Using Economic and Mathematical Methods During Formation of Construction Cluster

Elena A. Gladkaya, Elena N. Egorova, and Elina R. Torsunova

Abstract The article deals with the notion "economic cluster" and views the necessity for creation of clusters in construction industry. The author offers a hypothesis that cluster enables effective information exchange between its members, formation of integrated legal and financial environment, and development and promotion of single commercial strategy. As a result of the research, the author distinguished peculiarities, goals, and principles of formation of construction clusters which operate in the subjects of the RF. Special attention is paid to expediency of application of economic and mathematical methods during formation of a construction cluster. As a result of the research, the author shows that formation of a construction cluster is a possibility to increase the level of manageability of construction complex and effectiveness of interaction of economic subjects with the perspective of transition to innovational path of development, and strengthening of financial and economic situation in the region on the basis of application of economic and mathematical methods.

1 Introduction

At present, cluster approach becomes more popular in economic research. Probably, the term "cluster" was first used during formulation of the apparatus of cluster analysis of multivariable data in mathematics. That was in the late 1930s.

The founder of cluster approach in economics is M. Porter. He defined economic cluster as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and

E.A. Gladkaya (✉)
Volgograd State University, 100 Pr. University, Volgograd 400062, Russia
e-mail: gea@volsu.ru

E.N. Egorova
Russian State Social University, Moscow, Russia
e-mail: egelni@yandex.ru

E.R. Torsunova
Department of Applied Informatics and Natural Sciences, Perm Institute of Economics and Finance, 141 Ekaterininskaya St., Perm 614068, Russia

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complementarities" (Porter 1998). M. Porter came to the notion of economic cluster from analysis of specific spheres of economy of one or another country in the global market.

Other scientists gave their interpretation of the term "cluster":

1. Rosenfeld (1997, p. 4), Van den Berg et al. (2001, p. 187), and Enright (1996, p. 191) distinguish geographical aspect as the main one during formation of cluster;
2. Crouch and Farrell provide a general definition of "cluster", supposing that this is a tendency of companies of one sphere for unification without any important reason of presence in this very sphere (Crouch and Farrell 2001, p. 163);
3. Roelandt and den Hertag characterize "clusters" as association of manufacturers and companies which are interconnected by production chain (Roelandt and den Hertog 1999, p. 9);
4. Feser considers that enterprises united into "economic clusters" are not just connected by production chain; clustering would allow them become more competitive (Feser 1998, p. 26);
5. Simmie and Sennett distinguished "innovational cluster", defining it as "a large number of interconnected industrial and/or service companies having a high degree of collaboration, typically through a supply chain, and operating under the same market conditions" (Simmie and Sennett 1999, p. 51).

Definitions of "economic cluster" of foreign scientists could be united by the following principles: radius of transport influence, economic profits, and characteristics of workforce and agglomeration. By the middle of the nineteenth century, Russia had theoretical and methodological foundations, factors, and principles of economic zoning, within which specialization of region's development is pre-determined by its resource-raw materials potential.

Cluster approach to analysis of economic phenomena develops and expands its limits. New and more precise definitions of economic cluster appear. However, the literature uses verbal models of economic clusters which are the studied by classic methods and do not allow building vivid dynamic economic & mathematical models of clusters.

2 Formation of Construction Cluster

A material basis of real estate market is a construction sphere, which consists of several cooperating spheres of material production and R&D works which ensure the construction. Construction sphere includes:

1. capital construction (construction production);
2. material and technical basis of construction (spheres which manufacture products and provide market services);

3. construction design (providing a possibility of professional functioning of construction production) (Kamenitskiy 2008).

Viewing the necessity for creation of clusters in construction sphere, it should be mentioned that clustering stimulates improvement of quality of living standards, influences demography and processes of migration, and provides potential for the formation of region's positive image.

Creation of clusters in construction sphere allows:

1. receiving additional financing of construction sphere;
2. reducing the cost of products and services for cluster members;
3. receiving more effective protection of legal rights and interests of cluster members at various levels;
4. reducing transaction costs of companies which appear due to opportunistic behavior of suppliers and rivals.

At present, five active construction clusters has been formed in Russia: Ural construction cluster, Inter-regional scientific and production cluster, International cluster of timber house-building and timber processing, Cluster of industry of construction materials and house-building, and Cluster of composite construction materials, Fig. 1.

