

Cluster initiatives in bioeconomy: systemic features of formation, development and management

Seda Aslakhanova^{1,*}, *Shardan Saida*², and *Amadey Ansel*³

¹ Kadyrov Chechen State University, Grozny, Russia

² North Caucasus State Academy, Cherkessk, Russia

³ Complex Research Institute named after Kh. I. Ibragimov Russian Academy of Sciences, Grozny, Russia

Abstract. The expansion of the bioeconomy is driven by integration strategies that come in various forms. Natural integration is characterized by businesses combining forces and establishing diverse organizational interactions such as conglomerates, multinational corporations, cartels, and other structures. Conversely, disintegration and quasi-integration lead to the disaggregation of businesses and the formation of more formal associations, often with the aim of obtaining control rather than ownership of these business entities. An illustrative example of quasi-integration is the concept of enterprise clusters, which represent a collective of geographically connected and interrelated companies sharing common objectives and strategies. While the benefits of companies participating in these clusters were apparent at the end of the 20th century, it is increasingly evident in the early 21st century that the ways companies interact within these clusters are evolving into new hybrid forms, and the clusters themselves can undergo various transformations in a relatively short period.

1 Introduction

The concept of the bioeconomy is widely recognized as a promising approach to preserving the Earth's energy resources [1]. It encompasses key principles such as the development of alternative energy sources, enhanced energy efficiency, effective waste utilization, the advancement of renewable energy from biomass, the implementation of eco-friendly practices in industry, improved sustainability in agriculture, the creation of novel food products, advancements in medical technologies, and the utilization of biotechnologies based on renewable biological resources. The roots of bioeconomy development in Russia can be traced back to the establishment of the State Scientific Center for Virology and Biotechnology "Vector" in the Novosibirsk region in 1974. Over time, this scientific center evolved into the All-Union Scientific Research Institute of Molecular Biology, which has

*Corresponding author: zvezdochkagoodluck@mail.ru

now transformed into the Scientific and Production Cluster "Siberian Science City." The active participation of clusters in the bioeconomy aligns with the contemporary perspective on clusters as a promising means of fostering collaboration among enterprises to enhance regional competitiveness [2].

In Russia, the formation of clusters has been ongoing since 2005-2007, prompted by various objective factors [3]. The Ministry of Economic Development of the Russian Federation, as the principal facilitator of the cluster formation process, initiated the creation of regulatory and legislative documents regarding cluster policy. Additionally, it provided administrative and organizational support for clusters in securing state funding. Cluster policy, comprising a series of state measures to support clusters, is complemented by cluster initiatives, which originate from the potential or existing cluster participants seeking partners, investors, and buyers for cluster products. Cluster initiatives are highly valuable as they are grassroots efforts, always relevant, timely, and based on a deep understanding of the initiative's subject matter. Foreign researchers have identified the primary objectives of cluster initiatives as establishing communication networks within the cluster and among firms involved, fostering innovation, building a regional brand, and supporting business communities. While Russian studies in this area may be somewhat lacking, an analysis of Russian cluster practices suggests that the weaknesses of cluster initiatives often stem from the absence of specialized knowledge possessed by potential resource providers, such as investors, government agencies, and buyers [4].

The primary instrument for state support of cluster development in terms of finances is state programs, encompassing federal and regional state programs, as well as departmental target programs. Notably, technological platforms are highlighted as modern and innovative programs for economic development.

2 Research methodology

The "Comprehensive State Program for the Development of Biotechnology in the Russian Federation for the Period until 2030" aims to establish a globally competitive bioeconomy sector in Russia, alongside the nanoindustry and information technology. The program sets ambitious targets for the bioeconomy's contribution to the country's GDP, with a goal of reaching approximately 1% by 2030 and at least 3% by 2030. The development of this program occurred within the Biotech2030 technology platform, which emphasizes various priorities, including biomedicine and biopharmaceuticals, industrial biotechnology and bioenergy, agricultural and food biotechnology, forestry biotechnology, environmental biotechnology, and aquatic resource biotechnology. These areas of research and development are pursued through a comprehensive set of activities that involve R&D, logistics, human resources, information, regulatory, and economic support.

