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# *SUSTAINABLE POST-WAR RECOVERY OF BORDER UNIVERSITIES IN UKRAINE: A CONCEPTUAL MODEL*

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***The full-scale war of the Russian Federation against Ukraine has drastically transformed the operation and mission of Ukrainian higher education institutions, especially border universities exposed to heightened risks. These institutions have faced infrastructure damage, relocation of staff and students, and disruptions to educational and research activities. Despite the conflict, they have acted as community hubs, providing shelter, material support, psychological assistance, and integration services for internally displaced persons, highlighting the increasing importance of the "third mission" of universities - engagement with society. This study proposes a conceptual model for the sustainable post-war recovery of Ukrainian border universities, based on sustainable development principles and digital transformation. The model comprises five interconnected blocks: strategic-target, functional-structural, partnership, digitalization, and monitoring-evaluation. The strategic-target block emphasizes safety, educational quality, research relevance, and sustainable leadership. The functional-structural block addresses renovation and reconstruction of campuses, resilience of processes, and institutional adaptability. The partnership block relies on the Quadruple Helix model, fostering collaboration between academia, industry, government, and civil society to generate synergistic effects for universities, local businesses, and communities. The digitalization block focuses on AI, big data, IoT, blockchain, and cloud technologies to enhance interactivity, remote experimentation, campus security, and institutional efficiency. The monitoring-evaluation block provides indicators to assess strategic alignment, financial sustainability, educational quality, digital competence, security, and partnership outcomes. The proposed model enables border universities to adopt a "build back better" approach, transitioning to a higher level of development that strengthens societal impact, competitiveness, and international recognition. Integrating sustainable development and digitalization ensures resilience, adaptability, and the capacity to meet post-war challenges, contributing to the systematic reconstruction of higher education in Ukraine.***

***Key words: higher education institution; sustainable development; digital technologies; Sustainable Development Goals; borderland universities; post-war***

***university recovery model.***

***Повномасштабна війна Російської Федерації проти України радикально змінила функціонування та місію українських закладів вищої освіти, особливо прикордонних університетів, що зазнають підвищених ризиків. Ці заклади стикнулися з руйнуванням інфраструктури, релокацією персоналу та здобувачів вищої освіти, а також з перебоями у навчальній та дослідницькій діяльності. Незважаючи на війну, вони виступали як хаби підтримки громад, надаючи притулок, матеріальну допомогу, психологічну підтримку та послуги з інтеграції для внутрішньо переміщених осіб, що підкреслює зростаюче значення так званої «третьої місії» університетів — взаємодії з суспільством.***

***У цьому дослідженні пропонується концептуальна модель сталого повоєнного відновлення українських прикордонних університетів, що базується на принципах сталого розвитку та цифрової трансформації. Модель складається з п'яти взаємопов'язаних блоків: стратегічно-цільового, функціонально-структурного, партнерського, цифровізаційного та моніторингово-оціночного. Стратегічно-цільовий блок акцентує увагу на безпеці, якості освіти, актуальності досліджень та сталому лідерстві. Функціонально-структурний блок охоплює реновацію та реконструкцію кампусів, стійкість процесів та адаптивність установ. Партнерський блок спирається на модель Quadruple Helix, сприяючи співпраці між академічними закладами, бізнесом, органами влади та громадським сектором для створення синергетичних ефектів для університетів, локального бізнесу та громад. Цифровізаційний блок зосереджено на використанні штучного інтелекту, великих даних, Інтернету речей, блокчейну та хмарних технологій для підвищення інтерактивності, дистанційного проведення експериментів, безпеки кампусу та ефективності роботи закладів. Моніторингово-оціночний блок передбачає індикатори для оцінки стратегічної відповідності, фінансової стійкості, якості освіти, цифрової компетентності, безпеки та ефективності партнерства.***

***Запропонована модель дозволяє прикордонним університетам застосувати підхід «build back better», переходячи на вищий рівень розвитку, що посилює їхній суспільний вплив, конкурентоспроможність і міжнародне визнання. Інтеграція принципів сталого розвитку та цифровізації забезпечує стійкість, адаптивність і здатність відповідати на виклики повоєнного періоду, сприяючи системній реконструкції вищої освіти в Україні.***

