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FUNCTIONING OF THE INNOVATION INFRASTRUCTURE OF UKRAINE IN THE CONTEXT OF PERMANENT CRISIS PHENOMENA

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Abstract. The issue of the functioning of Ukraine's innovative infrastructure is of particular importance. The purpose of the article is to study modern aspects of the functioning of innovative infrastructure of Ukraine in crisis conditions. Increasing the efficiency of innovative infrastructure in conditions of permanent crisis phenomena requires a comprehensive approach, which includes support for scientific research, development of innovation clusters, use of digital technologies, flexible regulation, internationalization of activities, support for startups and adaptation to crisis conditions. Only comprehensive and coordinated actions at the state and business levels can ensure sustainable development of the national economy and its innovative potential. Theoretical aspects of innovative infrastructure research are justified. It has been established that innovation infrastructure is a multifaceted concept that encompasses a wide range of resources and institutions that support innovation activity. In the European literature, this concept is revealed in detail through various aspects, including technical, financial and organizational components. An important characteristic of innovative infrastructure is its ability to adapt and develop in conditions of constant changes and crises. Innovation infrastructure is a multifaceted concept that encompasses a wide range of resources and institutions that support innovation activity. In the European literature, this concept is revealed in detail through various aspects, including technical, financial and organizational components. An important characteristic of innovative infrastructure is its ability to adapt and develop in conditions of constant changes and crises. In general, the war significantly increased the processes of degradation of innovative ecosystems in Ukraine, and primarily among industrial small and medium-sized businesses. Many innovative enterprises of small and medium-sized businesses worked on export markets before the war – today they are also lost or frozen. Dozens of participants in the innovation ecosystem – universities, research institutes, incubators – accelerators, business associations, development agencies, etc. – also went into survival mode. At the same time, the war gave Ukraine enormous attention and support from the EU and the international community. Therefore, the country has new opportunities in the future, the only question is whether it will be able to implement them effectively.

Keywords: innovation, innovation infrastructure, innovation ecosystem, innovation processes, crisis phenomena.

JEL Classification: J21, J23, M12

1. Introduction

Innovative economy appeared as early as the 50s and 60s of the last century, that is, during the heyday of industrial society. The famous American futurologist E. Toffler (Toffler, 1971) dates the emergence of the innovative economy in the USA as early as 1956. The formation and development of a new type of economy is impossible without appropriate infrastructural support, therefore, simultaneously with the development of an innovative economy, an innovative infrastructure is formed. In 1987, K. Freeman (Freeman, 1987) introduced the concept of a national innovation system, which is defined as a network of institutions of the public and private sectors, the interaction of which allows to initiate, adapt, change and transfer new technologies.

An important event for the Ukrainian economy was the emergence of the term "national innovation system", which took place in 2007 (Decision of the Verkhovna Rada, 2007) in accordance with the

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Concept of the Development of the National Innovation System (Decree of the CMU, 2009).

Today, issues of the functioning of the innovative infrastructure of Ukraine are gaining special importance. Increasing the efficiency of innovative infrastructure in conditions of permanent crisis phenomena requires a comprehensive approach, which includes support for scientific research, development of innovation clusters, use of digital technologies, flexible regulation, internationalization of activities, support for startups and adaptation to crisis conditions. Only comprehensive and coordinated actions at the state and business levels can ensure sustainable development of the national economy and its innovative potential.

2. Theoretical and Methodological Aspects of the Formation of Modern Innovative Infrastructure

Innovation infrastructure is an important component of the national economic system and as a subsystem of the innovation system has a functional purpose, which is manifested in the provision of services for the maintenance of the innovation process, ensuring the smooth implementation of its stages. The essence of the economic category "innovative infrastructure" is found in the optimal combination of subjects and objects acting in accordance with the set innovative goals and tasks. Innovative infrastructure is an important component of the national economy, especially in conditions of rapid changes and permanent crisis phenomena.

