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**ATTRIBUTES AND SECTORAL CHARACTERISTICS OF  
INNOVATIVE CLUSTER**

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***Abstract***

The article discusses the features and contradictions of cluster development, as well as the main types of innovation clusters as the main form of integration of high-tech industries at the regional level. Within the framework of the study universal characteristics of cluster formations are considered. Multiclusters are separated into a separate kind of clusters with a common core in the form of an innovation cluster. These universal characteristics determined the most significant attribute properties of innovation clusters. The essential content of the category "innovation cluster" is presented by the authors through the selection of such attribute properties as concentration, coordination, complementarity and competition. The article also highlighted the attribute properties of the cluster, which form the contradictions of the process of cluster development of the territory. The author's approach to the development of an integrated clustering model of the economic space of the Russian regions is to consider innovative clusters as the fundamental segments of innovative multi-clusters. Based on the results of the research, innovative multi-clusters have been identified as a form of economic development of territories with a multi-structured economy. At the same time, the phased integration of multi-clusters is considered through three echelons of clusters: innovative pilot clusters, integrating the production of breakthrough technologies; clusters of innovative technologies and engineering that create the technological basis for the modernization of the economy; clusters of high-tech products aimed at global markets for goods, works and services.

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**Keywords:** Cluster policy, economic development, innovative cluster, multi-cluster, new technologies, regional economy.



## **1. Introduction**

The solution of the task of restoring the sustainable rates of social and economic development of the Russian Federation in the context of the implementation of an integrated import substitution policy actualizes the problems of developing models for the formation of clusters as purposefully created self-developing economic systems (Markov, 2015). The importance of studying clustering processes is increasing due to the increasing global trends within the Russian economy associated with the processes of dematerialization of consumer goods, informatization of management systems and the networkization of socio-economic interactions (Gimadeeva, 2015).

It is necessary to note a tendency to intensify the contradictions in the development of the world economic system, the main one of which is multidirectional, on the one hand, the processes of globalization and international cooperation, on the other hand, the intensification of the processes of regionalization of production (Porter, 2003). The further development of these trends actualizes the practical search and scientific substantiation of new forms of the international organization of high-tech production in the field of network and cluster forms of economic interactions. At the same time, modern Russian conditions for industrial modernization and the creation of new high-tech industries are characterized by a decrease in the efficiency of territorial production complexes (TPC) as points of economic growth (Kleiner, 2015).

## **2. Problem Statement**

Today, the successful experience of implementing cluster initiatives in the world practice of managing the socio-economic development of territories allows us to consider the cluster as a demanded spatial-organizational form of implementation of the state regional policy (Matafonova, 2016). In Russia, the cluster approach to state regulation of the economy at the regional level is also gaining increasing political popularity and practical relevance (Dzhindzholia, Popkova, & Shakhovskaya, 2015). The complexity of the effective implementation by state authorities of the constituent entities of the Russian Federation of a cluster approach to state regulation of the economy is due to the fact that in modern Russian science and management practice a cluster is a synthesis of territorial and regional, innovation and industrial, sectoral and intersectoral approaches to spatial organization of production (Fikhtner & Shalmuev, 2012). This feature determines the need for an integrated approach to the study of cluster formations.

## **3. Research Questions**

It seems appropriate to consider the current state of cluster development of the Russian economy at the regional level, its main trends and contradictions.

No less important for the study are the issues of creating innovative clusters, their characteristics and features at the present stage of development.

Isolation and characterization of the attribute properties of the cluster will help to explain the contradictions of cluster development, and a study of the sectoral characteristics of clusters can illustrate the trends in regional economic development.

Special attention should be paid to multiclusters as a special type of clusters.

#### **4. Purpose of the Study**

The aim of the study is to systematize and clarify the attribute properties of innovation clusters, as well as systematization of the main industry trends in the formation of a new production and technology platform based on innovation clusters.

#### **5. Research Methods**

The proposed theoretical and methodological approaches to modeling the development of clusters are based on their attribute properties as a complex economic system, striving to streamline and develop the internal organizational structure by institutionalizing existing socio-economic relationships and developing effective forms of organizing interactions. It should be noted that the clusters are also characterized by the evolutionary nature of the processes of transformation of the institutional environment, due to the cooperation of the organizations participating in the cluster to increase the level of its self-organization as a whole (Kucenko, 2009).

In the course of the study, the cluster is also considered as a special socio-economic system that independently forms the following institutional mechanisms: self-organization and self-regulation of interactions between economic entities, self-development of its participants and self-improvement of the cluster as an integral system. The proposed approach to modelling the clustering processes in the economic space is based on the systemic, evolutionary, structural-functional approaches, it also takes into account the effects of clustering territorial economic systems such as synergy, emergence and supervenience.

