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Yuriy SENIUK

ECOLOGICAL ENGINEERING AND RESILIENT GREEN INFRASTRUCTURE AS A NEW INDUSTRIAL BASE FOR THE POST-WAR RECOVERY OF UKRAINE: INSTITUTIONAL, INNOVATIVE AND EDUCATIONAL PRIORITIES

Ukraine-Slovak International Center for Innovation and Technology Transfer
(Kosice, Slovakia)
National Science-Technological Association of Ukraine
(Kyiv, Ukraine)

Abstract. *Actually, such a platform, with some later modifications, is considered as the basis of a digital infrastructure for supporting and promoting international innovation and investment cooperation of SMEs in cluster forms with the key role of USICITT as a pilot cross-border institutional interface. In turn, the successful construction and operation of such a Center on the border with Slovakia, as well as other European neighboring states, will become an important condition for building a truly innovative Ukraine, and not a simple reconstruction of the old industrial base or even its modernization with using imitative technological innovations and borrowed institutional forms in framework of the future International Plan of post-war recovery of the country. Therefore, it is so important to understand and implement in such recovery activities, first of all, institutional, innovative and educational priorities*

Key word: *bioeconomy of health, innovative businesses, socio-economic reproduction, European Grouping of Territorial Cooperation, Scientific and Technological Council*

The russian armed aggression and the devastating consequences it caused for the economy and industry made the country face the need to find adequate responses to the global innovative challenges, unprecedented in their level of complexity and geopolitical uncertainty. Together with high innovative expectations of the partner countries in the development and financing of the future Program for the poet-war recovery of Ukraine, this puts the intellectual forces and political elite of the nation in front of cultural and creative problem of building a qualitatively new post-industrial reality, and not just restore the old post-soviet base and socio-economic infrastructure. From a theoretical and model point of view, this means the need to combine external, exogenous, and internal, endogenous factors of accelerating economic growth into a single innovative model of institutionally managed inclusive human-centered sustainable development, with leading role of humanitarian and institutional capital. In turn, inclusiveness implies a decentralized approach to sustainable development, which opens access to its institutions to everyone, and human-centricity puts the the human health into the focus of the whole system of the socio-economic reproduction as a living basis of humanitarian capital. In principle, such a transformation from a vertically integrated, in the extreme version - centralized, approach to the organization of industrial sectors with a manufacturing enterprise in the center to a decentralized human-centric and health-oriented economic activity of local community corresponds to the global trends of the post-pandemic transformation of the world economy. And even more than that , taking into account the fact that in a war the enemy's efforts are primarily aimed at inflicting maximum damage to the life and helth of the enemy, and the focus of post-war recovery is also the life and the health of the population, the construction of a qualitatively new socio-economic reality actually means the need building an innovative Bioeconomy of health. Such an economy, whose target function, in contrast to past models of Industrial and "green" Bioeconomy, focused on the production and distribution of goods and services as the tools for life and health, is aimed on the expanded reproduction of both individual and group (public) health of local community. It is important to note that the very term and model of the Bioeconomy of health as a new type of economic reality was first publicly presented here, in Vinnitsa in May 2021 in framework of the same II International Conference /1/.

In contrast to the linear sectoral structure of the previous two models of the Industrial and "Green" economy, the Bioeconomy of health ("Blue") model is based on the non-linear, ecospheric principle of the "nuclear system", the core of which is innovative territorial system of public health of the local community. Unlike medicine, which is a centralized costly social sector that does not create added value in the logic of the econometric model of the productive function, the decentralized Public Health (PH) system is focused on the expanded reproduction of humanitarian capital as the leading productive factor of the "Blue" economy of the post-war

future. In the logic of this model, PH is an endogenous core, and the exogenous decentralized Bioeconomy of Health (BoH), aimed at preserving and increasing it, acts as a comprehensive means of ensuring its reproduction, acting as the first spherical "shell" of such system. The role of the second shell is given to the residential sphere, and since this entire complex bio-socio-economic sphere, pulsating in the daily rhythm of the reproduction of being, co-evolves in a dynamic balance with the environment, this whole complex harmonized ensemble must function like a living cell in a single human organism. Of course, to ensure the connection of such a primary "living ecospheric cell" as a proto-forming system-element, required to create a smart hub at regional level that performs a function similar to one of the organs in the human body, , an appropriate multi-level digital infrastructure will be required. In turn, on the basis of such regional innovative ecosystems, with the help of an appropriate digital multi-level infrastructure, a neuro-semantic network framework of the national PH system as a single organism is formed.