***Ключові слова: заклад вищої освіти; сталий розвиток; цифрові технології; Цілі сталого розвитку; прикордонні університети; модель повоєнного відновлення університетів.***

**Introduction.** The full-scale war of Russia against Ukraine has radically disrupted the established and traditional forms of activity of Ukrainian higher education institutions. Not only have the formats of functioning of domestic universities changed, but also their strategic goals and mission. A number of higher education institutions have effectively turned into hubs that provided shelter, material

support with housing and food for refugees, offered psychological support and assistance with integration into a new society for internally displaced persons. The so-called third mission of universities has become central in their activities.

The impact of the war has been felt by higher education institutions in various regions of Ukraine:

– some universities were forced to relocate to conditionally safer regions, which meant adaptation to new locations, the establishment of an adequate material and technical base, the creation of conditions for students' learning and staff work, the restoration of processes for implementing research and educational projects, as well as the proper organization of the admission campaign (recruiting applicants, competition in the domestic educational services market);

– border and frontline universities in most cases suffered destruction/damage from Russian attacks, and a number of their students, teachers, and researchers changed their place of residence; for this group of higher education institutions, typical challenges included the need for physical restoration of premises, academic buildings, research laboratories, infrastructure, as well as the need to establish effective support mechanisms and communication channels with relocated students and staff; approaches to marketing educational services (convincing applicants and their parents of the quality of distance and/or hybrid learning formats, as well as the ability of the university to ensure safe conditions for all participants in the educational process) and interaction with foreign partners (assuring and proving the university's readiness and ability to successfully fulfill obligations within various projects and initiatives despite the proximity to the aggressor country's border and the risks associated with it) also required reformatting;

– other higher education institutions located geographically distant from the border with the Russian Federation, in several cases, reoriented their activities by strengthening their focus on enhancing the country's defense capabilities and supporting vulnerable population groups (primarily internally displaced persons).

It is worth noting that the location of a university is not a guarantee of safety, since beginning in 2022 not only border and frontline institutions but also educational establishments in the western and central regions of Ukraine have been subjected to Russian attacks. The end of martial law in the country will lead to the emergence of new challenges for domestic higher education institutions; they must transition to effective functioning and high-quality implementation of educational, scientific, innovative, international, and financial-economic activities in peacetime conditions, however with an intensified focus on the safety of all participants in the educational process, continued support for internally displaced persons and relocated universities, and the orientation of research activities toward ensuring high defense capability and the post-war recovery of Ukraine and its regions. Despite the ongoing war, the scientific substantiation of models for the post-war recovery of universities remains relevant. This will make it possible to prepare a foundation and ensure their systematic and comprehensive development in the post-war period.

**Literature review.** Since the beginning of Russia's full-scale invasion of Ukraine, the functioning of higher education institutions under martial law has been studied by a number of domestic scholars from various scientific fields: economists,

educators, lawyers, sociologists, psychologists, and others. A. Zakotiuk and S. Oksamytna examine the main channels and consequences of the war's impact on educational inequality in society (Zakotiuk & Oksamytna, 2024). V. Prodan analyzes the experience of countries around the world in developing education under conditions of war and emergencies, as well as the possibilities of using such experience in Ukraine (Prodan, 2023). In article (Shevchuk & Shevchuk, 2022), I. Shevchuk and A. Shevchuk, based on analytics on the state of the educational sphere during martial law, identify key challenges and opportunities for higher education in our country. The cases of displaced universities are considered in a joint scientific report by V. Kurylo and O. Karaman (Kurylo & Karaman, 2023). A number of studies focus on examining the impact of the war on the psycho-emotional state of participants in the educational process. T. Yamchuk (Yamchuk, 2025) reveals issues of student resilience under wartime conditions. V. Kurapov et al. (Kurapov, Pavlenko, Drozdov, et al., 2024) conducted cross-sectional studies of the impact of the war on higher education students and staff of Ukrainian universities. V. Pavlenko et al. (Pavlenko, Kurapov, Drozdov et al., 2023) analyzed how the war affects the state and factors of quality of life of women in higher education institutions.

