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### **PRIORITY AREAS OF UKRAINE'S INNOVATIVE POTENTIAL IN THE CONDITIONS OF DIGITAL TRANSFORMATION**

**Abstract.** Given the complexity of the global epidemiological situation, the struggle for the competitiveness of national economies is exacerbated. For Ukraine, whose economy has now taken the form of deindustrialization, the intensification of innovation is a necessary, extremely important condition for its further development. It was previously thought that the socio-economic development and growth of countries depended mainly on their capital and labor resources, while other less tangible resources, such as information, training, infrastructure development were treated as external factors influencing market behavior only indirectly. However, overtime, the idea that knowledge management is a determining factor in productivity in both modern and traditional economies is becoming increasingly entrenched. The paper proposes results of the research of Ukraine's positioning in the global innovation space. It also determines the necessity of priority development of the innovative sphere of the country against the backdrop of crisis phenomena and assesses the position of Ukraine in the Indices characterizing the level of development of the innovative component of the competitiveness of the country's economy. It underlines the insufficient level of innovation infrastructure development in the country. The authors consider that the basis of Ukrainian innovative competitiveness is the development of institutions, infrastructure and business. These areas need special state support, as their effective implementation is the main competitive advantage of Ukraine. The research was conducted according to the Global Innovation Index sub-indices on the horizon of 2013—2021. Econometric methods are used to generalize the positioning of Ukraine in the global innovation space and the DEA method to study the relative individual effectiveness of the innovation environment and innovation activities in Europe.

**Keywords:** innovation, innovation potential, digitalization, digital transformation, competitiveness, Global Innovation Index.

**JEL Classification** O32, D24, F63

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## ПРІОРИТЕТНІ НАПРЯМИ ПІДВИЩЕННЯ ІННОВАЦІЙНОГО ПОТЕНЦІАЛУ УКРАЇНИ В УМОВАХ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ

**Анотація.** В умовах ускладнення глобальної епідеміологічної ситуації боротьба за конкурентоспроможність національних економік ще більше загострюється. Для України, економіка якої на сьогодні набула форм деіндустріалізації, активізація інноваційної діяльності є необхідною, украй важливою умовою її подальшого розвитку. Раніше вважалося, що соціально-економічний розвиток і зростання країн залежать головним чином від їхнього капіталу і трудових ресурсів, тоді як інші менш відчутні ресурси, такі як рівень інформації, підготовка кадрів, розвиток інфраструктури, трактувались як зовнішні фактори, що впливають на поведінку ринку лише опосередковано. Однак із часом ідея про те, що управління знаннями є визначальним фактором продуктивності праці, стає очевидною. Наведено результати дослідження позиціонування України у глобальному інноваційному просторі. Визначено необхідність першочергового розвитку інноваційної сфери країни в умовах кризових явищ. Проведено оцінку місця України в індексах, що характеризують рівень розвитку інноваційної складової конкурентоспроможності економіки країни. Зазначено недостатній рівень розвитку інноваційної інфраструктури у країні. Зроблено висновок, що основою української інноваційної конкурентоспроможності є розвиток інституцій, інфраструктури та бізнесу. Ці сфери потребують особливої державної підтримки, оскільки їхня ефективна реалізація і є головною конкурентною перевагою України. Дослідження проводили за даними субіндексів глобального інноваційного індексу у 2013—2021 рр. Використано економетричні методи для узагальнення позиціонування України у глобальному інноваційному просторі та метод DEA для вивчення відносної індивідуальної ефективності створення інноваційного середовища та інноваційної діяльності країн Європи.

**Ключові слова:** інновації, інноваційний потенціал, цифровізація, цифрова трансформація, конкурентоспроможність, глобальний інноваційний індекс.

Формул: 1; рис.: 4; табл.: 2; бібл.: 20.

