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ASSESSMENT METHODOLOGY OF THE CLUSTERS' EFFECTIVENESS IMPACT ON THE REGION INNOVATION STABILITY

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Abstract

The study of the degree of influence of the efficiency of cluster functioning on innovation sustainability is based on: a systematic approach; the theory of economic security in the aspect of forming reference parameters to ensure the criterion of sustainability of innovative development; the method of complex rationing and the index method for developing a procedure for assessing the level of innovation sustainability of the territory; economic and statistical methods and expert assessment methods; the method of cluster analysis for assessing the degree of influence of cluster performance indicators on the level of innovative development of socio-economic systems. The algorithm of the assessment methodology includes the sequential implementation of three stages: 1) assessment of the effectiveness of clusters operating in the regions of the Russian Federation; 2) assessment of the level of innovation sustainability of the region; 3) assessment of the impact of the effectiveness of the functioning of cluster structures on innovation sustainability. The proposed methodological approach and the system of assessment indicators can be used by regional public authorities to monitor the state of efficiency of innovative and industrial clusters and innovation sphere. The results of the assessment can be used to adjust the existing and develop new conceptual documents and improve the methods of the implemented innovation, investment and cluster policy.

Keywords: Cluster structures, efficiency, innovation sustainability, innovation policy, regional economy

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1. Introduction

The problem of sustainability of innovative development from the point of view of the implementation of mechanisms for investment support of territories has become in recent years the subject of researches of many scientists and practitioners. The directions of research in the aspect of developing a general theory of sustainability and ensuring sustainable socio-economic development of various types of territories that meet the "challenges" of modern society were implemented (Bossel, 1999; Commission on Sustainable Development, 2001; Grzebyk & Stec, 2015; Gul, 2011; Zinina & Olentsova, 2020). Various aspects of the formation of mechanisms for ensuring sustainable socio-economic development of territories, including those on the basis of network and cluster interaction, were studied (Bembenek, 2015; Brykov, 2013; Korneyko, 2017; Makhmudova, 2010; Pechatkin, 2010). Many of the authors' works reflect the issues of studying the patterns and strategic aspects of regional development, as well as the problems of regional investment, innovation and cluster policy (Njøs & Jakobsen, 2016; Podgornova, 2015; Sidyakina & Sayapin, 2015; Suresh et al., 2016; Tsertseil & Kookueva, 2018).

2. Problem Statement

However, most studies are limited to assessing and analyzing the level of innovation and investment development of territories (Bortnik et al., 2012; Hollanders et al., 2009; Peran & Sirilli, 2008), without solving the problems of managing the innovation process and applying possible mechanisms for investment support of innovative development of regions, taking into account their industry specifics, as well as from the point of view of sustainability. Applied methodological approaches to assessing the impact of the effectiveness of cluster structures on the innovation sustainability of regions remain insufficiently developed.

3. Research Questions

The study of the degree of influence of the efficiency of cluster functioning on innovation sustainability is based on:

1. a systematic approach to the consideration and systematization of modern concepts for assessing the sustainable innovation and investment development of the regional economy;
2. the theory of economic security in the aspect of forming reference parameters to ensure the criterion of sustainability of innovation and investment development;
3. the method of complex rationing and the index method for developing a methodology of assessing the level of innovation territory;
4. economic and statistical methods and methods of expert assessment of the effectiveness of the functioning of cluster structures;
5. the method of cluster analysis to assess the degree of influence of cluster performance indicators on the level of innovative development of socio-economic systems.

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4. Purpose of the Study

The purpose of the study is to form methodological tools for evaluating the impact of the cluster structure functioning on the region innovation stability.

It is efficient to carry out the evaluation procedure of the impact of the cluster structures functioning efficiency on the innovation stability of the region in a differentiated manner, namely, to distinguish between the assessment of the effectiveness of the clusters functioning and the assessment of innovation stability because of the large volume of indicators in the system. Thus, the algorithm of the evaluation methodology will include a step-by-step solution of three tasks:

1) evaluation of the effectiveness of clusters operating in the regions of the Russian Federation;
2) evaluation of the level of innovation sustainability of the region;
3) evaluation of the impact of the effectiveness of the functioning of cluster structures on innovation sustainability.

5. Research Methods

As part of the solution of the first problem, it is proposed to use the methodological approach presented in the author's research (Ruiga et al., 2021).