Within this article, we focus on border universities because they operate under heightened risks during the war, and even after the end of martial law they will still be forced to take additional measures for protection and risk prevention due to the unpredictability of Russia's behavior. In other words, proximity to the border with Russia will compel such universities to continuously address security issues, act as support hubs for local communities, and serve as innovation centers for the development of local businesses. Due to significant destruction in Ukraine's border territories and the active relocation of enterprises and highly qualified specialists from these areas, universities will face new demands. These demands will concern the preparation, within relatively short timeframes, of specialists needed for regional recovery and for staffing new industries/fields of activity that will emerge in the post-war period. In addition, the challenges will involve transforming approaches to conducting research activities, particularly in the direction of strengthening the practical value of expected research results. The development of a conceptual model for the post-war recovery of border universities will, in our view, ensure their ability to provide high-quality and timely responses to the needs of communities and local businesses; it will focus the attention of management and staff on priority areas of activity and will contribute to the mobilization of resources and reserves for their successful implementation (minimizing the risks of duplication, irrational use of resources, and fragmented actions that will not have a systemic impact).

**Results.** In our view, the post-war recovery of Ukraine's border universities should follow the "build back better" principle, meaning not so much achieving the pre-war state as transitioning to a qualitatively higher level of development that will ensure increased impact on communities and businesses, enhanced competitiveness in the educational services market, and greater international recognition. We believe that the foundation of such recovery should be the concept of sustainable development, which can be integrated into the model of post-war recovery of border universities through:

– sustainable teaching – modernizing the educational process based on sustainability principles and aligning it with the current needs of local communities, businesses, and the labor market (in particular, in terms of training specialists whose competencies and expertise are in demand for the post-war recovery of border regions);

– sustainable research – directing scientific projects toward meeting the needs of businesses, including the development and implementation of sustainable innovative technologies, which will enable local enterprises to increase their competitiveness in domestic and international markets;

– sustainable campus development – rebuilding facilities (university buildings, classrooms, laboratories, libraries, etc.) and infrastructure based on sustainability and environmental safety principles;

– sustainable management and leadership – demonstrating, through the university's own example, cases of sustainable development, promoting sustainable values in society, and advancing ideas of sustainable behavior among the younger generation.

Taking into account the above, we have developed a conceptual model of the post-war recovery of Ukraine's border universities based on the concept of sustainable development, in the structure of which the following components are distinguished:

1) *strategic-target block,* which includes defining the key strategic priorities of sustainable post-war recovery of border universities (with the integration of components of sustainable teaching, research, campus, management, and leadership). Such priorities may include:

– ensuring the safety of all participants in the educational process (inclusive shelters, danger alert systems, digital tools for monitoring the condition of facilities and communications, personal data protection tools, etc.);

– improving the quality of educational services through the integration of sustainability components into the educational process and the use of modern digital technologies, which can ensure equal access to education for all students regardless of their location, as well as maintain connection with students who were forced to relocate due to increased wartime risks;

– orienting scientific research toward addressing the current needs of communities and businesses (including the development of innovative products and technologies);

– strengthening the role of universities as agents of sustainable social transformations through sustainable leadership and advanced management aimed at sustainable principles of functioning;

– introducing innovative digital technologies into the educational, research, innovation, international, and other areas of university activity to automate internal resources, enhance cybersecurity, and optimize costs.

2) *functional-structural block*, whose key principles of construction are:

2.1) renovation – restoring the educational and research processes on the basis of sustainability to strengthen the impact of universities on the sustainable development of communities and businesses;

2.2) revampment – restoring university campuses according to the principles

of environmental sustainability;

2.3) resilience – ensuring the stability and capacity of universities to recover after the impact of exogenous challenges;

2.4) relationship – building trusting relationships with external stakeholders and improving the internal management system through the implementation of diversity management principles.

These fundamental principles, in our opinion, should form the basis of the sustainable post-war recovery of Ukraine's border universities (including sustainable teaching, sustainable research, sustainable management, a sustainable campus, and sustainable leadership). In other words, the outlined principles should be integrated into the processes of improving: educational activities in the direction of orienting them toward the current needs of local communities and local businesses; research and innovation activities to focus on generating environmentally safe technologies, socially important innovations, and economically and investment-attractive developments; infrastructure – through the introduction of advanced digital technologies; approaches to managing university activities – to direct them toward leadership in sustainable societal transformations, as well as toward attracting and motivating talents.