**Introduction.** Given the complexity of the global epidemiological situation, the struggle for the competitiveness of national economies is exacerbated, as only highly competitive economies are able to provide security, high standards and quality of life for their citizens in extreme situations. According to the innovative theory by J. Schumpeter, overcoming the crisis and economic downturns can be ensured only through innovative development [1]. For Ukraine, whose economy has now taken the form of deindustrialization, the intensification of innovation is a necessary, extremely important condition for its further development [2]. Against the background of a significant slowdown in global economic growth in 2020, there is a need to study the trends of the Global Innovation Index (GII).

It was previously thought that the socio-economic development and growth of countries depended mainly on their capital and labor resources, while other less tangible resources, such as information, training, infrastructure development were treated as external factors influencing market behavior only indirectly [3]. Under this new holistic concept, more and more jobs need to focus on generating innovative ideas that apply to products, services and processes.

**Analysis of research and problem statement.** Support for innovation, such as the ability to generate, acquire, adapt and use new knowledge to achieve sustainable competitive advantages over time [4], is provided in the development plans of all countries, where innovation policy is formed as a key element of industrial policy. Ukraine, on the other hand, faces problems typical of developing economies, such as poor coordination, high levels of corruption, shortages of skilled human capital, and limited ability of governments to act, which reduces the effectiveness of public policy [5].

The Organization for Economic Co-operation and Development (OECD) notes that a reliable assessment of innovation potential is important for the proper development of public policy and emphasizes that current benchmarks do not fully reflect the role it plays in the modern economy [6]. Against this background, this study focuses on the analysis of components, which determine the formation of the Global Innovation Index. The hypothesis tested in the paper is that it is not always

true that a higher level of innovation determines a stronger economy with greater development potential. The aim here is to measure the effectiveness of innovation management through statistical analysis of a number of observed variables obtained from the Global Innovation Index during 2013—2020. This index provides an annual ranking of the world's largest economies in terms of innovation and their impact on development. The economies included in the index account for 92.8% of the world's population and 97.9% of world GDP.

According to the European Commission (1995), innovation is the application of knowledge to transform an idea into a new or upgraded product, service or manufacturing process. Therefore, it is obvious that innovation is especially important for the development and competitiveness of developing economies [7] describes how innovation can address the challenges that these economies face, such as cleaner production [8; 9], overcoming poverty and social insecurity, or importing technology and adapting to modernize production, particularly agriculture [10]. Over the last century, various interpretations of innovation have been proposed, especially when they were conceived as a process. The main ones include a technology incentive model that encompasses the innovation process, starting with science and technology, up to the commercialization of an economically viable product or process. An alternative interpretation of innovation is a chain model in which different areas based on information and knowledge successfully link the three main areas in the process of technological innovation (research, knowledge and the central chain of technological innovation), which requires interaction between technological capabilities and requirements of the market. Some scholars argue that innovation is driven by industrialization, and is conditioned by the market growth [11]. However, for innovation to have a significant social impact, research efforts must focus on addressing and improving the well-being of the population, a task that should undoubtedly involve both private and public entities [12].

Innovation involves different processes, depending on whether the country is highly developed or developing [13]. Strategies to encourage innovation in high-income countries often include creating the conditions for factor mobility in markets, open trade and investment. However, emerging economies need to focus on knowledge and infrastructure management, being the strategies able to bridge the gap with developed countries [12].

Technology transfer is the movement of knowledge or technology from one organization to another, from universities and research institutions to business, where knowledge can be transformed into innovation — new products and services that will benefit society, new forms of work and communication and people's lives on the whole [14; 15].

**The purpose of the article** is to determine the place of Ukraine in the global innovation space and to evaluate the indicators of innovation activity, based on the outcomes of the research in the global indices of innovative development and competitiveness.

**Research results.** The digital transformation of Ukraine is a huge investment resource, as it allows freeing up the millions of hours that people spend in queues, paperwork, reconciling registers or certificates, and directing them to economic development. According to experts, the use of digital technologies in business accelerates its development by 2—3 times [15]. The use of digital technologies has a number of advantages. Digitalization is the creation of high added value for the state, increasing the efficiency of the economy and business. All these measures will become a geopolitical advantage of Ukraine [16; 17].