In European scientific literature, this concept is considered as a set of institutions, resources and services that provide support for innovative activity at various stages of its development. According to the definition of the European Commission, "innovation infrastructure is a set of organizational, technical, financial and informational resources that ensure the creation, development and dissemination of innovations" (European Commission, 2010). According to Cooke (Cooke, 2002), innovation infrastructure can be interpreted as "a system of institutions and networks that provide conditions for the development, financing, implementation and commercialization of new technologies and products."

Radosevic S. (1999) noted that the innovation infrastructure includes universities, research institutes, business incubators, technology parks, venture funds and other institutions that contribute to innovation development. Etzkowitz H., Leydesdorff L. (2000) note that innovation infrastructure includes physical (technology parks, innovation centres), financial (venture capital funds) and informational (databases, patent offices) components that support the innovation process. According to Heindl J., innovation infrastructure promotes individual creativity, facilitates collective thinking to produce a constant stream of valuable and radical innovations.

Therefore, innovation infrastructure is a multifaceted concept that encompasses a wide range of resources and institutions that support innovation activity. In the European literature, this concept is revealed in detail through various aspects, including technical, financial and organizational components. An important characteristic of innovative infrastructure is its ability to adapt and develop in conditions of constant changes and crises. Although this can be said about the entire system of Ukrainian innovative enterprises (Stroiko et al., 2024).

The Law of Ukraine approved the definition of innovative infrastructure as a group of organizations, enterprises, associations, both public and private, that provide various types of services for innovative activity (Law of Ukraine "On Innovative Activity", 2002).

Innovative infrastructure is separated into an independent institutional sphere when the activity of providing services and creating general conditions for the innovation process is separated in the system of social division of labour, and this activity goes beyond the intra-organizational form, becoming institutionalized, thereby gaining the right to enter into independent economic relations with the rest of the subjects of the innovative infrastructure.

The element-functional approach claims that the innovative infrastructure consists of independent elements that contribute to its development and perform certain functions, mainly providing certain types of resources or services. As for the purpose of innovative infrastructure, opinions are unanimous – it accelerates the implementation of innovations, ideas, and developments; creates appropriate working conditions for innovators, provides them with access to the necessary resources, simplifies the commercialization of innovations; creates new jobs; establishes more efficient production processes.

Innovative infrastructure accelerates the implementation of innovations, ideas, developments; creates appropriate working conditions for innovators, provides them with access to the necessary resources, simplifies the commercialization of innovations; creates new jobs; establishes more efficient production processes. Thus, the innovation infrastructure covers activities within the innovation process (research – mechanics – production – consumption) and should have the following properties:

– Prevalence in all regions, which will make it possible to solve the tasks of a functionally complete innovation cycle on the spot: from marketing and technical and economic substantiation to the introduction of innovations into production with personnel support and service;

– versatility, which will ensure the implementation of any turnkey project in any sector of the economy or production;
– professionalism, which is based on conscientious and high-quality customer service, an objective and interested attitude to "other people's" knowledge, scientific technologies, equipment and systems;
– constructiveness, which will ensure orientation towards the final result;
– financial and information security;
– flexibility, which will ensure adaptability of innovative infrastructure to changes in market requirements.

3. Innovative Infrastructure on a Global Scale

Investments in infrastructure have always been a key component of the country's development. Investments in infrastructure bring important benefits by increasing the potential output and productivity of all inputs. For example, bigger and better public transport networks reduce transport costs, improve the quality of life for people and the business environment for businesses.

Investments in telecommunications infrastructure can improve access to information and technology, for example by expanding markets, promoting competition and promoting technological innovation.

However, infrastructure investment also plays an important role in the short term as it has a direct impact on gross domestic product (GDP) growth both directly and indirectly – directly because infrastructure investment is an integral part of aggregate demand, and indirectly, because depending on the state of the economy at the time of investment, they can have an increased impact on both GDP and employment through the so-called economic multiplier effect (Secchi and Belladonna, 2020).

