

# Assessment of functional contours of an innovative cluster

## Evaluación de los contornos funcionales de un clúster innovador

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### Abstract

Paper deals with the cluster aspect of the innovative policy, problems of assessment of cluster development in the regional economic space is considered. The purpose of this research is to offer a systematization of methodological approaches to assessment of cluster's functional contours. Four main functional contours of the innovation cluster are identified: organizational, scientific and technological, educational and industrial. The indicators of evaluation of the infrastructure component and functional contours of the innovation cluster are systematized.

**Key words:** innovative policy, functional circuits, innovative cluster, regional development.

### Resumen

El documento trata sobre el aspecto cluster de la política innovadora, se considera problemas de evaluación del desarrollo de clústeres en el espacio económico regional. El propósito de esta investigación es ofrecer una sistematización de enfoques metodológicos para la evaluación de los contornos funcionales del clúster. Se identifican cuatro contornos funcionales principales del clúster de innovación: organizativo, científico y tecnológico, educativo e industrial. Se sistematizan los indicadores de evaluación del componente de infraestructura y los contornos funcionales del clúster de innovación.

**Palabras clave:** política innovadora, circuitos funcionales, clúster innovador, desarrollo regional.

## 1. Introduction

An integrated approach to the scientific problem of regulating clustering processes and innovative development of Russian regions is the study of an innovation cluster as a set of infrastructure components and interdependent functional contours (The World Inequality Lab, 2018). At the same time, the assessment of the effectiveness of the innovation cluster's functional contours should be made on the basis of an interconnected system of economic indicators (Porter and Ketels, 2009). Such a system of indicators makes it possible to comprehensively consider the cluster from the point of view of various aspects of its competitiveness (Economic health of Russian regions: current level and dynamics of changes, 2019). Indicators of cluster infrastructure efficiency are the basis for developing an organizational and economic model of state regulation of clustering processes in the region's economy, as well as improving the institutional mechanisms for its implementation (Dokholyan, Petrosyants & Sadykov, 2014).

An important scientific and practical problem is the insufficient use of tools for assessing the development of the infrastructure component and functional contours of the innovation cluster at the level of regions and municipalities (Abdullaeva, Gamidullaev & Sultanov, 2019). This, in turn, hinders the optimal use of the potential

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of regional enterprises and innovative infrastructure objects. Solving problems of economic development of regions actualizes the task of improving indicators for assessing cluster development.

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## 2. Methodology

The theoretical basis of the research are the concepts and hypotheses in the field of cluster theory, theory of spatial development, theory of innovation and innovative development, theory of institutions and institutional transformations. The study is based on the dialectical method of scientific cognition, which involves the consideration of economic relations within innovative clusters in their relationship and development. In the course of the study, a systematic approach is widely used, which involves a comprehensive study and structural and logical ordering of economic systems. In the framework of the study, the methods of structural and comparative analysis are also in demand, the solution of scientific problems of the study required the use of general theoretical research methods such as abstraction and concretization, analysis and synthesis, induction and deduction, comparison and contrast.

Methodological features of calculating quantitative indicators of cluster development, the values of which are presented in tables 2 and 3. The indicator "number of specialized cluster organizations directly involved in its development" is the quantitative value of public or private institutions that perform the functions of managing the development of the cluster and coordinating its participants. The information basis for calculating this indicator is the cluster's constituent documents and regional regulations. The following indicator "average number of employees of specialized organizations in an innovation cluster" is an arithmetic mean and is the result of dividing the total number of employees of these organizations by the number of these organizations in the cluster. The indicators "number of institutionalized platforms for interaction of organizations participating in the innovation cluster" and "number of banks and other credit and financial organizations included in the innovation cluster" are calculated based on the registers of cluster participants formed by the Russian cluster Observatory. The indicators shown in table 3 are calculated by the author based on the methodology of the Federal state statistics service of the Russian Federation. During the calculations, the software product MS Excel 2016 was used.

