Artículo de investigación

Clusters classification in the modern innovation economy

Классификация кластеров в современной инновационной экономике
Clasificación de los clústers en la economía moderna de la innovación
Classificação dos clusters na moderna economia da inovação

Recibido: 13 de abril de 2019. Aceptado: 25 de mayo de 2019

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Abstract

The purpose of this study is to research the essence and classification of clusters in a modern innovative economy. The clusters are becoming one of the most effective forms of integrating financial and intellectual capital in the modern economy, providing the necessary competitive advantages and solving problems in the field of modernization and innovative development of the industry around the world. They are aimed at the development of the innovation component of industries, their investment attractiveness, the creation of new high-tech industries and the training of highly skilled labor.

Keywords: cluster classification, competitiveness, industrial policy of the Russian Federation, industrial cluster, innovative development, innovative orientation, state innovation policy.

Аннотация

Целью данного исследования является исследование сущности и классификации кластеров в современной инновационной экономике. В современной экономике кластеры становятся одной из наиболее эффективных форм интеграции финансового и интеллектуального капитала, обеспечивающей необходимые конкурентные преимущества и решающей задачи в области модернизации и инновационного развития промышленности во всем мире. Они направлены на развитие инновационной составляющей отраслей промышленности, их инвестиционной привлекательности, создание новых высокотехнологичных отраслей и обучение высококвалифицированной рабочей силы.

Ключевые слова: государственная инновационная политика, инновационная ориентированность, инновационное развитие, классификация кластеров, конкурентоспособность, промышленный кластер, промышленная политика РФ.

Resumo

O objetivo deste estudo é o de investigar a essência e a classificação de cluster moderna de inovação da economia. Na economia atual, os clusters se tornando uma das formas mais eficazes de integração financeira e do capital intelectual, que garante a vantagem competitiva necessária e decisiva tarefa de modernização e de inovação e desenvolvimento da indústria em todo o mundo. Eles são direcionados para

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o desenvolvimento da inovação de uma componente de indústrias, a sua capacidade de atracção de investimento, a criação de novas indústrias de alta tecnologia e de formação de-obra altamente qualificada.

Palavras-chave: classificação de conglomerados, cluster industrial, competitividade, desenvolvimento inovador, orientação inovadora, política industrial da Federação da Rússia, política de inovação do estado.

Resumen

El objetivo de este estudio es investigar la esencia y la clasificación de los clústers en la economía innovadora moderna. En la economía contemporánea, los clústers se están convirtiendo en una de las formas más eficaces de integrar el capital financiero e intelectual, proporcionando las ventajas competitivas necesarias y los desafíos cruciales para la modernización y el desarrollo innovador de la industria en todo el mundo. Estos tienen como objetivo desarrollar el componente innovador de la industria, su atractivo de inversión, la creación de nuevas industrias de alta tecnología y la formación de una fuerza de trabajo altamente especializada.

Palabras clave: clasificación de conglomerados, clúster industrial, competitividad, desarrollo innovador, orientación innovadora, política industrial de la Federación de Rusia, política de innovación estatal.

Introduction

The clusters are widely used to solve problems in the field of modernization and innovative development of industry around the world. They are aimed at the development of the innovation component of industries, their investment attractiveness, the creation of new high-tech industries and the training of highly skilled labor. The use of clusters is a global and fairly well-known practice in solving such problems.

Today, the main source of sustainable economic growth is the country's highest level of competitiveness in world markets. Since at present, the success of the country is increasingly conditioned by the renewal of technologies, the development of new market niches and organizational innovations, the basis for improving the competitiveness of the state is high innovative activity of the business.

Innovative orientation is an important feature of the cluster (Mindlin, Novikov, Kireev, Adamenko & Belitskaya, 2016). The most successful clusters are formed where a "breakthrough" in the field of engineering and production technology is taking place or is expected with the subsequent entry into new "market niches". In this regard, many countries, both economically developed and just starting to form a market economy, are increasingly using the cluster approach in the formation and regulation of their national innovation programs (Lizunov, 2012).

Methodology

The issues of innovation development are relevant today for Russia more than ever. This topic is in the constant focus of attention of the political leadership of the country. The implementation of state innovation policy will significantly affect how and at what rate Russia will move from countries "catching up" to the category of countries which are global innovation leaders, at least in several positions capable of generating substantial and sustainable revenues from high-tech exports. Russia is facing a challenge related to strengthening the role of innovations in social and economic development (Novikov & Veas Iniesta, 2018).