3) *partnership block*, which includes the set of interconnections and interactions between the higher education institution and external stakeholders; the importance of this block of the model lies in the fact that partnership relations and cooperation can play a key role in the successful implementation of the model of post-war sustainable recovery of border universities. Previous studies make it possible to assert the feasibility of applying the Quadruple Helix model to justify the partnership block of the model. The Quadruple Helix encompasses cooperation between:

– academia (universities and research institutions), aimed at generating and disseminating knowledge and innovations;

– industry (business sector), oriented toward transforming knowledge into products, services, and technologies;

– government (policy makers and public authorities), directed at regulation, support, and stimulation;

– civil society (citizens, non-governmental organizations, cultural actors), whose needs and requests scientific research, projects, and their results must aim to satisfy.

Establishing long-term cooperation among the subjects of the Quadruple Helix will ensure the systematic and consistent processes of sustainable post-war recovery of Ukraine's border universities. Such cooperation will generate positive synergistic effects for all involved stakeholders. In the analyzed context, these include probable positive effects for:

– higher education institutions – increasing their level of security and strengthening their position in society;

– the business sector – introducing innovations and digital technologies into the activities of local businesses to support their competitiveness in the market;

– local authorities – activating entrepreneurial activity and creating prerequisites for the sustainable reconstruction of the regional economy;

– local communities – monitoring and promptly meeting their needs due to

the strengthening of the third mission of universities, as well as expanding the practice of applying the service-learning approach.

4) *digitalization block*, which encompasses the activities and initiatives of the digital transformation of a higher education institution aimed at supporting its effective post-war recovery. In our view, innovative digital technologies can significantly contribute to ensuring campus safety, protecting the data of participants in the educational process, improving teaching and learning, enhancing the quality of research outcomes, and more. This block of the model is oriented toward facilitating the reconstruction of border universities in the post-war period based on the "build back better" principle, taking into account the potential of innovative digital technologies in educational, research, and managerial activities, in particular:

– APIs – for integrating educational platforms (restoring normal functioning after the forced relocation of servers and learning management systems) and re-establishing damaged communication channels in higher education institutions (considering the physical destruction of such channels in border universities during the war);

– blockchain – for verifying authenticity, ensuring recognition, and protecting academic documents and personal data of participants in the educational process (given the large number of internally displaced persons and migrants among students of border universities who, during martial law, continued their education abroad or in other Ukrainian universities and will require recognition of their learning outcomes);

– cloud technologies – for organizing access to learning materials, libraries, and joint research projects in real time (considering that some learners may remain abroad - possibly in different time zones - or in other regions of Ukraine, and will need uninterrupted access to university resources for continued distance learning);

– Big Data Analytics – for processing large volumes of information required to improve the monitoring of changes in the needs of higher education learners, applicants, employees, and other stakeholders (acknowledging that war-related challenges may lead to radical shifts in living, family, professional, socio-economic, and other circumstances, affecting the work or study of academic staff and students of border universities, as well as stakeholder expectations of universities);

– Artificial Intelligence and the Internet of Things:

- in increasing the interactivity of learning and motivation to study (considering that the war events could have negatively affected the psycho-emotional state of higher education seekers, reducing their level of interest in learning);
- in remote management of scientific experiments (considering the likelihood that some leading scientists and heads of research projects may continue to stay abroad);
- in monitoring the condition of university premises (considering that shelters require permanent maintenance; the buildings and internal communications of border higher education institutions require continuous monitoring of their condition due to possible negative consequences after airstrikes, bombings and other war impacts; the introduction of an IoT system of sensors and detectors for surveillance and protection against external threats caused by territorial proximity to the borders with the Russian Federation will remain relevant);

5) *monitoring and evaluation block,* which encompasses a set of qualitative and quantitative indicators for the implementation of the post-war development model of Ukraine's border universities based on the concept of sustainable development in the digital era. In our view, it is advisable to develop indicators linked to each separate block of the studied model (Table 1):