Each cluster was created for different purposes—depending on the needs of the sphere and of the region. Territorial clusters of Sverdlovsk and Samara Oblasts aim for increase of competitiveness of construction complex and provision of the whole range of necessary materials. At that, the peculiar feature of the Ural cluster consists in aiming not only for preservation but for expansion of sales markets of products

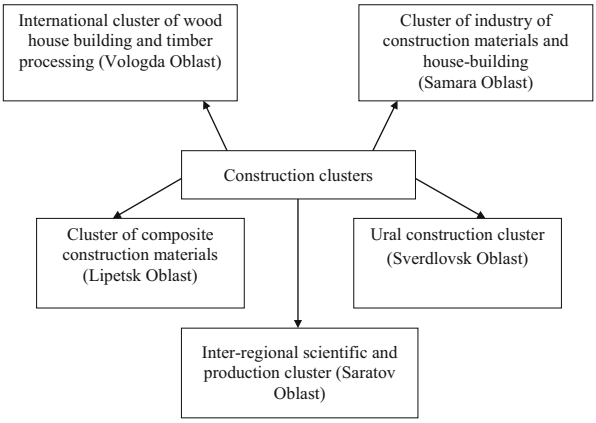

Fig. 1 Construction clusters in the RF (The Ural construction cluster. URL: stroycluster.ru; Program of development of innovative cluster of composite construction materials in Lipetsk region. URL: lipetskprom.ru; Program of development of International cluster of wooden house-building and woodworking in Vologda region for the period of years 2014–2020. URL: economy.gov35.ru; Development conception of construction materials and industrial house-building cluster on the territory of Samara region till 2020. URL: www.minstroy.samregion.ru)

by means of Northern territories (Lavrikova et al. 2013). The Saratov and Lipetsk construction clusters have innovational character and aim for implementation of new innovational products in the sphere of construction, increase of products' competitiveness, and entering new sales markets. The goal of Vologda cluster is attraction of foreign technologies for the purpose of development of a new sphere of wood house-building and entering new sales markets.

Depending on the goals of formation of a cluster, there are different principles of organization of cluster interaction. For territorial clusters (Sverdlovsk and Samara), these are primarily territorial and sectorial concentration of economic entities for realization of large investment projects and combination of cooperation and competition; for innovational clusters—deep technological cooperation of cluster members, as well as innovativeness and technological nature.

Construction clusters are concentrated in the European part of the country and are located in the regions that are peculiar for a high level of development of construction complex. From the point of view of territorial structure, it is possible to distinguish cluster entities dispersed on the whole territory of the region (Sverdlovsk, Samara, and Lipetsk Oblasts) and examples of association of enterprises and scientific and educational organizations within several countries (Saratov and Vologda Oblasts). Thus, the members of Saratov cluster include enterprises from Kazakhstan and Belarus, and house-construction cluster of Vologda Oblast—construction enterprises from Finland.

Each cluster has its peculiarities which are shown in Table 1.

Viewing the systems of transfer and use of knowledge and innovations within functioning construction clusters, it should be noted that most of them suppose the purchase of progressive foreign technologies. Only in two clusters (Ural construction cluster and International cluster of wooden house-building and timber processing), the strategies of acquisition of new products for construction market and conduct of own R&D and design works are planned (Loshchenko et al. 2013).

The process of formation of construction cluster is related to a range of problems but it allows acquiring certain competitive advantages (Table 2).

Table 1 Characteristics of construction clusters in the RF

Cluster title	Initiative sources of creation	Innovation component
Ural construction cluster	Business society initiative	Purchase of progressive foreign technologies
Inter-regional scientific and production cluster	Business society initiative	Conduct of own R&D and design works
International cluster of wooden house-building and timber processing	Government initiative	Purchase of progressive foreign technologies
Cluster of industry and construction materials and house-building	Government initiative	Purchase of progressive foreign technologies
Cluster of composite and construction materials	Center for cluster development of the region	Conduct of own R&D and design works