In accordance with the objectives of the study, the following tasks were identified and solved:

- the essence and concept of clusters, their role and place in the modern organization of production;
- features of industry development in the Russian regions and problems of formation of industrial clusters;
- methods of formation of industrial clusters;
- the principles of formation of clusters in the domestic industry;
- development and application of cluster approaches to formation of innovative economy of the Russian Federation.

The share of organizations in the industry implementing technological innovations has remained almost unchanged for five years. It

amounts to 9.2–9.7%, which indicates a low innovation potential of the economy and an insufficient rate of its development, according to the Institute of Statistical Studies and Knowledge Economics, the department of Higher School of Economics (Berezina, 2018).

The technological innovations in Russia were used by 9.6% of the industrial enterprises in 2017. Russia remains on the 28th place in the ranking of European countries, where similar surveys are conducted, ahead of only Romania (6.4%). In Germany, the figure is 58.9%, in Finland is 52, in France is 46.5, in Great Britain is 45.7 and in Denmark is 39.4. In other sectors in Russia, innovation is also used a little: 8% of telecommunication and IT companies and 3.1% of agricultural enterprises (Berezina, 2018).

There is a lag in the development and testing of innovations is due to the low level of commercialization of scientific research in the opinion of experts. Universities do research at their own discretion, and companies introduce new technologies, focusing on their own needs. The links between science and business are still extremely weak. The formation of multi-sectoral clusters can strengthen them by the intentions of the authorities.

The development and application of cluster approaches to the formation of an innovative economy in the Russian Federation has been used for a long time. However, it was not systematized and did not have a sufficient methodological basis. At the state level, this problem was addressed in 2008 with the adoption of the Concept for the long-term socio-economic development of the Russian Federation for the period up to 2020. In the above Concept, one of the key conditions for modernizing the economy and realizing the competitive potential of the Russian regions is the formation of clusters focused on high-tech businesses in priority sectors and on the processing of raw materials and energy production using modern technologies (Pinkovtskaia, Balynin, Arbeláez Campillo & Rojas-Bahamón, 2019).

Further development and support of the clusters at the state level continued with the adoption in 2011 of the Russian innovation development strategy for the period up to 2020. This document assumes that the formation of the territories of innovative development and innovation clusters will contribute to the intensification of innovative activities (Novikov, 2018).

The definition of an industrial cluster and the possibility of applying incentives for its activities was enshrined in the adopted Federal Law “On Industrial Policy in the Russian Federation” in 2014. The condition for providing support is the creation of a specialized organization that accompanies the development of the cluster, as well as confirmation of its compliance with the requirements established by the Government of the Russian Federation.

In development of the Federal Law (FL) of December 31, 2014 No. 488-FL “On Industrial Policy in the Russian Federation” by the Decree of the Government of the Russian Federation of July 31, 2015 No. 779 (as amended by the Decree of the Government of the Russian Federation of September 26, 2016 No. 963) “On Industrial Clusters and Specialized Organizations of Industrial Clusters” approved the requirements for industrial clusters and specialized organizations of the industrial clusters in order to apply to them incentive measures in the industry and the Rules confirming compliance with the industrial cluster and industrial cluster specialized organization requirements to industrial clusters and specialized organizations of industrial clusters with a view to applying to them the measures to stimulate activity in the industry.

The Ministry of Economic Development switched to supporting cluster initiatives based on the project management principles by launching the priority project “Developing Innovation Clusters — Leaders of World-Level Investment Attractiveness” in 2016. Its main goals are to create advanced growth points, innovative development, and export high-tech products and technology commercialization, increased labor productivity and the creation of high-performance jobs, increasing the country's competitiveness. The new initiative considers the experience of the pilot innovation cluster support program, with an emphasis on a number of priority areas. They include the following:

- a formation of the cluster management system based on modern experience and high quality of human resources (Nedelkin, Novikov, Titov, Sannikov, Mikhailova & Popova 2017), in particular, training of regional leadership teams for the development of cluster leaders;
- an assistance in access to the existing forms of support for the development of territories, including budgetary instruments and development

institutions, the use of the status of a special economic zone and a territory of advanced socio-economic development;
- an assistance in integrating territories into development programs for suppliers of large companies with state participation;
- a support for entering foreign markets, including export promotion, attracting investment and facilitating cooperation with foreign partners.