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## 3. Results

The study examined the processes of cluster development in the Volga Federal district. Indicators of cluster development located on the territory of the Volga region regions are shown in table 1. The leaders of the Volga region in terms of economic coverage by clustering processes are the following territories: Tatarstan Republic, Perm region, Penza region, Samara region, Ulyanovsk region. Allocated to the following clusters under high level of institutional development (highlighted in green): Nuclear innovation cluster of Dimitrovgrad (Penza region), Udmurt engineering cluster, Petrochemical territorial cluster of the Bashkortostan Republic, Scientific-educational-production cluster "Ulyanovsk-Avia", Kama territory innovative cluster.

**Table 1**  
Clusters of the Volga Federal district

Regions of the Volga Federal district	Cluster	Key sectoral specialization	Number of participating organizations, units	The number of employees in the cluster, persons
Nizhny Novgorod region	Industrial innovation cluster of automotive and petrochemicals	Automotive industry	33	5581
Penza region	IT-cluster	Information technologies	11	202
	Zarechensk cluster of technology integration	Microelectronics and instrumentation	11	768
	Biomed production cluster	Medical industry	15	2264
	Instrument cluster " Security"	Defense industry	34	7639
	Penza region total		71	10671
Perm region	Technopolis "New Star"	Space industry	44	34696
	Innovative territorial cluster of fiber-optic technologies "Photonics"	Fiber-optic technologies	34	15762
	IT-cluster	Information technologies	10	7822
	Perm region total		88	58280
Bashkortostan Republic	Petrochemical territorial cluster	Chemical production	211	49094
Chuvash Republic	Innovative territorial electrical engineering cluster	Production of machinery and equipment	23	11006
Mordovia Republic	Energy-efficient lighting and intelligent lighting control systems	Microelectronics and instrumentation	24	9866
Tatarstan Republic	Innovative territorial cluster in the field of nanotechnology	New material	12	27646
	Kama territory innovative cluster	Automotive industry	213	151561
	IT-cluster	Information technologies	70	1576
	Machine-building cluster	Automotive industry	157	20366
	Food cluster	Food production	20	5023
	Agropolis "Agrobiopole"	Environmental protection and waste management	33	1055
Tatarstan Republic total		505	207227	
Samara region	Aerospace cluster	Space industry	13	43257
	Cluster of medical and pharmaceutical technologies	Medical industry	55	10806
	Samara region total		68	111863
Udmurt Republic	Engineering cluster	Defense industry	61	36211
Ulyanovsk region	Scientific, educational and production cluster	Aircraft building	77	30028
	Nuclear innovation cluster	Nuclear and radiation technologies	54	26482
	Ulyanovsk region total		192	56510

Source: Russian cluster Observatory: <http://map.cluster.hse.ru/list>

Average institutional development are the following clusters (highlighted in yellow): cluster «Energy-efficient lighting and intelligent lighting control systems», Territorial-industrial cluster Agropolis "Agrobiopole", Machine-building cluster of the Tatarstan Republic, Innovative territorial cluster of fiber-optical technologies "Photonics", territorial Innovation cluster "Technopolis "New Star", Innovative territorial aerospace cluster of the Samara region, Biomed production cluster (Penza region). The other clusters considered are at the initial level of development.

During the analysis of institutionalization of organizational and economic relations within innovation clusters, Four main functional contours of innovation clusters are identified, which are interconnected with its infrastructure component. These functional contours include the organizational, scientific and technological, educational and production contours of the innovation cluster. Indicators for evaluating efficiency were developed for these functional contours, which also include indicators for the development of the infrastructure component of the innovation cluster. Indicators for assessing the organizational contour of the innovation cluster include the following:

- number of specialized cluster organizations that are directly involved in its development (units);
- average number of employees of specialized organizations in the innovation cluster (people);
- number of institutionalized platforms for interaction between organizations participating in the innovation cluster(units);
- number of banks and other credit and financial organizations that are members of the innovation cluster (units);
- number of international and national development institutions participating in cluster projects (units);
- share of organizations participating in the cluster that are participants in international and national projects in the field of scientific, technical and industrial cooperation (percent).

In the course of the study, basic indicators of organizational contour development were calculated for clusters formed on the territory of the Volga Federal district (table 2). We note a significant differentiation in the values of indicators for the development of the organizational contour of clusters, including within the same region. The situation due to different level of development and "institutional maturity" of the clusters.

