THE ROLE OF INNOVATION CLUSTERS FOR THE SUSTAINABLE DEVELOPMENT OF THE REGION

Olga Kudrina[1], Yuliia Klius[2], Yevhen Ivchenko[3]

Abstract. The article considers the directions of intensification of the processes of clustering in the regions of Ukraine. Based on the analysis of the experience of clustering is proposed zoning, taking into account the collisions of national business and industry, as well as regulatory policy. The *subject* of the study is innovative clusters and their role in the sustainable development of regions. The *purpose* of the study: to develop practical recommendations to ensure and stimulate the processes of clustering in the context of InDev regions of Ukraine. *Methodology.* For this purpose the following tasks were solved step by step: the peculiarities of InDev region in the economic and social progress of territories in the context of clustering processes were determined; the strategic prospects for the formation of InDev system of Ukrainian regions and the directions of intensification of clustering processes were substantiated; the key problems of innovation clusters development in Ukraine were systematized taking into account international experience of their creation; the management basis for the formation of innovation cluster models was developed; normative legal acts for information support and proper organizational and economic support of the process of innovation clusters formation were elaborated; methodological support for the processes of diagnostics of innovation clustering in the InDev system of the region was improved. Theoretical (analysis, systematization and generalization of scientific results; process modeling) and statistical (express-analysis) methods were used. *Conclusions.* Recommendations on the diagnosis of processes of innovation development of regions and processes of innovation clustering on the basis of express-diagnostics procedure, which is based on the assessment of parameters of innovation clustering. According to the results of innovation clustering regions of Ukraine for the first cluster recommended principles of management support processes clustering: the development and implementation of a policy of active integration with Europe, a free economic zone with the EU and other countries of the world; investments in innovation infrastructure; stimulation of venture financing; creation of business gas pedals and platforms of innovative design; organization of technoparks, involving foreign investments, grant projects, budget financing. The second cluster is recommended: involvement of scientific institutions in the processes of active learning business incubators and business gas pedals, adaptation and dissemination of benchmarking technology for innovation clustering. The third cluster is recommended: implementation of industry-specific target projects by InDev, creation of innovation infrastructure facilities based on clustering processes, implementation of regional programs to support business and individual industries, formation of new industry projects to develop production (new production facilities, logistics centers, etc.).

Key words: cluster formation, innovation development, clustering processes, information activities, economy.

JEL Classification: O31, C38, D83

1. Introduction

Under decentralized economic development, the scale and direction of changes in regional economic complexes are determined by the priorities and strategic vectors of innovative development (InDev) of Ukrainian regions. The dynamics of such changes in the modern world community is provided by innovation clusters. Clustering processes in InDev

[1] Sumy State Pedagogical University named after A.S. Makarenko, Ukraine *(corresponding author)*
E-mail: science@sspu.edu.ua
ORCID: https://orcid.org/0000-0002-7364-1998
[2] Volodymyr Dahl East Ukrainian National University, Ukraine
E-mail: docentklus@gmail.com
ORCID: https://orcid.org/0000-0002-1841-2578
[3] Volodymyr Dahl East Ukrainian National University, Ukraine
E-mail: ivchenkoevg85@gmail.com
ORCID: https://orcid.org/0000-0002-6665-2461

regions allow to create conditions for the generation of innovations, stimulate the production of innovative products and increase the competitiveness of individual structures. Formation of InDev regions system on the basis of clustering processes creates the basis of consolidated economic space of the state, in the formation of which the leading role is played by innovation clusters as the basis of InDev regions.

Assessing the state of InDev regions of Ukraine, it should be noted that InDev regions are mainly carried out using outdated models and mechanisms, which determines its low efficiency. The key reason for this is the lack of a clear understanding of the diversity of innovation environment of the regions, the fundamental heterogeneity of processes taking place in innovation activity, the lack of effective tools and technologies for active clustering of the regional economy, taking into account the best European practices.

The study of modern trends and leading models of InDev regions proves the complexity and ambiguity of these processes. Innovative progress in the modern understanding of scientists gets its realization only in certain conditions of active, multilevel, scientifically grounded support, corresponding to the needs of economic interests of regions and the country as a whole.