#### **6. Findings**

##### **6.1. Universal characteristics of cluster formations**

Inclusion of self-organization mechanisms and self-regulation of relations in the field of management of innovative clusters: flexible adaptation and forward reaction to changes in the external competitive environment, the formation of multi-level networks of structural interaction, the cyclical development of the cluster's institutional environment, the development of new functions and structures of the cluster on the interaction social-economic interactions (Grekova & Fikhtner, 2013). As part of the study, the following universal characteristics of cluster formations were considered: the unity of cluster elements; the combination within the cluster of centripetal and centrifugal forces; vagueness and mobility of cluster formation boundaries; high dynamics of the composition and structure of cluster elements; the cluster has its own element base (Boush, Kulikova, & Shelkov, 2016). It is advisable to dwell on these universal characteristics of cluster formations.

*The unity of cluster elements* represents the similarity of cluster residents based on their combination for mutual distribution of external effects, optimization of access to resources and sources of generation of innovative technologies. At the same time, a distinctive feature of multiclusters allocated as a separate type of clusters is the ability to clearly distinguish large industry segments united by a common

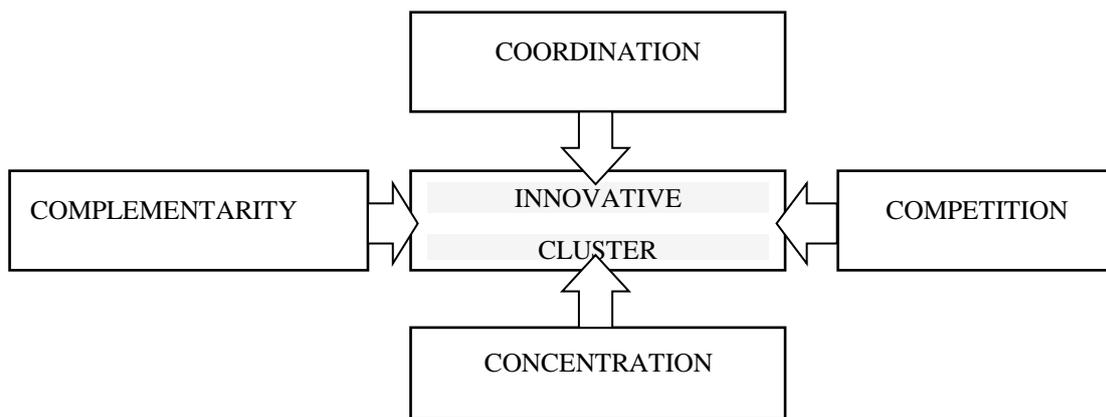
core as an innovation cluster, which is explained by the mutual action of *centripetal* forces providing mutual “attraction” and *centrifugal* forces preventing their merging, which It also differentiates the multicluster from the territorial-industrial complexes.

*The vagueness and mobility of spatial boundaries*, as well as the composition and structure of cluster residents, are due to the gradual integration and interaction of economic entities identified on the basis of identifying priority areas for the economic development of Russian regions that differ in their mixed nature.

*The mobility of the composition and structure of clusters* is also often due to the lack of formal grounds for attributing to the cluster structure of an economic agent, in the first place, small and medium-sized business structures. The relationship between the dynamic nature of the integration of economic agents into the cluster and the possibility of free exit from the cluster structure is determined, which is due to the preservation of economic individuality and independence of economic agents within the cluster. This provision complements such a universal characteristic of cluster formations as the homogeneity of elements due to the independence of economic entities in making management decisions regarding the degree of integration into the cluster structure and exit from it. The own element base, common for all residents of the cluster, includes labor resources, scientific and technological potential, a special institutional environment and channels for disseminating information.

## 6.2. Attributes of innovative cluster

The most significant for building a complex clustering model of the regional economy are the attribute properties of innovative clusters: concentration, coordination, complementarity, competition. The essential content of the category “innovation cluster” is schematically presented in Figure 01.



**Figure 01.** Essential content of the “innovation cluster” category (developed by the authors)

Such a property of a cluster as a *concentration* should be considered not only through spatial localization, but also as the formation by residents of a cluster of a special type of territory, characterized by the environment-forming industry specifics of production and the formation of cultural identity. Consequently, concentration is the basic characteristic of clusters, on the basis of which a complex of economic activities complementary to each other is formed. Cultural identity enhances the

competitiveness of residents of cluster education through the formation of sustainable socio-cultural ties based on the unity of traditions, norms and rules of interaction.

*Complementarity* as an attribute property of clusters is manifested in the following aspects: the formation within the borders of the territory of closed technological cycles; integration within the cluster of suppliers of resources, producers and consumers of goods, works and services. The complementarity of the cluster residents makes it possible to achieve a reduction in transaction costs due to the formation of a common technological platform and resource base of production activities, as well as the implementation of joint innovation projects.