The priority project of the Ministry of Economic Development of Russia suggests focusing efforts of the innovation clusters on achieving the global leadership in the investment attractiveness positions. On this basis, the effectiveness of their functioning is determined primarily by the volume of attracted investments from extrabudgetary sources. This figure amounted to 163.9 billion rubles in 2016 according to the data presented in the agreements to support the development of innovative clusters concluded by the Ministry of Economic Development of Russia and the highest executive bodies of state power of the constituent entities of the Russian Federation. It is expected to grow by 69% by 2020.

The following cluster classification features are suggested in accordance with the system approach (Novikov, 2018):

- The degree of homogeneity (concentration on the main business). The boundaries of classification by this criterion are a branch cluster in which all enterprises have a similar main business, and an inter-branch cluster in which enterprises of different industries are combined.
- Degree of connectivity. The borders are a group of interacting enterprises that make up a single technological chain, which has a single governing body, and a group of competing companies (Zolotukhina, Bakharev, Kapustina, Novikov & Lygina, 2017).
- The participation degree of the innovation generation centers. The borders are the cluster is formed on the basis of research centers and universities, and innovation generation centers belong to individual enterprises, and innovation generation centers are absent.
- Degree of maturity. There are emerging clusters, formed (mature) clusters, clusters in the stage of decay (crisis).
- Degree of importance (cluster scale). There are regional, national and transnational cluster.

- Three main types of clusters differ in the directions of their connections (Kanashchenkov, Matveev, Minaev & Novikov, 2017):

- clusters with a regionally limited form of economic activity within related sectors, usually tied to one or another scientific institution (research institutes, universities, etc.);
- clusters with vertical production relations in narrow areas of activity, formed around the head companies or a network of main enterprises, covering the processes of production, supply and marketing;
- industry clusters in various types of production with a high level of aggregation (for example, a “chemical cluster”) or at an even higher level of aggregation (for example, an “aerospace cluster”).

We can make a classification of clusters based on the study of Western economists works, identifying the main types of innovative regions on the basis of a number of technical and economic parameters. The main characteristic of these regions is that certain types of companies are located in relative proximity to each other, i.e. they constitute the integration economic clusters or territorial clusters, the most common is the model of a regional production network, within which there are three types of clusters (Table 1).

Table 1. The cluster types according to the regional production network model

Cluster Type	Description	Characteristic
Type A	Linked clusters	The oldest type of cluster is a group of companies that were initially located close to each other in order to reduce costs.

Type B	New industrial areas (usually knowledge-intensive)	This type of cluster is characterized by high-tech companies such as computer manufacturing, information technology, and microelements.
Type C	Innovation environment	The basis is research groups. The social connections are established both between individual participants working in the same company, and between employees of different companies in the innovation environment.

In addition, there is an approach according to which clusters are fundamentally divided into industrial (based on functional communication) and regional (based on spatial communication).

The Organization for Economic Cooperation and Development (OECD) uses an approach based on the industrial scope of the cluster. Accordingly, there are three levels:

- the national (or regional) economy as a whole, which explores the relationship between sectors or integrated sectors;
- the level of industries and sub-sectors where inter-industry and intra-industry relations are explored;
- the firms are considered together with supplier networks, i.e. interfirm relationships are explored.

The researchers define the essence of cluster unions differently. Some distinguish geographic concentration as the main characteristic of a cluster, the second emphasize industry affiliation and the third single out innovative orientation. It is innovative orientation that becomes the main characteristic of modern clusters, since it determines their competitiveness in our opinion.

The main attention is paid to the principles of the managing mechanism formation of a small enterprises cluster in the work of Berezova A.T. (Berezova, 2012). The author highlights the principles shown in the Table 2.

Table 2. The formation principles of the managing mechanism formation of a small enterprises cluster

Item number	Principle	Characteristic
1	The principle of independence and cooperation	The cluster members within its framework retain their freedom and independence in their activities. At the same time, they can transfer to the general regulation level the resolution of issues number on the coordination of activities.
2	Principle of competition	The enterprises that are part of a cluster compete both with subjects of the external environment and among themselves within the cluster.
3	The principle of free entry and exit	Any cluster enterprise may withdraw from its structure or enter on its own initiative, subject to certain rules established in the cluster.
4	Principle of responsibility	The enterprises undertake to interact with other cluster members, while maintaining legal, commercial and industrial-technological independence. In addition, the cluster members should support the development of the industry by attracting new ideas for the implementation of internal projects, by attracting new partners offering more efficient solutions to internal problems.
5	Principle of complementarity	Combining the resources of cluster members should ensure the implementation of a synergistic effect.
6	Principle of awareness	Available technologies within the cluster, innovative developments can be available to all cluster members.