The Concept of Development of the Digital Economy and Society for 2018—2020 was adopted by the Order of the Cabinet of Ministers of Ukraine dated January 17, 18 № 67-p [18]. This document provided for the implementation of measures «to introduce appropriate incentives for the digitization of the economy, public and social spheres, awareness of the existing challenges and tools for the development of digital infrastructures, the acquisition of digital competencies by citizens». The results of the study in *Fig. 1* make it possible to assess the degree of achievement of the relevant indicators.

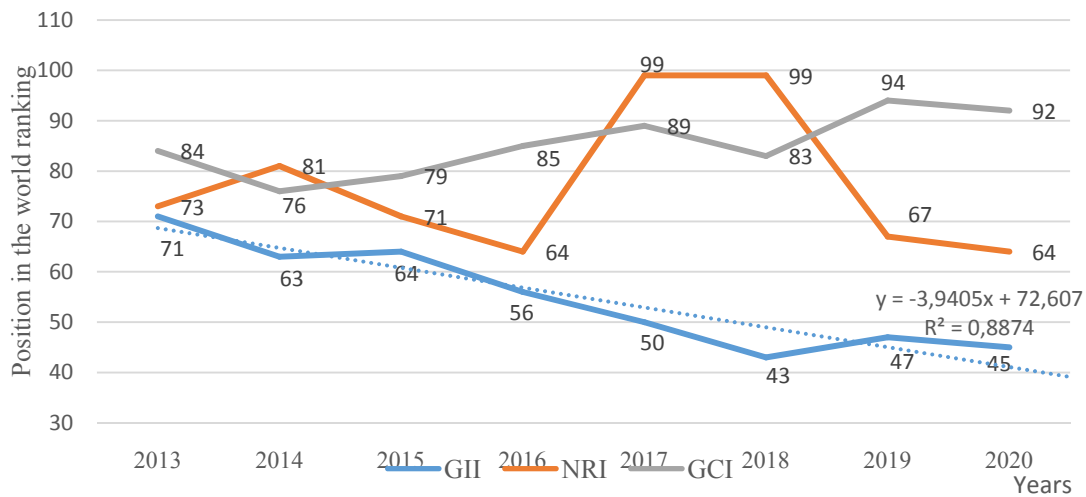


Fig. 1. Dynamics of the main indicators of digitalization of Ukraine's economy

Judging by the dynamics shown, it can be seen that no level of global indices has been achieved, but the Global Innovation Index (GII) is close to the expected level and if the upward trend of our place in the world ranking continues, Ukraine's position will be strengthened over a short period of time. It is therefore worth analyzing this index in more detail.

For positioning in the global space, we compare 10 countries, according to their place in the world by the Global Innovation Index, which approximates the Ukrainian one in 2013 and 2020 (Fig. 2).