**Table 2**  
Indicators for assessing the organizational contour  
of innovation clusters in Volga Federal district

Regions of the Volga Federal district	Cluster	Number of specialized cluster organizations that are directly involved in its development (units)	Average number of employees of specialized organizations in the innovation cluster	Number of institutionalized platforms for interaction between organizations participating in the innovation cluster(units)	Number of banks and other credit and financial organizations that are members of the innovation cluster (units)
Nizhny Novgorod region	Industrial innovation cluster of automotive and petrochemicals	1	8	5	0
Penza region	IT-cluster	1	2	1	0
	Zarechensk cluster of technology integration	3	5.6	3	1
	Biomed production cluster	1	2	1	0
	Instrument cluster "Security"	1	10	1	0
	Penza region total	5	19.6	5	1
Perm region	Technopolis "New Star"	1	4	6	1
	Innovative territorial cluster of fiber-optic technologies "Photonics"	1	4	1	0
	IT-cluster	1	4	1	0
	Perm region total	1	4	6	1
Bashkortostan Republic	Petrochemical territorial cluster	1	24	5	1
Chuvash Republic	Innovative territorial electrical engineering cluster	1	1	3	0
Mordovia Republic	Energy-efficient lighting and	1	78	2	0

Regions of the Volga Federal district	Cluster	Number of specialized cluster organizations that are directly involved in its development (units)	Average number of employees of specialized organizations in the innovation cluster	Number of institutionalized platforms for interaction between organizations participating in the innovation cluster(units)	Number of banks and other credit and financial organizations that are members of the innovation cluster (units)
	intelligent lighting control systems				
Tatarstan Republic	Innovative territorial cluster in the field of nanotechnology	1	5	1	0
	Kama territory innovative cluster	1	18	5	1
	IT-cluster	1	5	1	0
	Machine-building cluster	8	6.4	7	0
	Food cluster	1	3	1	1
	Agropolis "Agrobiopole"	2	1	5	1
	Tatarstan Republic total	14	6.4	20	3
Samara region	Aerospace cluster	1	5	1	0
	Cluster of medical and pharmaceutical technologies	1	12	3	0
	Samara region total	2	8.5	3	0
Udmurt Republic	Engineering cluster	1	6	2	1
Ulyanovsk region	Scientific, educational and production cluster	1	4	8	3
	Nuclear innovation cluster	1	4	1	0
	Ulyanovsk region total	2	4	9	3
Volga Federal district, total		32	9.63	64	10
Volga Federal district, average		1.45	9.63	2.9	0.45

Source: Russian cluster Observatory: <http://map.cluster.hse.ru/list>

The organizational contour of the innovation cluster also includes the objects and organizations of the cluster's innovation infrastructure that form the basis of its scientific and technological contour (Idziev, 2014). The following indicators for evaluating the development of the scientific and technological contour of the innovation cluster are proposed:

- share of enterprises and organizations in the innovation cluster that performed research and development activities during the year (percent);
- share of research and development organizations in the innovation cluster (percent);
- average number of employees in the innovation cluster participating in the implementation of research and development projects per year (people);
- amount of expenses of participants in the innovation cluster for research and development projects per year (\$);
- volume of investments of the participants of the innovation cluster for the development of the cluster's innovation infrastructure per year (\$);
- advanced technologies developed by enterprises and organizations in the innovation cluster (units).

If there is insufficient information about the quantitative values of the indicators proposed above for individual clusters, cluster policy indicators for the region as a whole can be used. An example of a combination of indicators for individual clusters and reginae as a whole is shown in table 3.