Multifaceted areas of research, the search for approaches to activate InDev regions, received their coverage in the scientific works of foreign and domestic scientists: S. Breschi, F. Malerba (2001), E. Jerome S. (2015), S. Engel, I. del-Palacio (2009), M. Muro, B. Katz (2010), O. Kudrina (2019; 2020; 2021), S. Markovsk, N. Mikula (Markovsky, 2011), M. Porter (Porter, 1998), A. Tkachuk, V. Tolkovanov, S. Tallman, M. Jenkins, N. Henry, S. Pinch (2004) etc., where the problems of regional innovation, development of innovation clusters, etc. are analyzed. The study of theoretical and practical developments of these authors allows us to assert that they proposed a practical tool for InDev region, in particular, on the basis of the creation of innovation clusters, but the diagnosis of the processes of clustering in InDev region and the formation of organizational, economic and information support of innovation clusters require solutions.

The aim of the study is to develop practical recommendations to ensure and stimulate the formation of clusters in the context of InDev regions of Ukraine.

To achieve this goal the following tasks were solved: the peculiarities of InDev region in the economic and social progress of the territories in the context of clustering processes were determined; the strategic prospects for the formation of InDev system of the regions of Ukraine and the directions of intensification of clustering processes were substantiated; the key problems of innovation clusters development in Ukraine were systematized taking into account the world experience of their creation; the managerial bases of innovation cluster model formation were developed; the provisions concerning the information support and corresponding organizational-economic maintenance of the process of innovation clusters formation were elaborated; the methodological support of innovations clustering processes diagnostics in the InDev region system was improved.

2. Theoretical foundations of clustering processes in the system of innovation development of the region

Gradual transition to a post-industrial society involves the formation of an innovative model of economic development, providing the most efficient use of all types of resources, including information, and qualitative improvement of all factors of production based on the latest achievements of the innovation economy. (Porter, 1998) Innovative development is an indispensable condition of socio-economic progress of territories, which is reflected in the paradigm of relations: "Knowledge" – "Scientific and technological progress" – "Innovation" – "Innovative processes and technologies" – "Innovative industries and industries" – "Innovative economy" – "Innovative social progress" – "Socio-economic progress of territories". (Markovsky, Mikula, Tkachuk & Tolkovanov, 2011)

The study of the essence of the key conceptual characteristics of InDev enterprise ("innovation", "innovation process", "innovative development", "innovation economy", "innovation clusters", "cluster development potential", etc.) allowed to define innovation as newly formed or improved competitive technologies, products or services, as well as organizational and technical solutions of a production, administrative, commercial or other nature that significantly improve the structure and quality of production and (or) the social sphere. (Breschi, Malerba, 2001) It is established that there is no unified approach to the definition of the categories of InDev region, and their systemic vision is determined in accordance with the provisions of modern economic theory and management (Figure 1).

Within the framework of national economies and their unique diversity, InDev systems of states and territories are formed, focused on the realization of the potential of territories using the unique combination of resources available to the territory – labor, capital, intelligence. (Engel, Jerome, 2015) Internal and external characteristics of innovation systems of the region, their connections, infrastructure support, institutional reflection of inno-
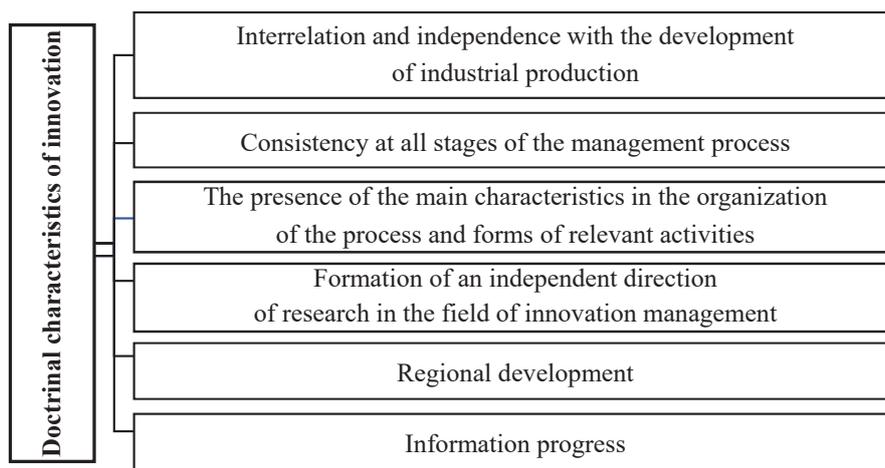
Figure 1. Provisions of modern economic theory and management