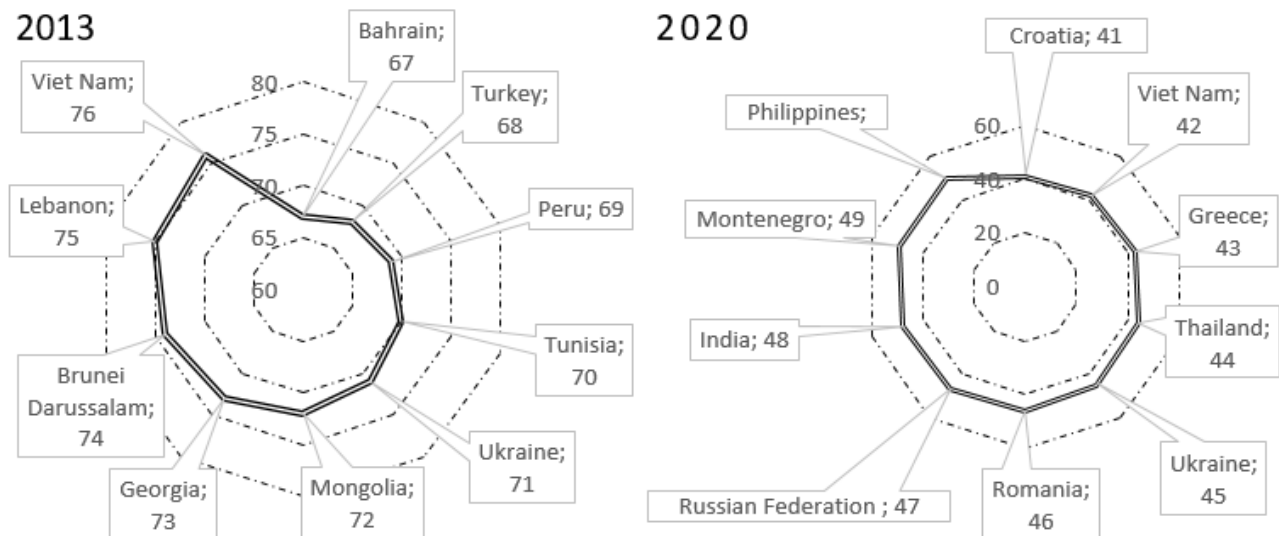


Fig. 2. Ukraine's position in the vicinity of countries with approximate GII

The transformations are significant: in 2013 Ukraine was ranked 71th, while in 2020 it is ranked 45th with Romania, Thailand and Greece, next in rank.

It is determined that an important condition for sustainable economic development of the country and increasing competitiveness is the effective implementation of innovations. Innovation is recognized as a central driver of economic growth and development [19]. The purpose of the Global Innovation Index is to provide in-depth data on innovation and, in turn, to assist economies in assessing their innovation performance and informed thinking on innovation policy.

Innovation Input Sub-Index consists of five main areas, covering components of the national economy that promote innovation: Institutions, Human Capital and Research, Infrastructure, Market sophistication and Business sophistication.

Fig. 3 analyzes the dynamics during 2013—2020 of these components for Ukraine in terms of importance and rank on the global scale.

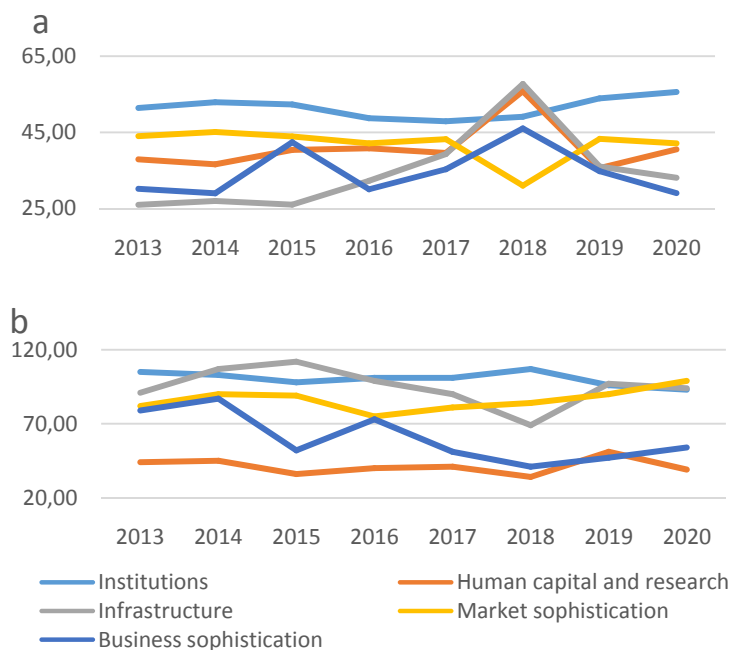


Fig. 3. Dynamics of the components of Innovation Input Sub-Index (where *a* — the value of the indicator, *b* — position in the world ranking)

Innovation Output Sub-Index provides information on the outcomes, which are the results of innovation in the economy. There are two directions of initial data: Knowledge and technology results and Creativity results. Fig. 4 analyzes the dynamics of the components of this sub-index for Ukraine by value and the world ranking.

