Integration function in cluster structures as an aspect of the implementation of sustainable regional development

Oleg Lyamzin*, and *Anna* Skurikhina

Novosibirsk State Technical University, Novosibirsk, Russia

Abstract. The purpose of this article is to analyze the processes of integration of educational and research functions carried out by organizations participating in cluster structures at the present time, as well as to develop individual recommendations for improving the efficiency of these processes. The article is intended to identify new opportunities for increasing the efficiency and competitiveness of cluster structures, which are an important modern factor in ensuring sustainable territorial development. The article is intended to identify new opportunities for improving the efficiency and competitiveness of cluster structures. As a methodological base, the works of such authors as K. Haewon, J. Lee, Y. Xu et al. The result of the research work is a list of recommendations for improving the mechanism for introducing educational and research functions into the cluster structure in order to increase the efficiency of each of its participants and the entire system as a whole.

1 Introduction

Regional clustering as a way to ensure sustainable economic development of a territory today is of interest scientific interest. Without being completely new, the topic of the formation and development of clusters, however, remains insufficiently developed in aspects of both a strategic and tactical nature. The issues of forming the right conceptual basis in the construction of clusters and adequate methodological and instrumental support for making their management decisions are presented in the publications of a number of authors, but they have not yet become the subject of agreement among researchers in this area of economic development [1, 6, 7].

Thus, an urgent problem in the functioning of the cluster remains the problem of effective integration of the educational and scientific functions of the participating organizations within it. These functions, being one of many others implemented in the cluster, play a leading role in the process of creating its competitive final product.

Speaking about scientific and educational integration, we do not mean only a large educational institution as a type of participating organization, for which it is initially natural task. The integrative nature of cluster-type systems involves considering and maximizing

*Corresponding author: trendy88@ngs.ru

the use of any function (business process) and product of any participant as a possible input resource for the functions of other participants and vice versa.

This circumstance stimulates the cluster management to formalize, analyze and cross-use the potential of all functions (business processes) implemented within the cluster, and not only those types of participants for which they are "core" due to their industry specifics, but all participants in general. This directly concerns all aspects of the participants' activities, and especially their educational and scientific activities, the effective integration of which largely determines the degree of competitiveness of the final product of the cluster and thereby the chances of its survival and development in the fight against other systemic market entities. This formulation of the question is reflected in the presented article, both in terms of determining the role of the educational and scientific functions among other functions of the cluster, and in terms of clarifying their interaction with each other.

2 Materials and Methods

The topic of the principles of formation and effectiveness of integrated structures, the interaction of their elements with each other, the development and support of the innovative function in cluster structures and their impact on the sustainable development of regions is increasingly becoming the subject of research in scientific works. As an example, we can cite studies by such authors as K. Haewon "Industry cluster, organizational diversity, and innovation", J. Lee "The Role of a University in Cluster Formation: Evidence from a National Institute of Science and Technology in Korea", Y. Xu "Connected knowledge spillovers, technological cluster innovation and efficient industrial structure", A. Maghssudipour "The role of multiple ties in knowledge networks: Complementarity in the Montefalco wine cluster" et al.

All of the above studies formed the basis for the development of an approach to the effective integration of educational and research functions into cluster structures, described in this article.

3 Results and Discussion

An important distinguishing feature of any cluster structure is the presence of an innovation-oriented factor, which is determined by the tendency to form a cluster in those market sectors where there is potential for scientific research and development that can positively affect the effectiveness of each element of the system and leads to the need to integrate educational and scientific functions into it.

Among the factors stimulating the introduction of these functions into the cluster structure, one can note the increasing intensification of the intellectual component in all sectors of production, leading to the need to combine knowledge in new ways; the ability to take advantage of the intra-company hierarchy and market mechanism, which leads to a faster and more efficient distribution of new knowledge, scientific discoveries and inventions and their practical implementation; agreed upon requirements of enterprises for educational institutions, including the quality of educational services, level of education and qualifications of graduates of educational institutions; more efficient nature of collective innovation in knowledge-intensive industries and lower costs of their implementation due to economies of scale [5].