vation activity, state and regional innovation policy, activity and relevant policy of corporations form a specific national innovation model. The formation of InDev systems in the region within the national innovation model should be carried out in the most effective way on the basis of clustering processes. (Engel & del-Palacio, 2009) The author's vision of the innovation cluster as a target association of enterprises, organizations, highly qualified specialists for the development, implementation and realization of initiatives of the innovation cluster is presented. Participants of the innovation cluster are stakeholders in the InDev system of the region. (Kudrina, 2019)

3. Study of problems and experiences in the formation of clusters in the InDev system of the region

The authors have systematized features of global and domestic experience of clustering processes in the InDev system of the region. This allowed to establish that the provision of InDev territories in the world is
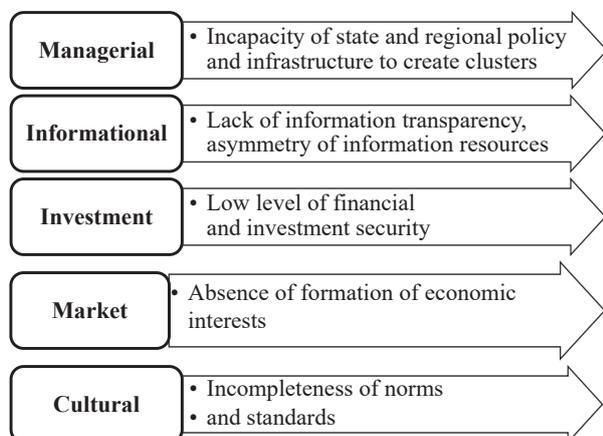

Figure 2. Problems hindering the formation of the cluster

mainly due to the formation of innovative clusters. According to experts' estimates, clustering currently covers about 50% of the world's leading economies. (Muro & Katz, 2010)

The characteristic features of the process of formation of clusters were defined:
– dynamics of the process of clustering and active growth in the number of clusters;
– increase in the share of clusters with state participation; activity of diversification processes in the positioned clusters and cluster initiatives;
– significant diversity of cluster models, cluster forms of relations, goals of cluster initiatives, as well as mechanisms and technologies of interaction within innovative clusters.

Provision of InDev regions based on the stimulation of clustering processes should be carried out using modern methods of managerial influence on the processes of clustering. (Tallman, Jenkins, Henry & Pinch, 2004)

The vectors of such impact include:
– development and implementation of the targeted innovation policy of the regions, creation of the institutional foundations of InDev territories, taking into account the objectives of regional development programs;
– development and implementation of the regional policy of clustering and formation of innovation clusters;
– creation of scientific basis for formation of innovative model of economy;
– formation of the institutional structure of the national system of science and education; development of state programs and plans for financing InDev region with its priority areas;
– harmonization of the region's InDev conditions with international norms, standards and business principles; integration of the education and

science system into the European intellectual market, etc.

Characteristics of the problems hindering InDev regions and the creation of innovation clusters in Ukraine are shown in Figure 2.

The problems that constrain the processes of clustering in the InDev system of the region reflect the systemic nature of internal conflicts at various levels of regional governance, so the solution of certain problems should occur systematically, at the level of state and regional development programs aimed at the transition to an innovative model of economic development. This model is based on clustering processes in the system of InDev regions as a tool to complete the process of market transformation and transition to the European model of InDev regions. (Omelyanenko, Kudrina, Semenikhina, Zihunov, Danilov, Liskovetska, 2020)

4. Ensuring the formation of clusters in the InDev system of the region

In modern management theory and practice, the cluster approach is the most recognized and effective form of stimulating InDev. It represents a unique way to consolidate science, education, production and the state to create an environment of innovation and implementation of cluster initiatives of different duration. (Omelyanenko, Prokopenko, Kudrina, Petrova, Biloshkurska, Biloshkurskyi & Omelyanenko, 2021) The cluster approach to InDev regions provides a fuller use of the territory's resource potential, unique opportunities to enter new markets, and stimulates the development of small and medium-sized businesses. In addition, this model of management of the InDev region organization helps reduce costs by reducing transactions, share human resources, infrastructure facilities, services and other resources, simplify the information support of the cluster, and finally, obtain synergies for all cluster members.