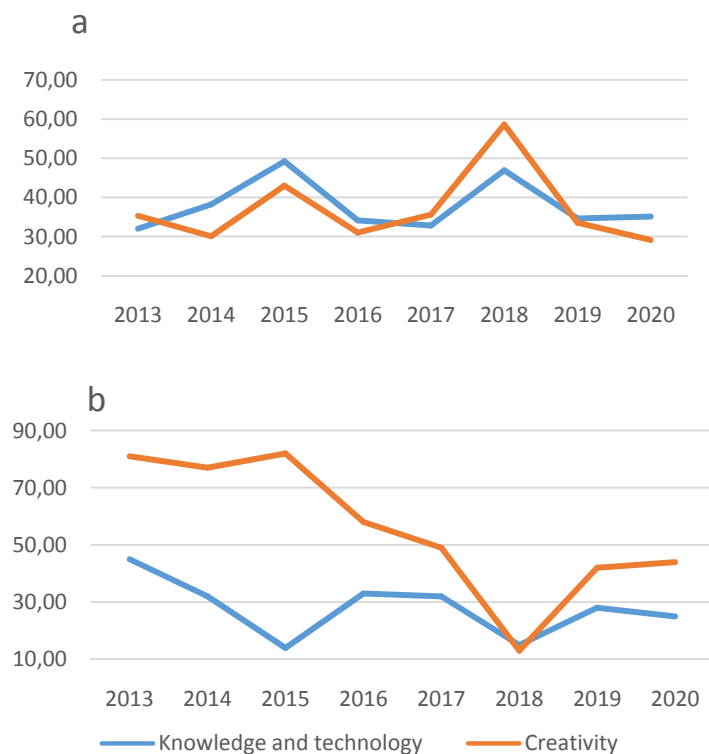


Fig. 4. Dynamics of the components of Innovation Output Sub-Index (where *a* — the value of the indicator, *b* — position in the world ranking)

Research shows a close direct relationship between the Global Innovation Index and the Infrastructure Input Sub-Index (0.87) and the Creativity Output Sub-Index (0.71). The constructed regression model (Table 1) will allow predicting the increase of these sub-indices to increase the overall index (GII).

Table 1

**Statistical model for estimating the impact of GII sub-indices**

Model	R Square	Significance F	P-value of the coefficients
$Y_{GII} = 33.76 + 0.07_{Infrastructure} + 0.02_{Creativity}$	0.86	0,0276	$a_0 = 1,88E - 07$ $a_{Infrastructure} = 0,018057$ $a_{Creativity} = 0,049116$

We will analyze which of the components of the Infrastructure sub-index determines its result in the first place. Studies show a close direct relationship only between the Innovation Input Sub-index and the Infrastructure sub-index (0.68). In contrast to the Innovation Output Sub-index, the Human capital and research components (0.67), Infrastructure (0.71), Market sophistication (0.69), and Creativity (0.83) are closely related.

Evaluating the effectiveness of innovation policy means evaluating the effectiveness of many indicators for the organization of the search for the optimum [20]. Data Envelopment Analysis (DEA) is a mathematical programming approach for assessing the relative effectiveness of decision makers (DMU).

In the traditional context of performance evaluation, data analysis shows that, there is  $p$  of input data ( $x_1, x_2, \dots, x_p$ ), which are used to obtain  $q$  outputs ( $y_1, y_2, \dots, y_q$ ) in which  $n$  subjects are involved, and technical efficiency can be assessed using the following model (1):

$$\max_{u_r, v_i} \frac{A_{r=1}^q u_r y_{r0}}{A_{i=1}^p v_i x_{i0}}$$

$$\frac{\sum_{r=1}^q u_r y_{rj}}{\sum_{i=1}^p v_i x_{ij}} \leq 1,$$

where  $j = 1, \dots, n, r = 1, \dots, q$  and  $i = 1, \dots, p$ . Further,  $u_i, v_i \geq e$ , where  $e$  is a value that is infinitesimally small but greater than zero.