*Coordination* of cluster residents is understood as a set of information flows and network interaction channels. This type of development factors, unlike other traditional resources, is invariant to the material carrier and, depending on the environment, can be transformed under the influence of the evolution of economic systems: from industrial to service and knowledge types of development.

*Competition* implies the existence of a multipolar structure of economic growth within the framework of the internal environment of the cluster, in particular, concentration of large-scale economic entities that are complementary to large enterprises and organizations generating innovative technologies. Competition is the main stimulus for the generation and commercialization of innovative technologies by the residents of the cluster.

The following attribute characteristics of clusters are identified, which, in accordance with the law of unity and struggle of opposites, form contradictions in the process of cluster development, are presented in Table 01.

**Table 01.** Cluster attributive properties that form the contradictions of the cluster development process

<b>The attributive properties of clusters inherent in the traditional interpretation of this economic category</b>	<b>The attribute properties of the cluster, forming the contradictions of the process of cluster development</b>
The formed structure of spatial localization of enterprises and organizations of the cluster in the region, due to infrastructure, logistical advantages, economies of scale and other factors	Plastic adaptability of the spatial boundaries of the cluster, the presence of several circuits of interaction with the external environment (political, investment and financial, technological, personnel, etc.)
Monocentric agglomeration of production around a single cluster core, which is a large production or scientific-educational complex	Polycentric conurbation, which is a complex multicomponent system with intensive production, transport and organizational links
Absorption of external effects of cluster development of the peripheral territory of the cluster, the positive impact of clustering processes on the socio-economic development of the region as a whole	Formation of the core of the cluster and a stable structure of economic relations and relations within the internal environment of the cluster, the occlusive nature of external transactions in adverse economic conditions
Variety of organizational forms and options for the industrial specialization of cluster members within value chains	The need to maintain the complementarity of organizations and enterprises of the cluster, as well as its relative homogeneity with respect to the external environment
Dependence of cluster development on the existing sectoral specialization of the region in the scale of the national economic system	The need to implement an innovative scenario of advanced development of production of a new technological structure in order to ensure competitiveness in international markets
Cooperation of cluster enterprises within the framework of the general infrastructure and institutional environment forming on its territory	Competition between cluster enterprises for common cluster resources, technologies, and infrastructure capabilities
Centralization of functions for managing cluster development processes at specialized cluster management companies	Decentralization of cluster development processes, independent strategies of enterprises and organizations to realize the benefits of participation in the cluster

Note: Developed by the authors

The above general attribute attributes allowed to make a conclusion about the possibility of separating a separate type of clusters, characterized by a more complex multicomponent structure and adjacent sectoral affiliation of economic entities participating in the cluster. Partial removal of the contradictions presented in Table 1 arising in the process of clustering of the economic space is possible within the framework of the formation of innovative multiclusters identified as an independent type of cluster formations. The integration of high-tech industries related to related industries within the innovative multi-cluster takes place around a single technological and manufacturing “core”, which is played by an innovation cluster.

Thus, the development of innovative multi-clusters allows, through more effective implementation of advanced innovative technologies, to intensify the processes of modernizing industrial production and forming a common knowledge environment of the territory based on effective cooperation institutions of state power, high-tech production, science and education.

### 6.3. Sectoral characteristics of innovative cluster

The considered clustering model of the economic space of the Russian regions is based on the dialectic law of denial of denial: the cluster development policy replaces the previous concept of territorial production complexes, but in practice it uses the industrial and infrastructure bases that have developed within it.

This negation of negation forms institutional synthesis, which is one of the conceptual foundations of the cluster formation and development model, developing on the basis of a conglomerate of industry complexes. Within the framework of the author's approach to the development of an integrated clustering model of the economic space of the Russian regions, innovation clusters are considered as a fundamental segment of innovative multi-clusters, the development of which is proposed as one of the areas of differentiation of the strategic economic development of territories with a multi-component economy (Table 02).