To assess the state of innovation sustainability of the region, it is necessary to determine the method (s) of assessment and form a system of assessment indicators. Among the main methods used in the modern scientific literature, the following can be distinguished:

- Observation of the main economic indicators at the regional level and their comparison with threshold values (Glazyev, 1997);
- Assessment of economic growth rates by the main economic indicators and the dynamics of their changes (Senchagov & Mityakov, 2011);
- The method of expert assessment to rank territories by the level of threats (Primakin & Bolshakova, 2012);
- The method of analyzing and processing scenarios (Kupreschenko & Fedotova, 2010);
- methods of multivariate statistical analysis (Senchagov & Mityakov, 2012).

As a result of the comparative analysis of these methods, according to the authors, the method of observing the main economic indicators at the regional level and comparing them with the threshold values is optimal for identifying problem areas. The algorithm for assessing the sustainable development of the region in the innovation sphere should be implemented in six stages.

The first stage involves the selection and justification of indicators, as well as their threshold values for determining sustainable development in the innovation sector of the region. It is important to emphasize that the highest degree of safety, and, consequently, the state of stability, is achieved provided that the entire set of indicators is within the permissible limits of its threshold values, while the threshold values of one indicator are not reached at the expense of the others (Novikova & Krasnikov, 2009).

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The second stage involves the collection of statistical data, the third stage is the comparison of data with threshold values, as well as their analysis in dynamics.

At the fourth stage, the indicators are ranked according to the degree of distance from the threshold value. In this regard, it is proposed to use a "zonal" approach for ranking indicators, according to which it is assumed that the values of indicators are separated by zones of distance from the threshold level based on the use of two functions: for indicators with the criterion "not less" and for indicators with the criterion "not more" (Senchagov & Mityakov, 2011). The use of complex functions makes it possible to expand the range of visualization of the results. Thus, the logarithmic dependence allows us to study the nonlinear structure of indicators within a sector; a less smooth power dependence allows us to ignore insignificant details when the indicators significantly exceed their threshold values (Zemskova, 2016).

At the fifth stage, the "risk zones" are determined based on the results obtained in the previous actions. The use of the complex base of the logarithmic function allows you to define the following “risk zones”:

1) the “catastrophic risk” zone – the indicator does not exceed the value of 0.25, while its value differs from the threshold one by more than 10 times. If the indicators fall into the "catastrophic risk" zone, an immediate response from the state administration is required;
2) the "critical risk" zone is limited to the values of 0.25 and 0.5; at the same time, the real value of the indicator differs from the threshold one by 3-10 times. Being in the "critical risk" zone indicates the development of crisis phenomena in the economy and requires strategic decisions to gradually enter a safer mode of operation;
3) the "significant risk" zone is located in the range from 0.5 to 0.75. The threshold value of the indicator differs from its real value by 1.6-3 times. This situation is undesirable, in many cases it is not possible to quickly correct it, so it is important to study the trends in the corresponding indices;
4) the "moderate risk" zone is limited to the values of 0.75 and 1. The threshold value of the indicator differs from its real value by no more than 1.6 times. This situation is typical for a number of indicators and does not pose significant threats to the socio-economic system;
5) the zone of "stability" - the value of the indicator exceeds 1. In this zone, any indicator value is positive. At the same time, the extremely high values of the indicators, repeated over a number of years, indicate that this indicator has lost its significance for monitoring threats to the socio-economic system.

The final (sixth) stage involves the generalization of indicators and the formation of an aggregated indicator of innovation sustainability (Senchagov & Mityakov, 2012). To do this, generalized indicators are calculated on the geometric mean formula for each of the projections (2):

$$\Phi_i = \sqrt[m]{\prod_{j=1}^{m} y_{ij}}, \quad (2)$$

where y_{ij} – functionally transformed (normalized) j-th indicator of the i-th sphere; m – the number of indicators in the projection.

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Thus, the final summary indicator for determining the level of stability of the region can be calculated according to the formula (3):

$$\Phi_i = \sqrt[m]{\prod_{j=1}^{m} y_{ij}}, \quad (3)$$

where k is the number of indicator groups in the system.

The implementation of these stages in a certain sequence allows us to form the level of sustainable development of the region in the innovation sphere.