A number of cluster formation principles are also presented in the work of Marchenko E.V. (Marchenko, 2011):

- territorial and sectoral isolation;
- voluntary partnership of enterprises with preservation of competition within the cluster;
- the organization of high-tech production within the cluster;
- focus on the compact placement organization of the entire production cycle.

Drozdova N.V. also cites the fundamental principles of the cluster's construction, which are presented in the Table 3 (Drozdova, 2011).

Table 3. The fundamental principles of the cluster construction

Principle	Content
Self-organization	1. Historical background of the cluster development 2. Structural and functional commonality of the cluster enterprises 3. Strengthening the relationship of enterprises in the cluster 4. Creating conditions for the development and formation of the cluster
Intracluster cooperation and competition	1. Competition between enterprises 2. Cooperation in entering the foreign market 3. Efficiency and development of own economic activity 4. Stimulating innovation processes
Relationship based on common economic interests	1. Dependence of participants on the success of each other 2. Increasing the level of business innovation 3. Preservation of autonomy and cohesion of cluster members 4. Coordination in the resolution of disputes and decision-making, the establishment of external relations
Corporativity	1. Culture of communication between the participants, the presence of a climate of trust 2. Reciprocity and good neighborliness, a unified system of values, patterns of behavior, ways of evaluating results, mutual control in resolving conflict situations 3. The possibility of sharing information, experience, co-education 4. Simplification of the interaction structure, cost reduction 5. Fulfillment of obligations to partners, the reputation of enterprises and the entire cluster as a whole.
Long-term cooperation	1. Maintaining relationships 2. Regular, long-term guaranteed supply and quality of services 3. Access to information, resources, participants awareness 4. Interaction to achieve and maintain competitive advantage
Partial lead	1. The presence of a "center" of attraction (structure-forming leading enterprises) 2. The dominant factor is concentration around large leading industrial enterprises and scientific centers. 3. The manifestation of the activity of the "center" and the attraction of "peripheral" enterprises
Dynamism (flexibility)	1. Constant "movement" of the cluster, i.e. continuous processes of formation, development and decay 2. Adaptation to the ever-changing demands of the market environment 3. The emergence of new industries, expanding the range of products 4. Increasing the level of innovative production
Comprehensive use of resources	1. The unification of participants in the framework of a single unbroken technological chain, integration and technological interconnection, a single technological approach, standards 2. The production sequence, participants are suppliers and consumers of services to each other 3. Orientation to requests of the end consumer, expansion of the range

	4. Improving business processes and management skills
Outsourcing specialization	1. Delegation of responsibility, fragmentation of business functions 2. Transfer of auxiliary operations under contract to contractors, cost reduction and resource savings 3. Formation of new unique abilities, the ability to access the best global manufacturing technologies

Rulinskaya A.G. considers the creation and development prospects of clusters in the region from the point of view of the following principles: general, which are common to all types and types of clusters, regardless of their sectoral focus, and special ones, which consider the sectoral focus of a real or emerging cluster (Rulinskaya, 2010).

General principles of the cluster's formation for the author are the following:

- the geographical location of the region;
- administrative and territorial structure of the region;
- features of nature and the natural resource base of the region, their influence on the living conditions of the population;
- population composition, demographic and ethnocultural features;
- features of the regional economy (that is, the main factors for the development of industries, problems of the region and ways to solve them).

Klimova T.B. believes that territorial clustering is based on the following principles: the presence of geographical proximity; the inclusion of private and state-owned business and non-business enterprises (Klimova & Bondareva, 2011)

Trofimova O.M. identifies the following principles of cluster formation in Russia (Trofimova, 2011):

- vertical integration of enterprises as a part of the cluster;
- the close cooperation relations, replacing competitive relations and increasing the synergistic level of the cluster;
- unified production and social infrastructure of the cluster;
- the clear specialization in the country and at the level of the economic region, a pronounced sectoral specialization;
- territorial concentration in a limited area with the necessary range and size of resources;
- high innovative activity due to cooperation with leading universities in the region, the availability of scientific institutions in the cluster.