The continuous interaction of the triad "education - science - production" leads to the implementation of the principle of cumulative innovative educational and scientific values of the cluster – educational and research organizations create value for business that meets its current requirements, strengthening its personnel and innovative potential and thereby

addressing its needs and problems, increasing demand for training specialists, conducting research and developing innovations. This approach is a catalyst for the dynamic development of innovative processes [3]. Elements of the integrated structure become more receptive to new knowledge and developments, it is easier to find effective ways to carry out their activities that allow them to outpace productivity growth, etc. It is worth noting that this applies not only to large players in the cluster. Medium and small firms in the cluster, being satellites of large companies, act as their suppliers, providing them with intermediate resources for the production of the final product, as well as providing services necessary for the implementation of the production of innovative goods or services of large enterprises. This factor has a powerful influence on medium and small businesses and contributes to their interest in increasing the efficiency of their activities by introducing new methods, technologies, equipment, etc.

The result of the implementation of the educational and scientific functions in the cluster is a carefully organized system of their distribution across a network of previously formed connections between all elements of the integrated structure [4]. At the same time, one of the main conditions for the successful transformation of inventions into innovations, and innovations into competitive advantages, is the continuous and close interaction of all cluster participants, which contributes to the rapid dissemination of necessary knowledge, reducing the overall costs of research and development, as well as implementing the innovative component of the cluster over an extended period of time.

The ability of a long-term and sustainable existence of a cluster, which arises due to the synergistic effect of innovation, results in the effect of investment synergy. The integral economic system of the cluster makes it possible to use production capacities and total reserves of raw materials together, as well as transfer research and development costs from one product to another, use the same equipment, etc. This allows participants to make more efficient use of their available resources and reduce investment risks. All this makes organizations within the cluster more attractive to financial institutions and investors and allows them to receive a more stable and higher volume of additional resources for implementing and improving the activities of enterprises. The centralized attraction of financial resources by companies that are members of the cluster is more likely to be implemented than individual attempts by independent companies.

Since the synergy effect is possible only when a network of stable connections is formed between all members of the cluster, this affects the forms of interaction between them, changing them and generating new ones. Thus, the nature of the activities of educational organizations in a cluster structure becomes adaptive and flexible, adapting to the requirements for the level of qualifications of the workforce emanating from enterprises. The result of such interaction is a sought-after specialist who has up-to-date knowledge and has the potential to produce innovative technologies that can bring the final product to a new level of competitiveness [6].

Obtaining a certain level of qualification by each employee entails possession of knowledge unique to him, which, under certain conditions, can be transformed into organizational knowledge. Organizational knowledge is the ability of an enterprise as a whole to create new knowledge, distribute it throughout the organization and translate it into goods and services [4]. In a cluster, organizational knowledge does not remain within the closed system of one organization, but is distributed among all participants in the system. In the process of “diffusion” of knowledge in a cluster, it, as a rule, undergoes changes, being filled with new meanings that come from the individual experience of each element of the cluster structure. Such a continuous exchange of information and experience, as well as the combination of many unique ideas into a single knowledge, makes it unique and impossible to copy by individualistic enterprises that are not involved in the cluster**.**

The scientific and production chain that unites the elements of the cluster, using new technologies, knowledge and innovations, leads to the fact that the final product of business enterprises within the cluster structure acquires fundamentally new characteristics and becomes more knowledge-intensive. The innovative component of a product or service created in a cluster makes it competitive in the long term (fig.1).

Another important factor of increased competitiveness is the time during which enterprises can implement created innovations and scale their production. Due to the dynamic and continuous operation of the entire system of the cluster structure, all processes within it can be implemented faster [8].