In the context of the third task of the study, the direct impact assessment is based on the following hypothesis: the level of efficiency of cluster structures and the level of sustainable development of the region are directly related.

It should be noted that the formation of a system of assessment parameters of innovation and investment sustainability and the impact on this indicator of the effectiveness of the development of cluster structures should be carried out on the basis of the following principles (Ruiga et al., 2019): target orientation; consistency; complexity; functionality; time orientation; information and analytical security; reliability and transparency; practice-oriented significance.

6. Findings

Following the three-level evaluation algorithm in the framework of solving the first task, it is necessary to form a system for evaluating the effectiveness of the cluster (Table 1).

Table 1. System for evaluating the effectiveness of cluster activities (compiled by the authors)

Criterion of the cluster activities effectiveness assessment	Factors that influence criterion of the cluster activities effectiveness assessment	Influence coefficient on the criterion (K**f**)	Assessment method
1. Presence of competitive enterprises-participants of the created cluster (M_1)			
Kf_1 –number of SME entities that are members of territorial clusters	indicator that characterizes the increase in the number of small or medium-sized businesses in the cluster	0.4	Indicator that shows the number of SME entities - members of the cluster
Kf_2 – influence of the cluster member enterprises on the region's industry	indicator showing the occupied market share	0.5	Indicator showing the private share from the total volume of goods (products) and services produced in this industry
Kf_3 – status of the cluster member enterprises in the industry	indicator that characterizes the level of business activity of enterprises participating in the cluster; an indicator that reflects the accumulated experience of functioning of enterprises participating in the cluster	0.1	Authors' (subjective) assessment
2. Growth of the industry economic indicators (M_2)			
Kf_4 – total volume of work and services	indicator reflecting the growth of the share of total volume of work and services at enterprises participating in the	0.4	Indicator showing the total volume of work and services produced by enterprises participating in the cluster

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Kf_5 – number of people employed in the industry	cluster formation in the total volume of work in the industry indicator that reflects the growth of the share of the number of employees of the enterprises participating in the cluster, in the total number of employees in the functioning industry; indicator that shows the number of jobs created during the year of operation	0.3	Number of people employed at the enterprises participating in the cluster
Kf_6 – volume of investments in fixed capital	indicator that reflects the renewal of basic production assets of enterprises participating in the cluster; an indicator that reflects an increase in the volume of investments in the region under consideration	0.3	Assessment includes an indicator that reflects an increase in investments
3. Development and implementation of innovative projects (M_3)			
Kf_7 – indicator that shows the degree of innovation in the industry	indicator of the growth in the number of innovations introduced in the industry after the creation of the cluster; the creation and implementation of new generation technologies	0.5	Assessment of the activity of the cluster structure, including participating enterprises.
Kf_8 – -introduction of new generation technologies	indicator that characterizes the availability of resources for the introduction of nano-technologies	0.5	Assessment that allows you to determine the availability of the necessary infrastructure for the creation and development of nano-technologies
4 The presence of connections and interaction among the enterprises participating in the cluster (M_4)			
Kf_9 – access to a more modern (new) level of management	ability of the heads of enterprises participating in the cluster to reach a higher level of management	0.3	Subjective (author's) assessment
Kf_{10} – creating the infrastructure necessary for the development of the cluster	indicator reflecting the possibility of creating the necessary infrastructure for a more successful functioning of the cluster formation	0.3	Subjective (author's) assessment
Kf_{11} – level of cooperation	ability of the entity to achieve the required level of cooperation	0.4	Subjective (author's) assessment
5 Geographical proximity of cluster members (M_5)			
Kf_{12} – territorial proximity of the enterprises participating in the cluster	indicator that reflects the geographical location of the enterprises participating in the cluster	1	Indicator that allows you to assess the proximity of the location

The results of assessing the effectiveness of the cluster, presented in accordance with Table 1, allow us to assess how effectively the created cluster is functioning, to determine the pattern of development and to identify threats in a particular block of indicators.

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As part of solving the second problem for assessing the level of innovative sustainability, it is advisable to form the following system of indicators in certain projections: macroeconomic indicators; indicators of industrial and innovative development; investment development indicators; indicators characterizing the level and quality of life of the population (Table 2).