Results and discussion

Porter M. is considered to be the founder of the modern concept of clusters and their influence on the formation of competitive advantages. Methodological and organizational-economic problems of formation and development of industrial clusters in foreign science are also considered in the works of Enright M., Ketels K., Brown R. and other scientists. Tatarkin A. I., Vinokurova M. V., Kibitkin A. I., Markova L.S., Lozinsky S. V., Lavrikova Yu. G., Berezova A. T., Marchenko E. V., Drozdova N. V., Rulinskaya A. G., Klimova T. B., Trofimova O. M. etc. were talking about the problems of clustering among Russian researchers. In recent years, domestic scientific literature marked the transition from addressing the problems of development of industrial clusters from a macro position to the development of constructive solutions to the clustering. It is important to determine how is the formation of industrial clusters in Russia.

However, the specific features of the industrial cluster, its large-scale characteristics and the required minimum composition have not yet been clearly defined in the domestic scientific literature. There is a lack of development of methods for the formation of industrial clusters. The questions of their classification, content and sequence of implementation activities for the creation of clusters remain controversial. This also applies to organizational and economic mechanisms and tools for managing the development of industrial clusters.

There are different definitions of cluster in the Table 4.

Table 4. Definitions of clusters

Author	Source	Definition
Porter	Competitive advantages of nations	Industrial cluster is a number of industries linked through buyer-supplier or supplier-buyer or through common technologies, common procurement, distribution channels or common labor associations
Smits	Clustering of small companies	Cluster is a group of enterprises belonging to the same sector and operating in close proximity to each other
Swan, Prevezer	Comparison of industrial speakers' clusters in the computer and biotechnology industries	Clusters are groups of companies within the same industry in the same geographical area
Enright	Regional clusters and economic development	Regional clusters are industrial clusters in which companies-members are in close proximity to each other
Rosenfeld	Moving business clusters to the basis of economic development	A cluster is a concentration of companies that are able to produce synergies because of their geographical proximity and interdependence, even though their employment scale may not be clear or visible
Porter	Competition	A cluster is a geographically close group of related companies and interacting institutions in a specific area, connected by communities and complementarities
Feser	Past and new theories of industrial clusters	Economic clusters are not only related and supportive industries and institutions, but related and supportive institutions that are more competitive based on their interconnections
Swan, Prevezer	The dynamics of industrial clustering	Cluster means a large group of companies in related industries in a particular locality
Elsner	Industrial policy project	Cluster is a group of companies that are functionally connected both vertically and horizontally. The functional approach emphasizes the quality of the existing relationships between companies and institutions supporting the cluster, and such relationships are determined through the market
Steiner, Hartman	The study of clusters	Cluster is a set of complementary firms (in the production or service sectors) from public, private and semi-public research and development institutions that are linked by labor market and/or input — output linkages and/or technological linkages
Roeland, Hertag	Cluster analysis in countries of Organisation for Economic Co-operation and Development (OECD)	Clusters can be described as networks of producers of highly interdependent companies (including specialized suppliers) connected to each other in a value chain of production
Simi, Sannet	Innovation in the metropolitan area	We define an innovation cluster as a large number of related industrial and/or service companies with a high level of cooperation, typically through a supply chain, and operating under the same market conditions
Bergman, Feser	Industrial and regional clusters	Industrial clusters can be defined in the most General terms as a group of commercial enterprises and non-profit organizations for which membership in the group is an important element of the individual competitiveness of each member of the firm. A cluster is linked together by sales

		transactions or common technologies, common buyers or distribution channels, or labor unions
Bergman , Feser	Industrial and regional clusters	Regional clusters are industrial clusters that are concentrated geographically, usually within a region that forms the Metropolitan area, labor market and other functional economic units
Egan	Toronto's competitiveness	A cluster is a form of industrial organization that depends on networks of highly specialized, interconnected private sector companies and public sector institutions whose final products penetrate markets beyond the central (metropolitan) region
Crauch, Farrell	UK: falling through "holes" in the network concept	The more general concept of the cluster suggests the tendency for companies of this type of business to be located close to each other, although without having a particularly important presence in the area
Vanden Berg, Brown, Vanwin-dan	Growing clusters in European cities	The popular term cluster is most closely related to the local or regional scope of networks. Most definitions share the concept of clusters as localized networks of specialized organizations whose production processes are closely linked through the exchange of goods, services and/or knowledge
OECD	World Congress on local clusters, regional clusters of Europe	Regional clusters refer to geographically bounded concentrations of interdependent companies and can be used as a keyword for older concepts like industrial districts, specialized industrial agglomerations and local production systems
Anderso n	Cluster policy	Clustering is generally defined as the process of co-location of companies and other actors within a concentrated geographic area, co-operation around a specific functional niche and the establishment of close relationships and working alliances to enhance their collective competitiveness