The activities of several bioeconomic clusters in Russia were analyzed based on materials available on the internet. The following bioeconomic clusters were examined:

1. Kaluga cluster of pharmaceuticals, biomedicine, and biotechnology.
2. Cluster of medical, environmental instrument making, and biotechnology in St. Petersburg.
3. Agrobiotechnological industrial cluster of the Omsk region.
4. Biotechnological innovative territorial cluster of Pushchino, Moscow region.
5. Biopharmaceuticals Cluster in the Belgorod region.
6. Biotechnology Cluster of the Rostov Region (Cluster for advanced grain processing in the Millerovsky district).
7. Cluster of medical, pharmaceutical industry, radiation technologies of St. Petersburg.
8. Altai biopharmaceutical cluster.

9. Innovative cluster of information and biopharmaceutical technologies of the Novosibirsk region.

10. Baikal pharmaceutical cluster of the Irkutsk region.

The establishment of bioeconomy clusters in Russia occurred from 2008 (Altai biopharmaceutical cluster) to 2015 (Cluster for advanced grain processing in the Rostov region). These clusters involve a varying number of participating companies, ranging from 10 to 63, with the number of employees in the clusters ranging from 2,133 to 10,500 individuals. Notably, seven out of ten clusters are at an initial stage of development, while the remaining three are at an average level of development. Among these clusters, the Kaluga cluster of pharmaceuticals, biomedicine, and biotechnology stands out as one of the most successful, demonstrating significant progress in the regional industry and the domestic pharmaceutical market. It has received international recognition, earning a silver "Cluster Excellence" certificate from the European Secretariat for Cluster Analysis (ESCA), which evaluates the cluster's management system and its core activities using 30 indicators based on the assessment methodology of the European Cluster Excellence Initiative.

The research methodology relies on the existing body of scientific work by both foreign and domestic scholars in the field of the cluster approach. The findings of this research are generated through the application of empirical and dialectical methods of scientific inquiry, as well as other scientific methods. The methodological tools employed encompass various approaches to information processing, including historical analysis, the analysis and diagnosis of cluster approach implementation, the comparative method, and modeling.

3 Results and Discussions

The cluster approach is recognized as one of the strategic foundations for enhancing the competitiveness of regions in the modern economy. Michael Porter is considered the founder of the cluster approach in economic science [5]. He defined a cluster as a complex network of interconnected and complementary organizations located within the same geographical area. Clusters are seen as a means to reduce logistics costs, enhance access to resources, and improve the quality of services and support services. This theory has been widely embraced by various scientists who further expanded on its principles.

In practical terms, the clustering process is approached from two main perspectives:

1. **Market Initiation:** In this approach, private enterprises gradually strengthen their relationships with one another based on cooperation over time.

2. **Initiation by Authorities:** In this case, the government or regional authorities play a proactive role in forming clusters.

Common participants in clusters include specialized manufacturing enterprises, public infrastructure organizations (e.g., energy, transport, communication, and environmental sectors), market infrastructure organizations (insurance, leasing, finance, consulting, trading, etc.), organizations of innovation infrastructure (e.g., technology parks, business incubators, venture funds, and investment attraction centers), business infrastructure organizations (business development centers, credit assistance funds, investment funds, etc.), educational and scientific sector organizations (universities, research institutes, colleges, professional training and retraining centers), as well as public organizations and non-profit organizations (NPOs).

Regional clusters exhibit several key characteristics, including geographic proximity, specialization of activities, a diverse range of participants, a blend of competition and cooperation, shared economic interests, and an orientation toward innovation.

According to the Global Innovation Index (GII) 2022, Russia ranks 54th out of 132 countries in terms of cluster development. Notably, one cluster in Moscow is included in

the list of the top 100 largest scientific and technical clusters, with China, the USA, and Germany leading the ranking [7].

The lag in Russia's cluster development can be attributed to the fact that this field is relatively new. For example, over 75% of clusters in Russia were established after 2011, and many of them are still in the early stages of development. The first cluster was created in 1999 in St. Petersburg, followed by a decade with no new clusters formed. This illustrates the evolving nature of cluster development in the country.

The majority of clusters in Russia are concentrated in the Central Federal District, although only two of them have achieved a high level of development in this district. In contrast, the Volga Federal District boasts five clusters with a high level of development. Overall, the level of cluster development in regions across six federal districts in Russia exceeds 50%, with the Southern Federal District, Far Eastern Federal District, and North Caucasus Federal District lagging behind, not having registered a single cluster. Moreover, there's a distinct preponderance of entry-level clusters, constituting 73.2% of the total, while clusters at an average level of development make up 18.4%, and high-level clusters represent only 8.4%. The number of participants in regional clusters ranges from 10 to 227. However, it's important to note that the number of participants does not significantly impact the level of organization. For example, an entry-level cluster, the Innovative Territorial Cluster of Nuclear Physics Technologies in Dubna, includes 80 entities, whereas one of the highly developed clusters, the pharmaceutical cluster in the Kaluga region, comprises 54 subjects [6]. The number of employees in these clusters varies from 21 to 151,561 individuals, and there's a moderate correlation between the number of entities and the number of employees with an average value of 0.564.

