klaipeda University, Lithuania
e-mail: halyna.mishenina@ku.lt

Mishenin Yevhen

Institute of Agroecology and Environmental
Management of NAAS, Ukraine
e-mail: eugeniy_mishenin@yahoo.com

Introduction

Relevance Published by the World Bank and its partners RDNA3 (Rapid Damage and Needs Assessment) in February 2024, estimated the cost of rebuilding Ukraine over the next decade at \$486 billion. As of January 2024, the total direct documented damage to Ukraine's infrastructure as a result of a full-scale Russian invasion was \$155 billion. At the same time, damage to infrastructure reached \$36.8 billion. And this amount is constantly growing. One of the important tasks of the post-war reconstruction of Ukraine is not only the physical reconstruction of the destroyed infrastructure, but also its modernization, as well as the transition to European standards. Ukraine needs to create transparent and understandable mechanisms to attract businesses to the area. One of the options is public-private partnership (PPP). In turn, the application of lean principles in PPP projects can significantly improve the quality and reliability of infrastructure facilities, contributing to the achievement of global sustainable development goals, and create the necessary prerequisites for compliance with EU standards. The implementation of LEAN principles also helps to reduce costs and increase the efficiency of PPP projects in infrastructure rehabilitation, which is extremely important in the context of limited resources in the context of the local population's needs for rehabilitation during and after the crisis events caused by the war in Ukraine.

Research problem is to determine how LEAN can help prioritise PPP projects, allocate financing and materials efficiently, ensure that all participants in the partnership (government, private companies) work at full capacity, and identify the potential of LEAN principles to optimise the timing of PPP projects in the context of infrastructure rehabilitation and reconstruction.

Aim The study sought to provide a comprehensive assessment of the role of LEAN principles in improving the efficiency, sustainability and reliability of PPP infrastructure projects in post-war Ukraine.

Tasks are to analyse the potential of LEAN principles to improve the preparation and implementation of PPPs for the rehabilitation of infrastructure projects in Ukraine; to explore the role of LEAN methodology in promoting innovation and sustainable infrastructure development, focusing on how LEAN principles can be integrated into long-term and high-budget PPP projects to meet EU standards and global sustainable development goals; to identify the challenges and opportunities of implementing LEAN principles in the complex regulatory environment of PPPs in Ukraine; and to identify the role of LEAN methodology in promoting innovation and sustainable development of infrastructure, focusing on how LEAN principles can be integrated into long-term and high-budget PPP projects to meet EU standards and global sustainable development goals.

Research methodology Given the interdisciplinary features of this research, which intertwines aspects of management, public administration, social and economic sciences, a mixed approach was chosen: document and literature analysis - to study existing scientific publications, reports and regulatory documents related to LEAN principles and their application in infrastructure projects; case studies to examine in detail successful and unsuccessful PPP projects in order to identify the key factors of effective application of the LEAN concept; analysis of expert opinions in the field of infrastructure construction, PPP and lean manufacturing to obtain a deep understanding of the practical application of LEAN principles; SWOT analysis - to assess the strengths and weaknesses, opportunities and threats of LEAN-principles in the context of implementation of infrastructure PPP projects in Ukraine.

Theoretical assumptions

The general theoretical framework for this study is provided by the underlying theories of lean manufacturing and public-private partnerships (PPPs) related to sustainable infrastructure development. Thus, Woetzel & Pohl (2014) emphasize that the implementation of lean principles in PPPs can improve efficiency by reducing redundant processes, thereby increasing the resource efficiency of infrastructure projects (Woetzel & Pohl, 2014). Lean methodologies in PPPs act as catalysts in achieving long-term sustainability, especially in the construction and infrastructure sectors. This approach is in line with the framework introduced by Ceranic et al. (2018) to include sustainability as a guiding criterion in PPPs (Ceranic et al., 2018). Also, Wright et al. (2018) emphasize in their work that this approach is crucial for sustainable infrastructure investments (Wright et al., 2018). Effective implementation of Lean principles in PPPs requires flexible collaboration with stakeholders, as outlined in the work of Eweje et al. (2021). The work argues that a multi-stakeholder approach in Lean PPPs significantly improves the ability to achieve sustainability goals (Eweje et al., 2021).