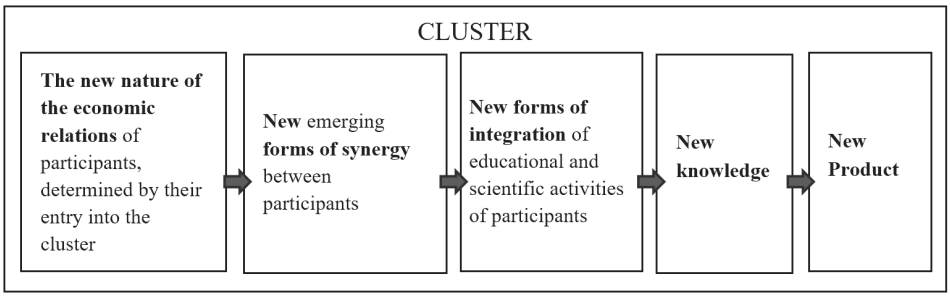

Fig. 1. The "education-science" connection in the formation of the final product of the cluster. *Source:* compiled by the authors

Thus, the educational and scientific function in the cluster is a fundamental element in creating a unique product that ensures the sustainable competitiveness of each participant in the system and the entire cluster structure as a whole.

Integration of these functions into the cluster occurs with the help of the main groups of resources, the presence of which ensures the feasibility of creating a cluster structure: production, information, administrative and scientific and technological infrastructure; natural, human and financial resources. In the process of forming a cluster and integrating educational and research enterprises into it, the listed resources of each of its participants require modification, lining up in new combinations to increase their efficiency and obtain a synergistic effect. Often this process is accompanied by difficulties**.** The solution to this problem may be the implementation of the principles of disintegration and quasi-integration at the stage of formation of the cluster.

The key principle of cluster formation is the principle of integration, that is, the combination of individual elements of any market into a single interconnected system**.** However, a method for increasing the efficiency of a cluster and introducing educational and scientific functions into it can be the reverse process – disintegration. Any cluster structure has its core – one or several large enterprises that produce similar goods or services. As a rule, outside the cluster, such companies have a large number of divisions, each of which performs its own functions – production, marketing, finance, etc. Among them are departments that are engaged in the scientific activities of the enterprise, as well as personnel management. Within the framework of a cluster structure, the presence of entire departments performing research and educational functions in each of its participants may be irrational and even contradict the concept of a cluster in the joint production of knowledge and the development of innovations. The solution may be the partial disintegration of production organizations and departments involved in research and development and HR management in them.

In practice, this is manifested in the separation of research and development and HR management departments from each participant from the cluster core and their unification into separate research and educational organizations. The work of such organizations can be

based on the principle of outsourcing, that is, large enterprises that previously included these divisions can place orders for conducting research, retraining employees, organizing scientific or educational events, etc. of necessity. Thus, the research and development and HR management departments combined together begin to provide services not only to the previous enterprise from which they separated, but also to work for the entire market in which the cluster exists.

The tasks of the newly created scientific enterprise will include conducting strategic research for a specific cluster member upon request; introduction of innovations developed by large research institutes into the technological process of a separate enterprise in a cluster, that is, adaptation of new developments to a specific product/service, taking into account the specifics of the company; conducting scientific events.

The objectives of the newly created educational enterprises will include short-term retraining of enterprise employees upon request; conducting educational events for personnel of a specific company; adaptation of employees wishing to work in one of the cluster enterprises.

Moreover, the educational function in this case can be embodied in the form of a virtual organization. Educational organizations that provide short-term online training can become the optimal form for implementing the above tasks. this will allow cluster participants to reduce costs for classrooms, equipment, personnel, etc.

In conditions of partial disintegration, the functions of research and development and personnel management do not completely disappear from large manufacturing enterprises. The simplified functionality of the research and development department may include the improvement and development of unified, rational planning documentation, the introduction of automated processing and acquisition of information, internal monitoring, etc. The functions of the HR department are reduced to hiring and firing employees, maintaining corporate culture, adapting new employees, etc.