Thus, the cluster is a unique management structure in which enterprises and commercial organizations can effectively interact with scientific and educational institutions, regional authorities. The analysis made it possible to develop a management structure for the formation of an innovation cluster. They include approaches to the diagnosis of InDev and the processes of creating innovation clusters, organizational and economic support of the processes of creating clusters in the region, including information support of the process of creating an innovation cluster. Proceeding from the urgent tasks of promoting the formation of clusters in the InDev system of the region, the authors improve the management framework for the formation of the model of innovation cluster. It has: description of participants of the process,

levels of their interaction, goal, objectives, principles and approaches to modeling the process of innovation cluster. This helped to form the model of an innovation cluster in the region's InDev system.

Based on the systematization of types of clusters focused on innovation as a key priority of interaction (innovation, innovation and education, innovation and production, industry and investment, innovation and investment, information and innovation, transboundary) it was found that one of the most promising organizational models of innovation cluster is the innovation and education model (innovation and education cluster). Its implementation can attract higher education institutions and other research institutes to the formation of the cluster. This makes it possible to form powerful research and scientific-educational centers for clustering, as well as to attract the potential of scientific institutions to support cluster development through grants for the best research and programs to support innovative projects to the processes of cluster formation.

Based on the definition of models of information support (closed, open, semi-closed and semi-open type with a description of the main characteristics of information activities and communication links), the purpose, objectives and principles of information support of innovation cluster were developed approaches to information support and appropriate organizational support of the formation of an innovation cluster, which allowed to identify key conflicts in the system of information support of innovation cluster, to develop an algorithm of information support for the development of innovation cluster and to form a mechanism of collective (integrated) use of information resources of innovation cluster.

The proposed approach to the diagnosis of InDev processes and the formation of an innovation cluster in the region is based on the calculation of the innovation clustering index of the region. It is an integral indicator that takes into account the assessment of the content of innovation activity, assessment of the innovative resource (the ratio of human resources) and assessment of the innovative potential of the region. This approach made it possible to develop an algorithm for rapid diagnosis of clustering processes in the InDev system of the region. This algorithm is aimed at assessing the parameters of innovation clustering in the region and at grouping regions according to the clustering criterion. It is a regulatory impact on the target groups of regions depending on their InDev and long-term plans of state, regional or sectoral management.

The algorithm for rapid diagnosis of clustering processes in the InDev system of the region provides the following steps:

1. Justification of expediency of express-diagnostics of innovation clustering in a particular region and the choice of parameters for assessing the state of innovation clustering.

2. Determination of indicators for assessing innovation clustering.

3. Formation of the information base required for rapid diagnosis in accordance with the established parameters and indicators.

4. Determination of methods and tools for collecting information: collection of statistical information, the formation of information requests for indicators.

5. Express diagnostics according to the set parameters.

6. Analysis of the information obtained (processing, systematization).

7. Development of recommendations for cluster formation processes in the InDev region.

For the purpose of analysis, forecasting, planning processes of clustering in InDev region, development of practical directions of innovation policy of clustering in the regions of Ukraine, rapid diagnosis of innovation clustering in the regions of Ukraine is proposed to conduct on the basis of indicators of innovation activity in the region.

The index of innovation activity of the region is a relative index that characterizes the innovation activity of the region in terms of human resources (employees involved in innovation and research activities), the results of innovation activity and the available potential in the region.

Determination of indicators of innovation clustering is based on the analysis of data on the state and dynamics of InDev in Ukraine and its regions. It is proposed to calculate the coefficient of availability of human resources, the coefficient of innovation activity and the coefficient of innovation potential of the region as indicators for assessing innovation clustering.

The coefficient of human resources provision is calculated as the ratio of the total population of the region to the sum of employees of scientific organizations and researchers. It reflects the share of the population engaged in innovative activities in the region, which, in fact, is its intellectual potential.

$$Chrp = N / (Ne+Nr)$$

where N – the total number of population of the region, KP – the number of employees of scientific institutions; Nr – the number of researchers.