**Table 3**  
Indicators for assessing the scientific and technological  
contour of innovation clusters in Volga Federal district

Regions of the Volga Federal district	Cluster	Amount of expenses of participants in the innovation cluster for research and development projects per year (mln \$)	Share of research and development organizations in the innovation cluster (percent);	Average number of employees in the innovation cluster participating in the implementation of research and development projects per year (people)	Advanced technologies developed by enterprises and organizations in the innovation (units)
Nizhny Novgorod region	Industrial innovation cluster of automotive and petrochemicals	1519.68	9%	2201	12
Penza region	IT-cluster	160.13	0%	376	10
	Zarechensk cluster of technology integration		0%		
	Biomed production cluster		0%		
	Instrument cluster "Security"		5.80%		
Perm region	Technopolis "New Star"	586.7	4.50%	759	40
	Innovative territorial cluster of fiber-optic technologies "Photonics"		23.50%		
	IT-cluster		10%		
Bashkortostan Republic	Petrochemical territorial cluster	464.91	11.80%	1106	11
Chuvash Republic	Innovative territorial electrical engineering cluster	97.58	17.30%	113	1
Mordovia Republic	Energy-efficient lighting and intelligent lighting control systems	42.61	8.30%	78	7
Tatarstan Republic	Innovative territorial cluster in the field of nanotechnology	2016.98	16.60%	1808	43
	Kama territory innovative cluster		4.70%		
	IT-cluster		0%		
	Machine-building cluster		2.50%		
	Food cluster		10%		

Regions of the Volga Federal district	Cluster	Amount of expenses of participants in the innovation cluster for research and development projects per year (mln \$)	Share of research and development organizations in the innovation cluster (percent);	Average number of employees in the innovation cluster participating in the implementation of research and development projects per year (people)	Advanced technologies developed by enterprises and organizations in the innovation (units)
	Agropolis "Agrobiopole"		0%		
Samara region	Aerospace cluster	675.84	15.30%	500	24
	Cluster of medical and pharmaceutical technologies		18.10%		
Udmurt Republic	Engineering cluster	148.07	9.80%	249	9
Ulyanovsk region	Scientific, educational and production cluster	132.36	7.70%	291	91
	Nuclear innovation cluster		17.70%		
Volga Federal district, total		5844,86	--	7481	248
Volga Federal district, average		265.67	8.75%	340.05	11.27

Source: Regions of Russia. Socio-economic indicators. 2019: Statistical Digest

The key feature of the scientific and technological sphere of the cluster is the conditionality of its development by the educational environment of the cluster and the territory of its placement as a whole (Novikov, 2018). The following indicators of the development of the educational contour of the innovation cluster are highlighted:

- average number of students enrolled in educational institutions of the innovation cluster and post-graduate students who are undergoing practical training in organizations of the cluster per year (people);
- number of graduates of educational institutions of the innovation cluster who are employed in the specialty at the enterprises and organizations of the cluster per year (people);
- winning a joint bid of companies and universities-participants of innovative cluster in contests within the framework of realization of federal programs in the sphere of higher education and science (units);
- level of cooperation between enterprises and organizations participating in the cluster in the framework of educational activities (including internships, professional retraining, professional development, etc.).

The effectiveness of the three functional contours of the innovation cluster discussed above has a decisive impact on the development of high-tech production and the final economic results (Novikov, Veas Iniesta, 2018). Indicators for assessing the development of the production contour of the innovation cluster include the following:

- total revenue from sales of innovation cluster enterprises in the national market for the year (\$);
- share of innovation cluster enterprises in total sales on the national market (percent);
- total revenue from sales of innovative cluster enterprises in the foreign market for the year (\$);
- share of innovation cluster enterprises in total sales in the global market (%);
- total share of small businesses in the total revenue of the innovation cluster (percent);
- the level of development of production cooperation between enterprises of the innovation cluster within the framework of common production chains (percent).

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## 4. Conclusions

The use of the above-mentioned indicators of the of the innovation cluster's efficiency complements the existing methods of state cluster policy and allows for a more comprehensive analysis of its infrastructure component. The advantage of using the theoretical and methodological potential of the institutional direction of economic thought in this study is the ability to assess the development of the infrastructure component and functional contours of the innovation cluster. At the same time, the key condition for the development of innovation clusters is the structural diversification of production based on the formation of an innovative infrastructure and institutional environment. The implementation of the proposed system of indicators in general is aimed at the economic efficiency of the development, implementation and transfer of advanced production technologies.

The results obtained in the course of the work actualized the scientific problems of modeling the organizational and institutional structure of innovative clusters (multiclusters), as well as modeling the infrastructure component of clusters as a direction for further research.

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