The experience of foreign countries shows that the share of high-tech products supplied to world markets is directly dependent on the level of development of the national innovation infrastructure (Rekhteta, 2016).

The state of innovation infrastructure in the world varies significantly depending on the country, availability of resources, government policy, culture of innovation and other factors. The United States of America is known for its strong innovation infrastructure, particularly in Silicon Valley. It is home to many leading technology companies such as Apple, Google and Facebook, as well as numerous startups. Innovation support includes access to venture capital, highly qualified personnel, and a developed scientific research base (Mazzucato, 2021; Atkinson & Ezell, 2020).

China is actively developing its innovation infrastructure through significant government investment in science and technology. In recent years, the country has made significant progress in the development of artificial intelligence, 5G technologies and other advanced areas (De Cremer & Tao, 2020; Wübbeke at al., 2016). According to the Global Innovation Index Database, the United States and China lead their groups in terms of the Global Innovation Index 2022 (Table 1).

In general, according to the rating, Ukraine ranks 4th among 36 countries with a lower-middle-income group economies below the average (Table 1). But among European countries, it ranks 34th among 39 European economies. Despite the very low positions in the rating of The Global Innovation Index among European countries, Ukraine has reasonable prerequisites for further innovative development.

4. Innovative Infrastructure of Ukraine During the War

Ukraine needs to find its place in the global economy, using for this the strengths of its economic, industrial, scientific and technical and intellectual capital. Much effort is needed to ensure the transition in the international division of labour from raw material to scientific and technical specialization. Increasing the competitiveness of products on the domestic and foreign markets is an indispensable condition for strengthening Ukraine's economic position in the world.

We are investigating the field for the development of innovative entrepreneurship in Ukraine, therefore the most important is the country's assessment according to The Global Innovation Index rating and the assessment of Ukraine in the European space according to the European Innovation Scoreboard.

The Global Innovation Index (GII) ranks world economies according to their innovation capabilities. Consisting of roughly 80 indicators, grouped into innovation inputs and outputs, the GII aims to capture the multi-dimensional facets of innovation.

The Table 2 shows the rankings of Ukraine over the past three years, noting that data availability and changes to the GII model framework influence year-on-year comparisons of the GII rankings.

In 2022, Ukraine has better indicators of innovative products than innovative resources, ranks 75th in terms of innovative resources, which is higher than last year (+1), but lower than in 2020 (-4). Regarding innovative products, Ukraine ranks 48th. Having lost 11 positions compared to 2021 and 2020.

As of the end of 2023, Ukraine had two current strategies that determine the development of innovative activities. In particular, we are talking about the Strategy for the Development of the Sphere of Innovative Activities for the Period Until

Table 1
10 best-ranked economies by income group (rank) Global Innovation Index 2022

High-income economies (48 in total)	**Upper middle-income economies (36 in total)**
1 Switzerland (1)	1 China (11)
2 United States (2)	2 Bulgaria (35)
3 Sweden (3)	3 Malaysia (36)
4 United Kingdom (4)	4 Türkiye (37)
5 Netherlands (5)	5 Thailand (43)
6 Republic of Korea (6)	6 Mauritius (45)
7 Singapore (7)	7 Russian Federation (47)
8 Germany (8)	8 Romania (49)
9 Finland (9)	9 Brazil (54)
10 Denmark (10)	10 Serbia (55)
Lower middle-income economies (36 in total)	**Low-income economies (12 in total)**
1 India (40)	1 Rwanda (105)
2 Viet Nam (48)	2 Madagascar (106)
3 Iran (Islamic Republic of) (53)	3 Ethiopia (117)
4 Ukraine (57)	4 Uganda (119)
5 Philippines (59)	5 Burkina Faso (120)
6 Morocco (67)	6 Togo (122)
7 Mongolia (71)	7 Mozambique (123)
8 Tunisia (73)	8 Niger (125)
9 Indonesia (75)	9 Mali (126)
10 Uzbekistan (82)	10 Yemen (128)

Source: Global Innovation Index Database, WIPO, 2022

Table 2
Rankings for Ukraine (2020–2022) in The Global Innovation Index

Year	GII	Innovation inputs	Innovation outputs
2020	45	71	37
2021	49	76	37
2022	57	75	48

2030 (Ministry of Economy) dated July 10, 2019 No. 526-r (current strategy) and the National Economic Strategy 2030 (Ministry of Economy) dated March 3, 2021 No. 179 (current strategy).