The implementation of the principle of disintegration will allow large research institutes and educational enterprises to focus on more strategic tasks. For large scientific organizations, this means conducting large-scale research related to the entire industry in which the cluster exists; developing innovations for the entire industry; solving cluster-wide problems related to the production chain, etc. For educational organizations, this is training qualified personnel for cluster participants, improving the skills of employees, conducting joint major research with scientific and industrial enterprises, etc.

In addition to the principle of disintegration, in order to further improve the efficiency of the cluster, the principle of quasi-integration can be implemented between large manufacturing enterprises that form the core of the cluster and smaller satellite enterprises, which consists in reaping the benefits of integration and weakening the degree of influence of large firms on smaller ones [7].

Often large market players have low-performing assets in the form of low-income businesses, unprofitable elements of the production process, irregularly used production space, equipment, etc**.** The principle of quasi-integration manifests itself in the form of the transfer of low-performing assets to small and medium-sized enterprises in order to improve the efficiency of existing assets of large companies. In turn, satellite enterprises have the opportunity to diversify and increase operational efficiency by expanding and improving production, using additional material assets of large companies, etc.

When implementing the principles described above, large firms within the cluster begin to strive to minimize their costs and are constantly looking for new opportunities for more rational use of their assets. They are willing to give more for the common benefit of the cluster and its participants, which increases the efficiency of the entire system.

4 Conclusion

The conducted research allowed us to formulate the following main conclusions:

1. The innovative orientation of the cluster, as one of the aspects of its formation, leads to the need to integrate educational and scientific functions into it, which in the long term has a positive effect on the efficiency of the entire system and each element within it.

2. Educational and scientific functions, being one of many others implemented in the cluster, play a leading role in the process of creating its competitive final product, which is achieved by implementing the "education-science" link during its formation.

3. One of the ways to effectively integrate educational and scientific institutions into a cluster can be the implementation of the principle of disintegration within the framework of a manufacturing enterprise and its divisions performing educational and research tasks, as well as the principle of quasi-integration between members of the cluster core and satellite firms.

Thus, the effective implementation of educational and scientific activities in the cluster structure largely determines the degree of competitiveness of the final product, as well as the likelihood of survival and development of the cluster in the fight against other integrated structures.

References

1. D. Ayrapetyan, N. Befort, F. Hermans, The role of sustainability in the emergence and evolution of bioeconomy clusters: An application of a multiscalar framework. Journal of Cleaner Production, **376**, (2022)
2. J. Lee, The Role of a University in Cluster Formation: Evidence from a National Institute of Science and Technology in Korea. Regional Science and Urban Economics, **86** (2021)
3. K. Haewon, H. Seung-June, Y. Woojin, Industry cluster, organizational diversity, and innovation. International Journal of Innovation Studies, **7**, 187-195 (2023)
4. A. Maghssudipour, L. Lazzeretti, F. Capone, The role of multiple ties in knowledge networks: Complementarity in the Montefalco wine cluster. Industrial Marketing Management, **90**, 667-678 (2020)
5. N. N. Davydova, E. M. Dorozhkin, N. V. Polyanskova, E. Y. Nuykina, Formation of a cluster integration system of educational institutions within the region. International Journal of Environmental and Science Education, **11**, 9206-9221 (2016)
6. O. Lyamzin, About analytical and structural aspects of the management system of organizations that implement the integration steps. International Multidisciplinary Scientific Conference On Social Sciences And Arts, **3**, 3-8 (2014)
7. A. A. Stupina, I. R. Ruiga, I. Boubriak, P. A. Kudryavtsev, Building the interaction mechanisms between universities and enterprises in accordance with TRL-system. Economic and Social Trends for Sustainability of Modern Society, **116**, 1151-1160 (2021)
8. Y. Xu, X. Li, C. Tao, X. Zhou, Connected knowledge spillovers, technological cluster innovation and efficient industrial structure. Journal of Innovation & Knowledge, **7** (2022)