*Table 1*

**Criteria for describing the model of post-war recovery of border universities in Ukraine (under the sustainable development concept)**

| Model Block | Criteria |
|---|---|
| **Strategic-Target** | - Availability of a strategic plan for post-war university recovery<br>- Integration of sustainable development principles into the strategy<br>- Prioritization: safety, educational quality, research relevance, sustainable leadership<br>- Flexibility of the strategy and ability to adapt to changes<br>- Policies on academic freedom, human rights, and inclusion |
| **Functional-Structural** | - Level of renovation and restoration of buildings, laboratories, and libraries<br>- Ecological and energy-efficient campus reconstruction<br>- Resilience of university processes to external crise<br>s- Adaptability of the institutional structure to new post-war requirements |
| **Partnership** | - Presence of local and regional partnerships (communities, authorities, businesses)<br>- Participation in international programs and grants<br>- Generation of synergistic effects through the Quadruple Helix model<br>- Social engagement: open platforms, community resources |
| **Digitalization** | - Use of AI, IoT, blockchain, big data analytics, and cloud services<br>- Availability of remote and hybrid courses for students, including relocated students<br>- Level of digital competence of faculty and students<br>- Security of digital systems and protection of personal data |
| **Monitoring-Evaluation** | - Indicators of strategic alignment and achievement of recovery goals<br>- Financial sustainability and diversification of funding sources<br>- Quality of educational programs and compliance with international standards<br>- Effectiveness of safety mechanisms<br>- Achievement levels in partnerships, digitalization, and sustainable development |

*Source: (*Kholiavko & Olyfirenko, 2025)

*Indicators:*

- within the strategic-target block of the model:

a) strategic alignment indicators, which include the presence of a sustainable development strategy for the higher education institution, a developed plan for its implementation; the percentage of achieved strategic goals (short-, medium-, long-term); the degree of strategy flexibility (the possibility of regular updates taking into account changes in the political, security, and demographic environment, trends in higher education and digital technologies, feedback from internal and external evaluators); the presence of policies ensuring academic freedom, human rights, and inclusion; the share of administrative processes transferred to digital format; the level of university autonomy in making managerial decisions; the readiness of leadership for external audit of the strategic plan by independent experts (stakeholder participation in joint evaluation; presence of advisory groups including community representatives, business, alumni, local authorities) and public reporting on sustainable development;

b) financial sustainability indicators, which include the share of funding allocated for the restoration and sustainable development of the university in the total budget; the degree of diversification of the higher education institution's funding sources (attraction of external resources – funds from the business, government, and civil sectors, as well as patronage support, alumni contributions, grants from international and national donors, organizations, and foundations); the number of implemented internal initiatives ensuring environmental responsibility;

c) quality indicators, covering compliance of educational programs with European quality standards; the position of the higher education institution in national and international rankings (UI GreenMetric, THE Impact Rankings, etc.);

d) security adaptability indicators, which include the presence of a crisis management plan at the university; the level of readiness to respond to threats (cyber and physical risks), the presence of approved procedures/instructions in case of hazardous situations;

-within the functional-structural block of the model:

a) human resources, including parameters of the ratio of higher education students to the number of academic (teaching) staff (optimal workload); the share of faculty members who have completed professional development in the field of sustainable development;

b) educational programs, namely the parameters of updated curricula with the inclusion of sustainability components (percentage of total projects); the share of interdisciplinary courses;

c) governance and institutions, which covers the presence of institutional units responsible for the sustainable development of the university; the level of student involvement in the management and strategic processes of the university;

d) environmental responsibility, the indicators of which may include the number of campus sustainability initiatives; energy efficiency indicators of buildings and infrastructure; the presence of implemented systems for water conservation, waste sorting, sustainable transport, bike lanes on campus, etc.