The analysis allowed us to identify the following main methods of formation of industrial clusters (Table. 5).

Table 5. Methods of formation of industrial clusters

Methods of forming	Essence of the method
The analytical method of creation of regional territorial and industrial clusters	Study of data on the territory, its natural, labor and financial resources of productive forces
Method of indicative planning of competitiveness	Quantitative and qualitative analyses of existing competitiveness and definition of its prospective
Modeling method	Study of cluster objects by building and studying models of real-life organizations, processes or phenomena
¨Input-output¨ method	Study of the circulation of goods and services between industries and other sectors of the economy

The algorithm of industrial cluster formation is shown in the Figure 1. It includes the following elements:

- assessment of the potential of the cluster;
- definition of goals, objectives, targets for the creation of the cluster.

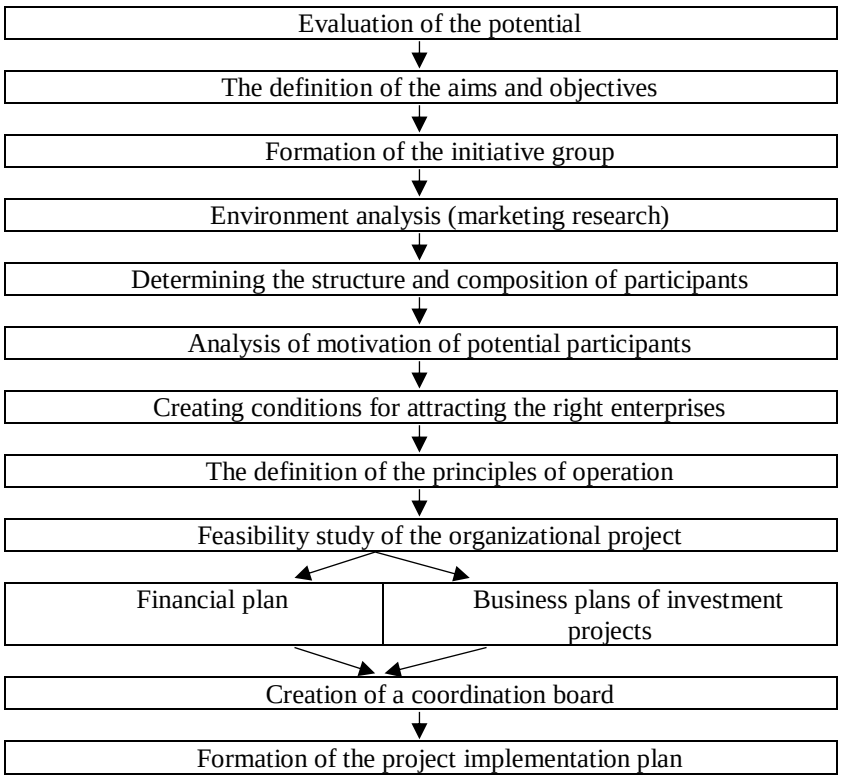

Figure 1. Algorithm of industrial cluster formation in the región

Conclusions

The development and application of cluster approaches to the formation of an innovative economy in the Russian Federation has been used for a long time. However, it was not systematized and did not have a sufficient methodological basis. Researchers define the essence of cluster unions differently. Some distinguish geographic concentration as the main characteristic of a cluster, others by industry, and others by innovation orientation. In our opinion, it is innovative orientation that becomes the main characteristic of modern clusters, since it determines their competitiveness.

An important element in the formation of the cluster structures is the determination of the principles of their construction. The main ones include: vertical integration of enterprises, the existence of close cooperation relations, a unified production and social infrastructure, the presence of clear specialization, territorial concentration and high innovative activity.

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