And it is clear that building such multi-level "organismic" system in the "bottom-up" direction, in addition to the vertically-integrated existing "top-down" industry-segmented reality, will require both its own institutional innovations and the creation of its own institutional architecture, focused on sustainable inclusive development. And since economic development, in contrast to economic growth, involves not so much a change in quantitative dynamics as quality, and hence the very capital and institutional framework, then, having in mind not only the post-war perspectives, but also the current political and economic situation, we are actually talking about creating a multi-level system of international horizontally-integrated innovation-Industrial cooperation on a cluster base. And here we have two problems that should be the innovative focus of our conference. One of them is that spatially distributed technological and value chains in form of clusters, both industrial, initiated by existing manufacturers, and innovative, generated by high-tech start-ups focused on the industrialization of new technological solutions, are widespread and effectively supported by European Commission forms of horizontal cooperation of small and medium-sized enterprises (SMEs) in the European Union, but not in Ukraine, where such an institutional form is not yet provided for by the Legislator in the legal space. The other is that SMEs, on their own, are generally not capable of designing, investing, building and managing such complicated international cooperation, not least due to both the lack of necessary professional knowledge and access to the investment required for this. As a result, an innovative demand arises for the creation of new development institutions responsible for designing, investing, building and management or coordination the activities of such clusters both at local, regional and national, as well as cross-border, transnational and global levels. The key role here in the current conditions for Ukraine as a candidate for EU membership, which is in the process of intensifying adaptation procedures that bring us closer to the normative and regulatory space of the United Europe, belongs to the cross-border hub as an innovation interface between two converging realities. And as such a pilot hub, it was established on March 27, 2023 at the initiative of the National Science-Technological Association of Ukraine on the basis of Uzhgorod National in Ukraine (UNU) and Kosice Technical University (TUKE) in Slovakia as well as their science parks, with the involvement of other national universities and leading institutions accompanied by innovative businesses of both countries, the Ukrainian-Slovak International Center for Innovations and Technology Transfer (USICITT). The general scientific and methodological management of the innovative activity of this Center is called upon to be carried out by the Scientific and Technological Council (STC) under the co-chairmanship of the rectors of TUKE and UNU.

Using its powers, STC immediately approved 10 priority areas for innovative cluster formation, focused primarily on joint selection, refinement and production of the best innovative typological modular solutions for ecological engineering and decentralized "green" smart infrastructure for the needs of the post-war recovery and modernization of the local communities in Ukraine. Of this 10 areas, 7 in one way or another relate to "green small-scale energy", including not only distributed generation and storage of electricity (end heat) using solar, hydrogen, wind-, hydro and bio-energy plants, but also their aggregation and smart consumption within the framework of local autonomous closed-cycle energy systems for United Territorial Communities (UTC), integrated, at the same time, into a single national power supply system of Ukraine. This kind of decentralized and independent from the national power supply system in emergency situations, including those of a military nature, is a strategic direction for ensuring the safety of UTC's critical infrastructure, and therefore the vital needs of the population. Instructive examples for us and legislative initiatives based on the study of the lessons of the russian aggression against Ukraine and related with this war threats to the country's energy security, as well as innovative solutions required for the implementation of such approaches was shown by Slovakia, having changing the national legislation accordingly and thus paving the way for innovative restructuring of the energy market. Of course, this kind of technological and institutional transformation in order to create decentralized autonomous energy power systems requires the appropriate construction of local smart grid networks, as well as digital platforms for managing the entire power generation cycle, optimizing the distribution of capacities, loads, consumption and financial settlements in UTCs, and hence the radical innovation of local economy. In addition, the 8th cluster direction is focused on the joint production and installation of standard modular mini-systems for water supply and sanitation, as well as territorial digital platforms for the integrated management of water resources of subregions. At the same time, the 9th direction is oriented on the construction of PH clusters, while

the 10th is aimed at the development of the local BoH. The practical implementation, if not all, then the absolute majority of these cluster areas requires the selection, refinement and co-production of the most effective technological innovations embodied in ecological engineering, as well as advanced sensors for appropriate smart control systems using AI and IoT.