- within the digitalization block of the model:

a) educational services, in particular the percentage of educational programs with integrated digital technologies (artificial intelligence, big data analytics, Internet of Things, blockchain); the number of courses in hybrid/distance format;

b) digital infrastructure, namely the number and effectiveness of internal digital services (learning management system LMS, e-portfolio, electronic document management); IT infrastructure resilience (backup systems, cloud services, etc.); the presence of internal digital security, openness, and inclusion policies;

c) digital literacy, including the level of digital competence of faculty and students; the number and quality of university-organized trainings and programs for developing digital skills of students and staff (including the provision by the university of access to trainings conducted by external organizations);

d) analytics and research, in particular the number of scientific projects using digital technologies; the use of digital information dashboards for monitoring and management;

- within the partnership block of the model:

a) local connections, which include the number of cooperation agreements with communities and local authorities; the share of graduates employed in the border region (contribution to restoring human capital); the level of university involvement in forming the regional innovation ecosystem;

b) business partnerships, covering the number of joint innovation and reconstruction projects with businesses; the volume of investments attracted from the private sector;

c) international integration, concerning parameters of participation in grant programs (Erasmus+, Horizon, Digital Europe, DAAD, etc.); the level of representation in international academic networks/associations; the number of actual partnerships/interactions with foreign higher education institutions;

d) social interaction, including the presence of open digital platforms and educational resources for the community; the level of trust in the university among local stakeholders; indicators of academic integrity and social impact; participation in projects for the development of local communities.

**Conclusion.** The full-scale war of the Russian Federation against Ukraine has fundamentally transformed the operational and strategic landscape of Ukrainian higher education institutions. The conflict has not only disrupted traditional forms of academic activity but also necessitated a reevaluation of the mission and objectives of universities across the country. Border universities, in particular, have been exposed to heightened risks, experiencing physical damage to infrastructure, forced relocation of personnel and students, and significant disruptions to educational and research processes. Despite the ongoing hostilities, these institutions have acted as hubs for community support, providing shelter, material assistance, psychological services, and integration support for internally displaced persons. This reality underscores the importance of the so-called "third mission" of universities - engagement with and service to society - which has emerged as a central priority.

The post-war recovery of border universities in Ukraine represents a multidimensional challenge. It requires not merely a return to pre-war conditions but the transformation of universities into resilient, adaptive, and sustainable institutions

capable of supporting local communities, regional economies, and national reconstruction. This study proposes a conceptual model for the sustainable post-war recovery of Ukrainian border universities, grounded in the principles of sustainable development and digital transformation. The model integrates five interrelated blocks: strategic-target, functional-structural, partnership, digitalization, and monitoring-evaluation. Each block addresses critical aspects of university operations, from strategic planning and resource management to technological adoption, stakeholder engagement, and continuous assessment of progress.

The strategic-target block emphasizes the alignment of institutional goals with sustainable development principles, prioritizing the safety of all participants in the educational process, the enhancement of academic quality, the relevance of research to community and business needs, and the promotion of leadership and management practices that support sustainable societal transformation. The functional-structural block focuses on the renovation and reconstruction of campus infrastructure, the resilience of educational and research processes, and the establishment of institutional mechanisms that support long-term adaptability. The partnership block leverages the Quadruple Helix model, fostering collaboration among academia, industry, government, and civil society to generate synergistic effects that strengthen universities, stimulate regional economic activity, and promote social development. The digitalization block outlines the integration of innovative technologies—artificial intelligence, big data analytics, Internet of Things, blockchain, cloud computing—to enhance educational interactivity, remote experimentation, campus security, and overall institutional efficiency. Finally, the monitoring-evaluation block provides qualitative and quantitative indicators for measuring progress across all model components, including strategic alignment, financial sustainability, educational quality, security adaptability, digital competence, and the effectiveness of partnerships and community engagement.

The proposed conceptual model serves as both a theoretical and practical framework for guiding border universities through post-war recovery. By adopting a "build back better" approach, these institutions can transition to a higher level of development that strengthens their societal impact, competitiveness, and international recognition. Furthermore, the integration of sustainable development principles and digital transformation within the model ensures that universities are equipped to respond effectively to ongoing challenges, including security threats, demographic shifts, and evolving labor market needs. This study contributes to the emerging discourse on post-conflict higher education reconstruction, offering a systematic and comprehensive approach to enhancing the resilience, sustainability, and societal relevance of border universities in Ukraine.

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