**Table 02.** Theoretical model of the phased formation and integration of innovative clusters

Innovative pilot clusters	Clusters of innovative technology and engineering	High-tech Clusters
Clusters of new composite and polymer materials	Clusters of additive technology and digital modeling tools	Heavy and Medium Machine Clusters
Clusters of sensorics and mechatronics	Robotics Clusters	Precision Engineering Clusters
Clusters of quantum communication and cryptography	Clusters of new communication technologies	Personal Security System Clusters
Clusters of new and portable energy sources	Clusters of distributed energy technologies	Energy Efficient Lighting Clusters
Clusters of genomics and synthetic biology	Clusters of biopharmaceuticals and biomedicine technologies	Personal Medicine Clusters
Clusters of nuclear physics research	Clusters of radiation technology	Nuclear Engineering Clusters
Nanotechnology Clusters	Radioelectronic clusters	Clusters of microelectronics and instrument engineering

Photonic clusters	Laser and fiber optic clusters	Industrial and medical equipment clusters
Neurotech Clusters	Clusters of virtual and augmented reality technologies	Clusters of artificial components of consciousness and psyche
Artificial Intelligence and Big Data Clusters	Clusters of unmanned aircraft, unmanned ships, vehicles without a driver	Aerospace clusters, shipbuilding clusters, automotive clusters
Innovative nature management clusters (INMC)	Clusters of environmental protection and restoration technologies	Timber industry clusters and subsoil use clusters
	Agrotechnological clusters	Clusters of personal food production
	Intelligent Water Supply and Drainage Technology Clusters	Drinking water production and purification clusters

Note: Developed by the authors

Innovation and industrial clusters formed during the implementation of state programs can be viewed in the context of the author's model by phased integration into the multicluster of three echelons of clusters, presented in Table 02:

- “Innovative pilot clusters” integrating production based on breakthrough innovative technologies of the following technological order;
- “Clusters of innovative technologies and engineering”, which form the technological basis for the modernization of the economy and initiate multiplicative effects;
- “Clusters of high-tech products”, focused on global markets for goods, works and services.

The debate on the formation of multiclusters and the insufficient development of methods (Kireeva, 2015) and tools for evaluating the effectiveness of cluster development (Achenbach, 2012) as an institutional phenomenon (Stricker & Baruffini, 2017) and the main form of integration of the Russian industry predetermined the need for this study. In modern conditions, the formation and development of clusters is a promising direction for improving the competitiveness of the national economy. At the same time, the problems of practical implementation of the cluster concept of regional development are actualized by the need to forcefully implement the policy of import substitution and increase the output of high-tech products (Liu, 2014). The optimal solution of these problems is possible with the support of the existing territorial-production complexes and individual large enterprises that are not included in the clusters. A key feature of the developed model of the innovation cluster is the possibility of synthesizing the organizational forms of economic development of clusters and territorial production complexes in order to minimize the negative consequences and weak points of the implementation of the traditional cluster concept (Kim, 2014).

An analysis of successful initiatives to form clusters in the Russian regions showed trends in the development of multicluster formations in modern Russian conditions. Clusters that integrate production in related economic activities have become widespread in the Russian Federation, and clusters that integrate traditionally unrelated economic activities are also highlighted. As an example of such clusters, the following can be distinguished: the Pharmaceuticals, Medical Equipment and Information

Technologies ITC, established in the Khabarovsk Territory Aviaostroenie and Shipbuilding, etc. This combination of industries within the cluster projects indicates the desire of the executive authorities RF strengthen potential clusters due to multiplicative and synergistic effects.

## **7. Conclusion**

The development of theoretical and methodological approaches to the spatial modeling of the formation of innovation clusters is based on considering the innovation cluster as a complex meso-economic system with a specific structure of the organizational hierarchy and network horizontal interactions, as well as its own mechanisms for institutionalizing economic interactions. The attribute attributes and features of innovation clusters identified in the course of the research allow consideration of the network interrelations between its participants as fairly equal and mutually beneficial.

It was concluded that the key components for the effective implementation of the formation of innovation clusters are: the “core” of the cluster, which is played by the innovative cluster itself, large high-tech enterprises, which determine the structure of economic relations within the industry segments of the cluster. The interrelation of individual industry segments of the innovation cluster is provided by optimizing the flow of economic, social and information resources within the overall internal environment.

At the same time, the complex structure of the innovation multi-cluster is due to the presence of two levels of organizational and economic interactions. The basic (sectoral) level of multi-cluster education forms economic relations and interrelations within the framework of adjacent industry segments of the multi-cluster. The second (cluster) level of multi-cluster education forms interconnections between industry segments of a multi-cluster based on economic transactions and the creation of value chains by enterprises and organizations belonging to adjacent industry segments.

The position on the relevance for the modern conditions of the Russian economy to the developed model of the formation of innovative clusters as the optimal form of using the resources of the territory, the complex modernization of industry and the production of high-tech products in demand in the domestic and foreign markets has been substantiated. At the same time, it was noted that in the conditions of the innovation paradigm of economic growth, enterprises that are members of an innovation cluster can effectively compete in global technology and innovation markets only if the clustering processes of the territory’s economic system are provided with the appropriate theoretical and methodological support. As a result, for the subsequent stages of the research, the scientific task is set to consider the methodological approaches to the development of an integrated model for the formation and development of innovation clusters in an essential and meaningful way. Please replace this text with context of your paper.

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