Figure 1 Guidelines for LEAN and Sustainable PPPs in Infrastructure Development
Source: created by authors

With this framework, the authors sought to show a structured approach to integrating LEAN principles into PPP infrastructure projects, emphasizing sustainability, resilience and efficiency. The National Recovery Plan of Ukraine (2022) emphasizes the importance of LEAN methods for the restoration of critical infrastructure, attracting investment and supporting the introduction of sustainable technologies in post-war reconstruction. The Construction 4.0 concept (2020) integrates digital technologies such as Building Information Modeling (BIM), Artificial Intelligence (AI), and the Internet of Things (IoT) to improve project efficiency and collaboration. This is consistent with the LEAN principles in the field of waste minimization. The European Green Deal (2020) and the OECD Sustainable Infrastructure Framework (2021) further emphasize the importance of efficient resource management, sustainability and resilience, justifying the integration of LEAN for green infrastructure. Finally, the UN Sustainable Infrastructure Principles (2021) focus on environmental, social and governance (ESG) factors. And in this respect, LEAN principles help ensure that PPP projects meet sustainable development and social impact goals.

Research results

Post-war reconstruction of Ukraine presents unique challenges and opportunities. The destruction caused by the military conflict requires rapid development of infrastructure that is not only functional, but also sustainable and flexible. LEAN principles can provide a structured approach to achieving these goals.

Table 1 - Use of LEAN principles in the implementation stages of PPP infrastructure projects

Stage	Application of LEAN principles
1. Initiating a partnership and submitting a proposal	Apply "just-in-time" approach to concept note and feasibility study preparation, ensuring that the required information is provided in an optimal timeframe. Use of visual management (e.g. mapping) to transparently track all stages of proposal preparation.
2. Analysing the effectiveness of PPPs	Applying the value stream principle to identify and eliminate inefficient processes in analysis, ensuring accuracy and timeliness of findings. Utilising the Kaizen method to continuously improve the analysis process.
3. Making a decision on PPP and holding a tender	Applying process standardisation to the development of tender documents, which reduces the possibility of errors and speeds up the process. Use of "5S" (Sort, Set in Order, Shine, Standardising, Sustain) to organise the tender process.
4. Organisation of the competition	Applying Lean Manufacturing to minimise wasted time and resources in setting up the panel, developing documentation, publishing advertisements, receiving and evaluating proposals. Utilising the "Just-in-Time" (JIT) method to manage and evaluate incoming proposals in a timely manner.
5. Approval of the results and conclusion of the contract with the private partner	Use of visual management and kanban system to clearly track approval and contracting milestones for transparency and efficiency. Use of "Poka-Yoke" (error prevention method) to minimise errors in contracting.

Source: created by authors

SWOT analysis showed that the use of LEAN principles and PPP models can significantly improve infrastructure development through increased efficiency, risk sharing and innovation. However, there are challenges and limitations. (tab.2)

Table 2 - SWOT-analysis of the application of LEAN-principles in the context of PPP infrastructure projects in Ukraine in the post-war recovery period
Source: created by authors