However, as the experience of successful post-industrial transformation of the most rapidly developing economies shows, the key role in their innovation is played not so much by technological as by institutional innovations. This provision is especially important for Ukraine, which is counting on the accelerated granting of EU membership. In this sense, for the formation of international industrial and innovative clusters, a fundamentally important role is given to USICITT as an infrastructural bridge for rapid integration into the cooperation space of the European Union. Given its typical cross-border nature, it is worth paying attention to its institutional form. USICITT as a subject of innovative activity under the laws of the Slovak Republic was created in the format of an international innovation consortium without creating a legal entity, but managed by legal entity represented by the International Center for Innovative Technologies (ICIT). The main mission of the USICITT is to consolidate, configure and coordinate the designing, investment, construction and management of cross-border innovation clusters and promote their integration with national, regional and local clusters on both sides of the border with the EU. And such a European legal personality is fundamentally important from the point of view of the use of already established structures for the implementation of innovation and investment cooperation between the regions of Ukraine and EU in form of European Grouping of Territorial Cooperation (EGTC), based on partner access to EU structural funds, open exclusively to the Member States. In contrast to the practice of implementing such inter-regional cooperation in the form of Euroregions, which was previously used in the European Union, EGTC involves the creation of a joint company as an EU resident, which manages such cooperation. From this point of view, USICITT has the prospect of participating in the process of institutionalization of International cooperation between the regions of Ukraine and the European Union in the form of EGTC. At the same time, for its successful operating , such a Center needs to be paired with initial information about digital business profiles and unused capabilities and outsourcing opportunities for SMEs interested in integrating into cluster technology and value chains from both sides of the EU border. In addition, this implies the need to create a digital infrastructure for multi-level integration of such capabilities and opportunities into different cluster chains being designed based on using AI, starting from local ones and ending with Global Value Chains (GVC).

Undoubtedly, such a complex multi-level system of internationally distributed horizontally integrated business activity aimed at the industrialization of technological innovations on a new institutional basis, requires the formation of relevant competencies and training of innovative entrepreneurs. In turn, this implies not only the existence of entrepreneurial universities (University 3.0), but also the creation on their basis of the Higher School of Innovative Entrepreneurship (HSIE) /2/. Meanwhile, in Ukraine, from a formal point of view, only classical universities (U1.0), traditionally focused on training specialists, are presented, although a certain number of leading Ukrainian universities , primarily technical ones, are quite close to the actual status of s research university (U2.0), more or less , but still with the help of technological businesses incubators and science parks focused on the commercialization of technological innovations. However, as a rule, such commercialization is usually carried out in the form of the sale of innovative start-ups abroad, when new capital is also created beyond Ukraine. It is quite obvious that such commercialization of innovations does not contribute much to economic development, since its necessary condition is not only the outstripping quantitative growth of the National fixed capital, but also the qualitative diversification of its structure. Such a situation for its changing in stationary conditions of peace and stability usually involves a gradual innovation-oriented market reforming “from above”, synchronized with an adequate institutional transformation “from below”. However, in the context of the ongoing brutal and destructive war, different, intensive approaches and faster and more decisive institutional innovations are needed, relying on broad international support, primarily from the EU side. In this sense, within USICITT, the “first stage” of the development of an innovative digital platform in the form of the International Virtual University 4.0 is now nearing completion. Such an University 4.0 is designed to implement the “triple integration” model, the schematic diagram of which is shown in Fig.1.

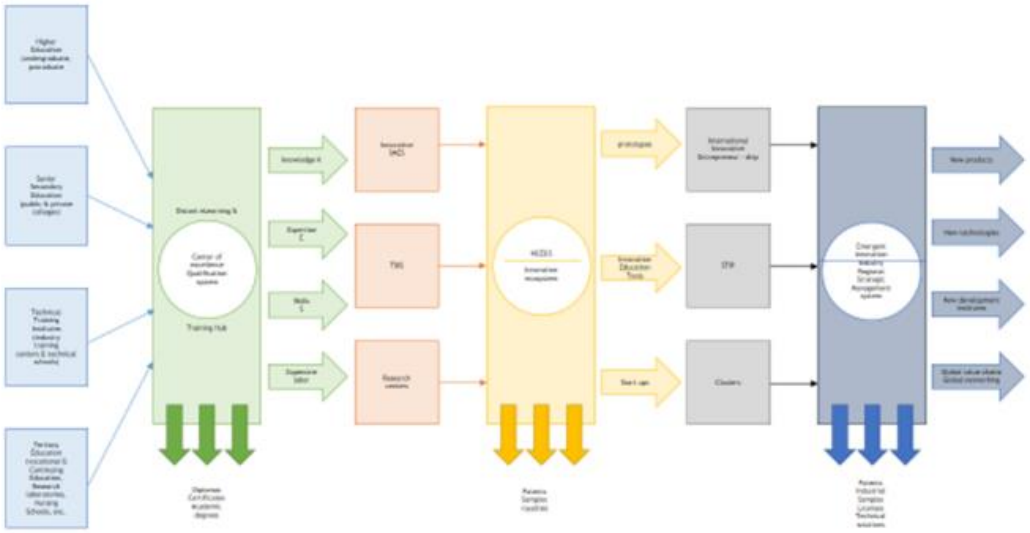

Figure 1. The model of «triple integration» e -Learning innovation educational platform
(Source: Seniuk (2017)

This figure shows parts integrated in framework of a single model: eLearning & training center; prototype center and regional innovation development system. The first part aimed to integrate advanced opportunities of higher, senior secondary and technical schools. And in their totality, all these 3 integrated parts form the institutional basis of HSIE. At the same time, the integration of qualified foreign assistance, the sharing of new knowledge and competencies within the framework of international cooperation and clustering is supposed to be implemented using a cross-border digital multi-level service platform, the architecture of which is shown in Fig. 2.