Innovations, on the one hand, are critically important for the reconstruction and support of Ukraine's transformation process. The main directions are defined as follows:

– Defense-tech for the protection of Ukrainians and the sovereignty of our state;
– modern, fast, climate-friendly reconstruction of infrastructure and housing, taking into account both "green" trends and smart city and urbanization processes;
– returning the quality of life to Ukrainians through modern medtech and biotech solutions that will help to overcome injuries during the war, to be more sustainable, as well as to build a new approach to increasing the duration and quality of life of Ukrainians in general, taking into account demographic trends;
– development of human capital through the development of edtech, digital literacy and STEM education, lifelong learning opportunities and in the context of personalized educational trajectories closely related to further employment or entrepreneurship development (as well as the use of AI in education);
– economic capacity, or an economy without borders through the development of innovative production, using Ukrainian capabilities.

The largest financial donor for the domestic economy today is the EU. Since the beginning of the war, the amount of support from European partners has reached 23.7 billion euros. At the end of 2023, the European Investment Bank allocated 20 million euros, which became the last tranche of the credit line of Ukreximbank in the amount of 300 million euros, which is aimed at financing Ukrainian small and medium-sized enterprises. The World Bank, on the basis of its MIGA division, started the formation of an investment insurance pool in Ukraine with the first contract for 40 million dollars. The export credit agencies of Germany and Italy are also gradually resuming cooperation in this direction

(Supporting investments in the industry of Ukraine in the conditions of war and post-war recovery).

In March 2023, the Innovation Development Fund (USF) in partnership with the Ministry of Education and Culture and the Ministry of Digital Transformation held a competition for innovative projects of scientists and entrepreneurs (Science&Business – GIST Pitch Days), as a result of which 25 Ukrainian startups received grants in the amount of $125,000 (25 Ukrainian science-intensive startups received $125,000 in support).

The government continues work on the Strategy of Innovative Development of Ukraine until 2030, which is based on new approaches, outlining key directions and working on projects of normative documents on stimulating developers, developing innovative activities of enterprises, removing bureaucratic obstacles when opening a business and investing in innovative developments, creating a competitive market for the implementation of own business projects, improvement of the ecosystem of innovations, development of priority industries. All these actions are supported by international partners, as they are aimed at the reconstruction and transformation of the state, which outlines the European vector of the development of the innovative economy in the country (Perminova et al, 2024).

In recent years, in the field of innovative development, in particular, the development of startups has received a lot of attention, including from state structures. The emergence and active activity of the Ukrainian Startup Fund, which immediately became noticeable, was initiated by the state. To one degree or another, the state supported the launch of individual incubators and accelerators (more than 10 of them in total), the Lviv School of Startups, promoted PR and the promotion of many other initiatives aimed at promoting the startup ecosystem. If you add to these private investments such as Unit.city, as well as a number of large holdings, a large number and activity of intermediaries – actors of innovative ecosystems and business – associations with their initiatives, etc. – all together, this created a fairly large promotion of startup activities.

5. Conclusion

In general, the war significantly increased the processes of degradation of innovative ecosystems in Ukraine, and primarily among industrial small and medium-sized businesses. Many innovative enterprises of small and medium-sized businesses worked on export markets before the war – today they are also lost or frozen. Dozens of participants in the innovation ecosystem – universities, research institutes, in cubators – acelerators, business associations, development agencies, etc. – also went into survival mode. At the same time, the war gave Ukraine enormous attention and support from the EU and the international community. Therefore, the country has new opportunities in the future, the only question is whether it will be able to implement them effectively.

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