Strengths	Weaknesses
1) Professionalism and efficiency: LEAN principles contribute to process optimisation. This allows for faster implementation of infrastructure projects and lower costs. 2) Risk sharing: PPPs share risks between private and public partners, making projects more resilient to economic and operational changes. 3) Attracting private capital reduces the fiscal burden on public budgets, which is especially important in the context of resource scarcity in the post-war period. 4) The application of LEAN principles encourages innovation and new management methods, which improves the overall efficiency and quality of projects.	1) Complex regulatory frameworks can make it difficult to implement PPP projects based on LEAN principles. 2) Uneven distribution of resources. The attractiveness of more profitable projects can leave less profitable but vital projects without the necessary attention and funding. 3) Dependence on external factors, such as political and economic stability in the country, can make it difficult to implement infrastructure PPP projects. 4) The introduction of new approaches and technologies can face resistance from state and local authorities that are accustomed to traditional ways of working.
Opportunities	Threats
1) Attracting the expertise and investment of foreign partners can increase the speed and quality of realisation of infrastructure projects. 2) Successful PPP projects can make a certain contribution to the socio-economic development of the country, create jobs and improve living standards in post-war Ukraine. 3) The use of innovative technologies and approaches can make infrastructure more efficient and sustainable. 4) Green initiatives. Opportunities to integrate environmentally friendly technologies and solutions into PPP infrastructure projects will contribute to the sustainable development of the country.	1) Economic and social instability, possible fluctuations in international financial markets may affect the attraction and retention of investments 2) Political instability and changes may disrupt the implementation of long-term PPP projects. 3) Corruption and lack of transparency in processes may reduce investor confidence and, as a result, reduce the effectiveness of projects. 4) Uneven distribution of financial and other resources, as well as possible inconveniences for the population (for example, toll roads) may cause social tension and protests

CONCLUSIONS AND RECOMMENDATIONS

International experience shows that the most frequent projects are roads, bridges, airports, pipelines and stadiums. These are the facilities that were damaged in Ukraine and need to be restored as a priority. But there are many more social infrastructure facilities (kindergartens, hospitals, schools) that also need rehabilitation and sometimes even construction. The integration of LEAN principles into PPP infrastructure projects for post-war Ukraine has significant potential in the context of improving efficiency and accelerating reconstruction. However, successful implementation requires overcoming regulatory and social barriers and striving to ensure political and economic stability.

Further focus of the study will be on assessing the impact of LEAN principles on optimising resource allocation in PPP projects and exploring how to improve this process to ensure efficient and timely implementation of these projects in the context of Ukraine's rehabilitation needs, as well as on developing practical recommendations and strategies for the integration of LEAN principles in PPP projects that will increase their contribution to Ukraine's sustainable development and compliance with European infrastructure standards.

References

- Woetzel, Jonathan and Pohl, Herbert, Infrastructure: Doing More with Less (May 1, 2014). World Bank Policy Research Working Paper No. 6882, Available at SSRN: <https://ssrn.com/abstract=2439703>
- Arowosafe, Oluwunmi, Oduyemi, Olufolahan, Ceranic, Boris and Dean, Angela (2018). Sustainable infrastructure delivery in Nigeria: implementation of the analytic network process for contractor selection. *Sustainable Buildings*. <https://doi.org/10.1051/sbuild/2018003>
- Eweje, G., Sajjad, A., & Nath, S. D. (2021). Multi-stakeholder partnerships: A catalyst to achieve sustainable development goals. *Marketing Intelligence & Planning*, 39(5), 587-601. <https://doi.org/10.1108/MIP-04-2020-0135>
- Wright, H., Dimsdale, T., Healy, C., Orozco, D., Williamson, S., & Mabey, N. (2018). *Sustainable infrastructure and the multilateral development banks: Changing the narrative*. E3G. <http://www.ijstor.com/stable/resrep21743>
- Government of Ukraine (2022). Ukraine's National Recovery Plan. Retrieved from <https://www.urc-international.com/urc2022-recovery-plan>
- Perrier, Nathalie & Bled, Aristide & Bourgault, Mario & Cousin, Nolwenn & Danjou, Christophe & Pellerin, Robert & Roland, Thibaut. (2020). Construction 4.0: a survey of research trends. *Journal of Information Technology in Construction*. 25. 416-437. <https://doi.org/10.36680/j.itcon.2020.024>
- European Commission (2020). European Green Deal Investment Plan. Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/ip_20_17
- OECD (2021). OECD Framework for Resilient Infrastructure. Retrieved from <https://www.oecd.org/gov/risk/resilient-infrastructure/>
- United Nations Environment Programme (2021). International Good Practice Principles for Sustainable Infrastructure. Retrieved from <https://www.unep.org/resources/publication/international-good-practice-principles-sustainable-infrastructure>