According to the calculation of the coefficient of human resources provision of the regions of Ukraine, it can be noted that the highest index has Kyiv; this is due to the high number of people who are engaged in scientific activity, namely the number of employees of scientific organizations and the number of researchers. The top three also include Kharkiv and Dnipropetrovsk oblasts.

The coefficient of innovation activity of the region CIAR is calculated as the ratio of the sum of scientific organizations (SSO) and the number of innovation-active enterprises (NIAE) to the sum of the number of enterprises (NE) that introduced innovations, and the number of introduced new technological processes (NIP).

$$CIAR = (SSO + NIAE) / (NE + NIP)$$

This coefficient reflects the degree of innovation-active enterprises, that is, the number of organizations that are engaged in innovation activities, as well as the degree of implementation of innovation products by these organizations. The leaders in this indicator are Kyiv, Odesa and Mykolaiv oblasts, which reflects the trends of growth in the number of innovation-active enterprises in these regions, expansion of ties with scientific institutions, strengthening of integration processes with Europe and other countries.

The coefficient of innovation ability (CIA) is the ratio of the sum of the number of executed scientific and scientific-technical works (NEW) and the number of created advanced technologies (NCT) to the sum of the number of introduced types of innovation products (NITIP) and the number of patents to inventions (NP).

$$CIA = (NEW + NCT) / (NITIP + NP)$$

The value of the coefficient of innovation ability reflects the ability of the region to create and use innovation products that are the result of the activities of scientific organizations in the region.

According to the results of calculation of the coefficient of innovation ability five most innovative regions were identified, in which the value of the indicator is in the range of 14.44-10.07. Among these regions are: Kyiv, Odesa, Luhansk and Chernivtsi oblasts. The only exception is Kirovohrad oblast, where, according to calculations, the coefficient of innovation capability reached 29.76. This is due to a large number of scientific and scientific-technical works performed in the region during the reporting period. According to the results of the analysis of calculation of the index of innovation clustering of regions of Ukraine the ranking of regions of Ukraine with the grouping of regions by the level of innovation activity of regions of Ukraine was carried out. At the same time, three zones of regions were identified according to their level of innovation activity in the interval framework of the development of innovation activity in the region from 32.26 to 2.02:

1. Zone of high innovation cluster formation (value from 1 to 10.00 and higher) – regions that are actively engaged in innovation activities,

HIGH	AVERAGE	LOW
• 1. Kirovohrad Oblast, 32,26 • 2. Kyiv (city), 16,62 • 3. Odesa Oblast, 15,38 • 4. Luhansk Oblast, 14,65 • 5. Rivne Oblast, 13,83 • 6. Chernivtsi Oblast, 12,33 • 7. Lviv Oblast, 10,60	• 8. Donetsk Oblast, 9,11 • 9. Poltava Oblast, 8,69 • 10. Volyn Oblast, 8,28 • 11. Khmelnytskyi Oblast, 7,86 • 12. Dnipropetrovsk Oblast, 7,74 • 13. Zhytomyr Oblast, 6,98 • 14. Vinnytsia Oblast, 5,88 • 15. Sumy Oblast, 5,83 • 16. Cherkasy Oblast, 5,55 • 17. Ivano-Frankivsk Oblast, 5,50 • 18. Ternopil Oblast, 5,43 • 19. Zakarpattia, 5,27 • 20. Kyiv Oblast, 5,05	• 21. Kharkiv Oblast, 4,42 • 22. Chernihiv Oblast, 4.24 • 23. Kherson Oblast, 3,29 • 24. Mykolaiv Oblast, 3,22 • 25. Zaporizhzhia Oblast, 2,02

Figure 3. The grouping of regions of Ukraine by the level of their innovation clustering

introduce innovations and have a high potential for InDev.

2. Zone of average innovation cluster formation (value from 10.00 to 5.00) – innovation activity in the regions of this group is developed, but does not take a leading place among the branches of the region, performing a service or complementary role in certain industries. The regions that have indicators within these limits are located in the middle zone of the innovation cluster.

3. Zone of low innovation cluster formation (value from 5.00 to 1.00) – regions where InDev is not a priority area of development, is at an initial or low level and requires the development of programs to create favorable conditions for InDev in the region, as well as appropriate investments.