Additionally, many clusters are confined to a single subject of the Russian Federation, with the formation of interregional clusters being relatively rare. Interregional clusters include a lifting equipment cluster in the Sverdlovsk region and Chelyabinsk region, an Innovative Territorial Electrotechnical Cluster of the Chuvash Republic, and the FarmDolina cluster spanning the Krasnodar region, Moscow region, and Moscow. Thus, the predominant trend is the formation of clusters within individual regions, while interregional and national clusters have received less attention.

Given the uneven development of regions and its impact on cluster policy effectiveness and innovation activity, the sectoral factor of clustering is being considered as a way to mitigate these regional disparities. This transformation in the cluster approach involves the creation of national clusters based on sectoral orientation, which are not limited to the territorial boundaries of a single region [8].

Examining the management of clusters directly reveals that as the number of participants in any system association increases, the area of their integrativeness decreases. This phenomenon naturally arises from the analysis of complex polymorphic systems' formation. An increased number of participants in such complex polymorphic formations leads to system instability, especially when the subjects have dominant interests outside the integrative zone. This imposes strict requirements on the participants in clustering processes: either the participants must have dominant interests within or very close to the integrative area, or the entities involved in clustering must identify specific components (such as divisions or structures) with a heightened interest in the clustering type [9]. These components should be granted a significant degree of autonomy to allow them to fully align with the internal functional connections of a particular cluster association. This requirement is crucial to ensure the seamless alignment of participants' strategic interests with the cluster's overarching strategic objectives and to foster a high level of trust among participants.

The creation of clusters in Russia is typically driven by the initiative of federal or regional authorities, representing a "top-down" approach to cluster development, often

accompanied by directive cluster policies. These clusters are primarily financed through federal and regional budget allocations in the form of target programs, such as federal target programs (FTPs) or regional target programs (RCPs) [10]. However, concerns have been raised by the professional community and citizens regarding the results of inspections conducted by the Accounts Chamber of the Russian Federation regarding the implementation of the Federal Target Program "Development of Domestic and Inbound Tourism."

For example, the Federal Target Program aimed to create 53 tourism clusters in 39 regions of Russia by the end of 2018, with a total expenditure of 31.5 billion rubles from 2015 to 2017. These funds included 9.2 billion rubles from the federal budget (29.2% of the total), 2.5 billion rubles from the consolidated budgets of the regions (7.9%), and 19.8 billion rubles from extra-budgetary sources (62.9%). However, by October 1, 2017, only two out of 44 tourist and recreational clusters had been fully established and completed. This analysis demonstrates the existing problems in cluster development.

The most active period for the development of cluster initiatives in Europe was during the early 21st century. During this time, comprehensive cluster policies were established at both national and regional levels, as well as within individual cluster associations. An important distinction between the development of cluster initiatives in Europe compared to Russia was that in most European countries and regions, robust innovation infrastructures had already matured by this time, and a significant number of small and medium-sized enterprises with a focus on innovation had emerged. This created favorable conditions for the organic growth of cluster initiatives from the bottom-up, as participants naturally sought to strengthen their positions in the market [11].

In documents related to the regional development of various areas in Russia today, you can find two approaches to cluster initiative development. The first approach involves clusters developing independently as separate systems within a regional agglomeration, without strong integration into the larger regional innovation system. The second approach sees clusters as a natural outgrowth of the regional innovation system, becoming integral components and fairly independent subsystems. It's essential to recognize that these two approaches differ significantly in terms of the logic and methods for constructing systems. However, those responsible for developing documents that regulate regional development may not always see this difference as a fundamental issue. Nevertheless, it's important to note that during the formation stage, if clustering processes naturally evolve from the regional innovation system in the second approach, leading to a new qualitative state, the first approach may result in sporadic development influenced by external factors, increasing the risk of failure due to higher uncertainty in the chosen development paths.

4 Conclusions

Clusters are formidable competitors in the ever-evolving global markets. They act as hubs for valuable intellectual resources and play a crucial role in capitalizing on and promoting these resources in combination with other production factors. Recognizing this fundamental role of clusters is vital when establishing management priorities for cluster initiatives. Unfortunately, this significance is not always fully considered in the construction of cluster formations within Russian regions.

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