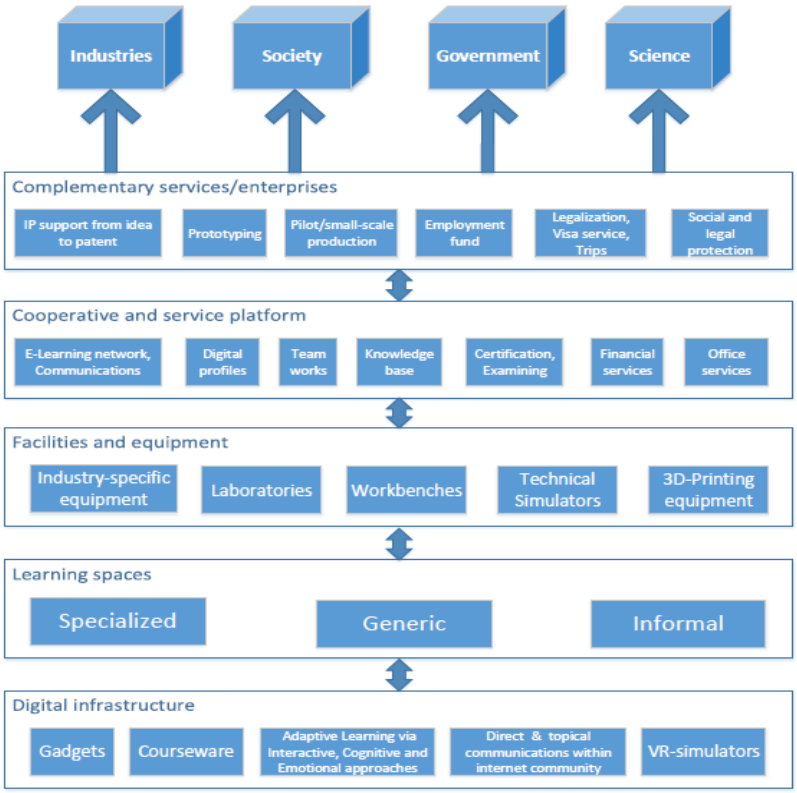

Figure 2. Transborder multi-level digital interactive eLearning service platform
(Source: Seniuk (2017)

Actually, such a platform, with some later modifications, is considered as the basis of a digital infrastructure for supporting and promoting international innovation and investment cooperation of SMEs in cluster forms with the key role of USICITT as a pilot cross-border institutional interface. In turn, the successful construction and operation of such a Center on the border with Slovakia, as well as other European neighboring states, will become an important condition for building a truly innovative Ukraine, and not a simple reconstruction of the old industrial base or even its modernization with using imitative technological innovations and borrowed institutional forms in framework of the future International Plan of post-war recovery of the country. Therefore, it is so important to understand and implement in such recovery activities, first of all, institutional, innovative and educational priorities

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SENIUK Yuriy – Head of Ukraine-Slovak International Center for Innovation and Technology Transfer (Kosice, Slovakia), National Science-Technological Association of Ukraine (Kyiv, Ukraine), e-mail: iuriiseniuk@ukr.net

Екологічна інженерія та стійка зелена інфраструктура як нова промислова база післявоєнного відновлення україни: інституційні, інноваційні та освітні пріоритети

Анотація. Запропонована платформа з деякими модифікаціями розглядається як основа цифрової інфраструктури для підтримки та просування міжнародного інноваційного та інвестиційного співробітництва SMEs у кластерних формах з ключовою роллю USICITT як пілотного транскордонного інституційного інтерфейсу. У свою чергу, успішне будівництво та функціонування такого Центру на кордоні зі Словаччиною, а також іншими європейськими державами-сусідами стане важливою умовою розбудови справді інноваційної України, а не простої реконструкції старої промислової бази чи навіть його модернізація з використанням імітаційних технологічних інновацій та запозичених інституційних форм у рамках майбутнього Міжнародного плану післявоєнного відновлення країни. Тому так важливо розуміти та реалізовувати в такій відновлювальній діяльності насамперед інституційні, інноваційні та освітні пріоритети.

Ключові слова: біоекономіка здоров'я, інноваційний бізнес, соціально-економічне відтворення, Європейське об'єднання територіального співробітництва, Науково-технічна рада

Сенюк Юрій Володимирович - Голова Ukraine-Slovak International Center for Innovation and Technology Transfer (Kosice, Slovakia), Національної соціологічно-технічної Асоціації України (Kyiv, Ukraine), e-mail: iuriiseniuk@ukr.net