The grouping of regions of Ukraine by the level of their innovation clustering is shown in Figure 3.

5. Conclusions

According to the results of innovative clustering of Ukrainian regions, the first cluster includes: Kyiv, Kirovohrad, Odesa, Luhansk, Rivne, Chernivtsi, Lviv oblasts. The principles of management support of cluster formation processes were recommended for them:
– development and implementation of a policy of active integration with Europe, a free economic zone with the EU and other countries of the world;
– investment in innovative infrastructure; stimulation of venture capital financing; creation of business gas pedals and platforms for innovative design; organization of technoparks, with foreign investment, grant projects, budget financing.

The second zone includes a cluster formed by regions with an average level of innovation activity: Donetsk, Poltava, Volyn, Khmelnytskyi, Dnipropetrovsk, Zhytomyr, Vinnytsia, Sumy, Cherkasy, Ivano-Frankivsk, Ternopil, Zakarpattia, and Kyiv oblasts (defined as territories with an average level of development and inactive innovation environment). It recommends the basics of management support for these regions: the involvement of scientific institutions in active learning processes of business incubators and business acceleration centers; adaptation and dissemination of benchmarking technology for innovation clustering.

The third zone includes regions with a low level of innovation activity: Kharkiv, Chernihiv, Kherson, Mykolaiv, Zaporizhzhia oblasts. The principles of management support are recommended: implementation of sectoral targeted InDev projects; creation of innovation infrastructure facilities based on clustering processes; implementation of regional programs to support business and individual productions; formation of new sectoral production development projects (new productions, logistics centers, etc.).

The obtained results and the developed recommendations constitute the methodological basis for stimulating clustering processes in the system of InDev regions. Diagnosis of InDev processes of regions and processes of innovation clusters formation using the index of innovation clustering provides measures of regulatory impact on the target group of regions in accordance with their InDev and state, regional or sectoral management plans.

References:

Breschi, S., & Malerba, F. (2001). The Geography of Innovation and Economic Clustering: Some Introductory Notes. *Oxford University Press, Industrial and Corporate Change*, vol. 10, no. 4, pp. 817–833.

Engel, Jerome S. (2015). Global Clusters of Innovation: lessons from Silicon Valley. *California Management Review*, vol. 57, no. 2, pp. 36–65.

Engel, S., & del-Palacio, I. (2009). Global Networks of Clusters of Innovation: Accelerating the Innovation Process. *Business Horizons*, vol. 52/5, pp. 493–503.

Kudrina, O. (2019). Formation and development of innovation clusters as one of the tools of increasing the competitiveness of the region. *Collection of Scientific Papers of DonSUU: "Problems and Prospects of Ensuring Sustainable Socio-Economic Development". Economy series*, XX, vol. 311, pp. 148–158.

Omelyanenko, V., Prokopenko, O., Kudrina, O., Petrova, I., Biloshkurska, N., Biloshkurskyi, M., & Omelyanenko, O. (2021). Digital Component of Innovation Landscapes: Context of Sustainable Development at the Local Level. The 44th International ICT Convention – MIPRO 2021. September 27 – October 1, 2021. Opatija, Croatia, pp. 1519–1523. DOI: https://doi.org/10.23919/MIPRO52101.2021.9597058

Omelyanenko, V., Kudrina, O., Semenikhina, O., Zihunov, V., Danilov, O., & Liskovetska, T. (2020). Conceptual aspects of modern innovation policy. *European Journal of Sustainable Development*, vol. 9 (2), issue 2. DOI: https://doi.org/10.14207/ejsd.2020.v9n2p238

Markovsky, S., Mikula, N., Tkachuk, A., & Tolkovanov, V. (2011). Competitiveness of territories. Kyiv: Legal Status ICC.

Muro, M., & Katz, B. (2010). The New cluster moment: how regional innovation clusters can foster the next economy. Metropolitan Policy Program at Brookings, pp. 1–59.

Porter, M. (1998). Clusters and the New Economics of Competition. Harvard Business Review.

Tallman, S., Jenkins, M., Henry, N., & Pinch, S. (2004). Knowledge, Clusters, and Competitive Advantage. *The Academy of Management Review*, vol. 29, no. 2, pp. 258–271.