Table 2. System of indicators for assessing the innovative sustainability of the region (compiled according to data (Glazyev, 1997; Novikova & Krasnikov, 2009; Ruiga et al., 2019; Senchagov & Mityakov, 2011; Senchagov & Mityakov, 2012)

Group	№	Indicators	Threshold values
Macroeconomic indicators	1	Average annual growth of the gross regional product (GRP) per year, %	Not less than 8%
	2	GRP in the average Russian GRP per capita, %	Not less than 100%
Indicators of industrial and innovative development	3	Share of processing industry in industrial production	Not less than 70%
	4	Wear and tear degree	Not more than 40%
	5	Share of innovative products in industrial production, %	Not less than 15%
	6	Internal research and development expenditures, % to GRP	Not less than 2%
Investment development indicators	7	Share of investments into fixed capital, % to GRP	Not less than 25%
	8	Share of foreign investments in the volume of investments into fixed capital	Interval 5-20%
Living standards and population's quality of life	9	Share of people with incomes below the subsistence minimum	Not more than 7%
	10	Life expectancy	Not kess than 70 years
	11	R/P 10% ratio	Not more than 8 times
	12	Unemployment rate according to the ILO methodology	Not more than 7%

The use of the integrated approach in the formation of a system of assessment indicators is driven by the need to conduct an assessment procedure both in the context of innovation and investment development, and in the context of socio-economic development. The presence of threshold values gives grounds to conclude about the level of stability or instability of the socio-economic system, while it is possible to identify threats (identify problem areas) in the context of innovation, investment, macroeconomic and social blocks.

As part of the solution of the third problem, it is proposed to conduct clusterization of regions in the context of two projections: 1) the results of the clusters ' activities; 2) the aggregated coefficient of innovation sustainability. It is advisable to differentiate each projection into three levels: low, medium, and high. As a result, nine quadrants will be formed. The intersection in different quadrants indicates the presence or absence of dependence, as well as the type of dependence: direct or reverse.

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7. Conclusion

The methodology proposed in the research for assessing the impact of cluster activity on the innovation stability of the region provides the following features:

- assessment of cluster and innovative development of socio-economic systems;
- determining the compliance of regional resources of innovative and investment development with the results of innovative and investment activities in the constituent entities of the Russian Federation;
- identifying risks and threats of innovative and investment development at the regional level;
- formation of practical recommendations for levelling and countering the identified risks and threats of innovation and investment development, taking into account the adjustment of methods of the implemented socio-economic policy of the region.

The methodological principles, methodological approach and assessment indicators developed by the authors can be used by regional public authorities to monitor the state of efficiency of functioning of cluster structures and the innovation and investment sphere in the context of infrastructure support and dynamics of innovation and investment development, timely identification of risks and threats, as well as to adjust existing and develop new conceptual documents and improve methods of the implemented socio-economic policy.

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References

Bembenek, B. (2015). The sustainable development of an industrial cluster in the context of corporate social responsibility - a new challenge for cluster management. *European Scientific Journal, 1.* 225-235. https://eujournal.org/index.php/esj/article/viewFile/5090/4862

Bortnik, I. M., Senchenya, G. I., Mikheeva, N. N., Zdunov, A. A., Kadochnikov, P. A., & Sorokina, A. V. (2012). System of assessment and monitoring of innovative development of Russian regions]. *Innovations, 9*(176), 48-61.

Bossel, H. (1999). Indicators for Sustainable Development: Theory, Method, Applications, *A Report to the Balaton Group. Manitoba, International Institute for Sustainable Development*, 124.

Brykov, S. S. (2013). Research and production clusters as a model for the development of regions of Russia, *Actual problems of modern science, technology and education, 71,* 279-283.

Commission on Sustainable Development. (2001). Indicators of Sustainable Development: Guidelines and Methodologies, *New York, United Nations Department of Economic and Social Affairs*, 93. https://sustainabledevelopment.un.org/content/documents/guidelines.pdf

Glazyev, S. Yu. (1997). The basis for ensuring the country's economic security: an alternative reformation course, *RER: Russian. economic journal, 1*, 3-19.

Grzebyk, M., & Stec, M. (2015). Sustainable development in EU countries: Concept and rating of levels of development. *Sustainable Development*, *23*, 110-123. https://doi.org/10.1002/sd.1577

Gul, T. N. (2011). Assessment of the sustainability of the development of the region. *Sotsial'no-ekonomicheskiye yavleniya i protsessy 10*(032), 34-39.