The DEA was used to measure and compare performance in sectors, which are considered critical to the national development. However, the method also contains limitations and risks. One of the main disadvantages of the DEA method is the problem of adequate definition of input and output data (in this paper, this definition is based on the external classification of GII). For this analysis, the indicators of 7 inputs of the input and output sub-indices were used as input, and the indicators of GII, the country’s rank in the world ranking and the indicator of innovation efficiency — as output. Regarding the countries that were involved in this model, Ukraine was evaluated on a set of 19 economies, which among European countries are close to the value of GII. The results of the model are shown in Table 2.

Table 2

**Analysis of technical efficiency of innovation**

DMU №	DMU Name	Input-Oriented CRS model Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks
1	Belgium	1.00000	1.000	Constant	1.000
2	Bulgaria	0.94967	1.173	Decreasing	0.044
3	Croatia	0.90592	1.060	Decreasing	0.428
4	Czech Republic	1.00000	1.000	Constant	1.000
5	Estonia	1.00000	1.000	Constant	1.000
6	Greece	1.00000	1.000	Constant	1.000
7	Hungary	0.98138	0.980	Increasing	0.415
8	Iceland	1.00000	1.000	Constant	1.000
9	Italy	1.00000	1.000	Constant	1.000

Table 2 (continued)

DMU №	DMU Name	Input-Oriented CRS model Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks
10	Latvia	0.93763	0.991	Increasing	0.192
11	Lithuania	0.92186	0.994	Increasing	0.157
12	Montenegro	0.94037	0.991	Increasing	0.147
13	Poland	1.00000	1.000	Constant	1.000
14	Romania	0.82112	0.993	Increasing	0.378
15	Russian Federation	0.82946	0.983	Increasing	0.403
16	Slovakia	0.84730	1.047	Decreasing	0.242
17	Slovenia	0.95298	0.990	Increasing	0.006
18	Spain	1.00000	1.000	Constant	1.000
19	Ukraine	0.87606	0.979	Increasing	0.249

The purpose of this study is to assess the effectiveness of creating innovative environments for Ukraine in comparison with European countries. The difference between the maximum possible efficiency value (1) and the observed value reflects the degree of inefficiency. The closer the value is to its maximum, the closer the relevant economy is to the efficiency limit.

**Conclusion.** Thus, based on the study, we can conclude that Ukraine is now demonstrating the growing dynamics of innovation. In particular, the paper offers the analysis of the country's positioning on the Global Innovation Index. The authors proved, that the problems of innovative development of Ukraine include: insufficient development of innovation infrastructure: clusters, technology parks, industrial zones; low level of attracting foreign direct investment and technology transfer; insufficient level of funding for applied research and their weak connection with industry, etc.

Ukraine, along with most European countries, is trying to adapt to the constant changes required by the world economy in search of development, thus, innovation has become a key element in this. Using data from the Global Innovation Index 2020 and applying the methodology of analyzing the Vol. of DEA data, this paper evaluates the effectiveness of 19 economies that are geographically part of Europe to create an environment conducive to innovation. The study identified key challenges for these countries in managing and using key inputs, regardless of the income levels of these economies. In fact, countries with the highest incomes and the highest GII are not always at the forefront of performance management, confirming that there is only a moderate relationship between these variables.

Although most of the policies and actions undertaken by the countries in the region to promote an innovation environment are consistent with their capabilities and relative advantages in a heterogeneous context, some challenges remain. One them is to strengthen resources that have traditionally performed poorly and, above all, to strategically use the Input / Output ratios that have the most reliable results so as to maximize their impact first on productivity and then on development.

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