Hollanders, H., Tarantola, S., & Loschky, A. (2009). Regional Innovation Scoreboard (RIS). *Pro Inno Europe.* http://www. proinno-europe.eu/page/regional-innovation-scoreboard

Korneyko, O. V. (2017). Cluster approach in the organization of free economic zones. *Economics and Management,* 37-38.

Kupreschenko, N. P., & Fedotova, E. A. (2010). Analysis of real and potential threats to the social sphere and their impact on economic security. *Bulletin of the Academy of Economic Security, 8,* 82-93.

Makhmudova, A. I. (2010). Varieties of network forms of integration in industry. *Bulletin of the Astrakhan State Technical University. Series: Economics, 1,* 211-218.

Njøs, R., & Jakobsen, S. E. (2016). Cluster policy and regional development: scale, scope and renewal. *Regional Studies, Regional Science*, *3*(1), 146-169. https://doi.org/10.1080/21681376.2015.1138094

Novikova, I. V., & Krasnikov, N. I. (2009). Methods for identifying indicators of economic security of regions. *Economic Bulletin of the Rostov Humanitarian University, 2*, 208-210.

Pechatkin, V. V. (2010). Methodology for assessing and analyzing the clustering potential of the regional economy. *Pechatkin. Economic analysis: theory and practice, 28*, 42-48.

Peran, L., & Sirilli, P. (2008). Benchmarking of innovation activity of Europian countries. *Foresight*, *1*(5), 4-15.

Podgornova, E. V. (2015). Implementation of the cluster concept in innovation policy. *Economics and Entrepreneurship, 6-1*(59), 696-700.

Primakin, A. I., & Bolshakova, L. V. (2012). The method of expert assessments in solving the problem of ensuring the economic security of an economic entity. *Bulletin of the St. Petersburg University of the Ministry of Internal Affairs of Russia, 1,* 191-201.

Ruiga, I. R., Kovzunova, E. S., Teterin, Yu. A., Bugaeva, S. V., & Burmenko, T. A. (2021). Assessment of the cluster structures functioning effectiveness in the agro-industrial complex: a methodological approach, practical implementation. In *IOP Conference Series: Earth and Environmental Science* (Vol. 677, No. 2, p. 022057). IOP Publishing.

Ruiga, I. R., Rogozinskiy, E. V., Yamschikov, A. S., Kovzunova, E. S., & Teterin, Y. A. (2019). Methodological aspects of machine-building complex economic security from the position of innovative and investment sustainability: macroeconomic cross-section. In Journal of Physics: Conference Series (Vol. 1399, No. 3, p. 033088). IOP Publishing.

Senchagov, V. K., & Mityakov, S. N. (2012). Innovative transformations as an imperative of the region's economic security: a system of indicators. *Bulletin of the Academy of Economic Security of the Ministry of Internal Affairs of Russia, 6,* 56-61.

Senchagov, V. K., & Mityakov, S. N. (2011). Using the index method for assessing the level of economic security. *Bulletin of the Academy of Economic Security of the Ministry of Internal Affairs of Russia. 5*, 41-50.

Sidyakina, O. A., & Sayapin, A. V. (2015). Instrumentariy obespecheniya ustoychivogo razvitiya agropromyshlennogo regiona. *Toolkit to ensure sustainable development of the agro-industrial region, 4,* 81-89. [in Rus]

Suresh, B., Erinjery, J. J., & Jegathambal, P. (2016). Indicators and Influence Factors for Sustainability Assessment of Inclusive Smart Innovation Clusters. *Journal of Geological Resource and Engineering*, *7,* 305-327. https://doi.org/10.17265/2328-2193/2016.07.001

Tsertseil, Yu. S., & Kookueva, V. V. (2018). Prospects of territories development within the implementation of the cluster approach in the Russian Federation. *Issues of innovative economy*, *8*(3), 365-374. https://doi.org/10.18334/vinec.8.3.39363

Zemskova, E. S. (2016). Assessment of the severity of crisis situations in the social sphere of the Russian Federation. *Content: Informational Mordovia, 12.* 33-38.

Zinina, O. V., & Olentsova, J. A. (2020). Elements of sustainable development of agricultural enterprises. *IOP Conference Series: Earth and Environmental Science*, *421,* 022003.