Table 2 Problems and perspectives of construction clusters in the RF

Cluster title	Problems	Competitive advantages
Ural construction cluster	Lack of projects for technological development in a cluster and termination in development	"Mega" cluster that allows realizing large investment projects. A "pioneer" in cluster development of construction complex. Presence of the largest interregional sales markets for cluster products. High resource provision of construction complex of the region. Initiative team of cluster development. Formed image of the cluster Presence of specialized cluster's web-site. Lobbyism within sectorial and professional associations. Active interaction with sectorial and professional associations
Inter-regional scientific and production cluster	Lack of competition between members	Foundation of cluster—full technological chain of creation of innovational house-construction systems and technologies (all links of added value are present) Close cooperation of enterprises of machine building and construction complexes. Federal and inter-governmental level of cluster, inclusion into global chains of creation of added value in construction technologies. Initiative leader and trust between cluster members Active cooperation between sectorial and professional associations
International cluster of wooden house-building and timber processing	Low level of personnel qualification, ineffective management of enterprise's resources, low depth and effectiveness of raw materials processing	Vologda Oblast is among the leaders of the subjects of the RF for availability of timber raw materials. Availability of formed and sustainable sales market
Cluster of industry of construction materials and house-building	Information non-readiness of specific initiatives of a cluster and cluster leaders from business	Accessible raw materials Effective demand for products Necessary infrastructure Support for public authorities Formation of fair competitive environment in the region

(continued)

Table 2 (continued)

Cluster title	Problems	Competitive advantages
Cluster of composite construction materials	Lack of potential large consumers and experience of use of cluster's innovational products, lack of personnel and specialized equipment	Availability of formed and sustainable sales market and sales channels, scientific and production base, cluster leaders, and cluster projects Variability and competitiveness of new product Possibility for quick and successive implementation of scientific developments

At present, marketing policy for promotion of construction clusters is not conducted properly. This complicated solution of a range of tasks before the cluster members: (1) positioning the cluster as one of the key points of growth of construction in the country; (2) creation and support for positive image of cluster in the investment society of the RF.

Besides, cluster enables effective information exchange between its members, formation of single legal and financial space, and development and promotion of single commercial strategy.

3 Methods of Construction Clusters Formation

Formation of construction clusters might stimulate growth of internal market and increase of international competitiveness. Like was said above, formation of construction clusters could be caused by various factors. Due to that, there appears a task of multi-criteria optimization which is solved by the methods of mathematical programming.

During formation of construction cluster, it is expedient to use the methods of successive concessions, as private factors (criteria) are ordered according to reduction of their importance. Thus, for example, the most important criterion is receipt of larger profit than before formation of the cluster. Then goes reduction of cost of products and services for cluster members, etc. Future members of the cluster can rank all the factors (criteria).

Let's assume that all private criteria are maximized and enumerated in the order of reduction of their importance. Let us find the maximal value Z_1^* of the most important criterion in the sphere of allowable solutions by solving a single-objective task:

$$Z_1(\overline{X}) \rightarrow max \qquad (1)$$
$$(\overline{X}) \in Q$$

The, based on practical ideas and the set precision, the value of allowable deviations is set $\delta_1 > 0$ (economically justified concession) of criterion Z_1 and maximal value of the second criterion Z_2^* is found under the condition that the value of the first criterion should not deviate from its maximal value by more than the value of allowable concession, i.e., the following task is solved:

$$Z_2(\overline{X}) \rightarrow max \tag{2}$$

$$Z_1(\overline{X}) \geq Z_1^* - \delta_1 \tag{3}$$

$$(\overline{X}) \in Q$$

The value of concession $\delta_2 > 0$ is set by the second criterion, which—together with the first concession—is used for finding a relative maximum of the third private criterion:

$$Z_3(\overline{X}) \rightarrow max \tag{4}$$

$$Z_1(\overline{X}) \geq Z_1^* - \delta_1 \tag{5}$$

$$Z_2(\overline{X}) \geq Z_2^* - \delta_2 \tag{6}$$

$$(\overline{X}) \in Q$$

The same procedures are repeated until the maximum value of the least important criterion for formation of construction cluster Z_m is determined—under the condition that the value of each of the initial $m-1$ private criteria is different from the corresponding relative maximum by not more that the value of allowable concession for this criterion. The solution received at the last stage is considered to be optimal.

4 Conclusion

As a result of the research, it is possible to say that there appear new and more precise definitions of economic cluster. Formation of construction cluster stimulates improvement of living standards of the population, improves demography and migration processes, and provides potential for formation of region's positive image.

At present, there are five active construction clusters in Russia. Each cluster was created for different aims—depending on needs of the sphere and the region. Principles of organization of cluster interaction are also different—depending on the goals of cluster formation. Construction clusters are concentrated in the European part of the country and are located in regions peculiar for high level of development of construction complex. During formation of construction cluster, it is necessary to use methods of mathematical programming. Thus, formation of

construction cluster is a possibility to increase the level of manageability of construction complex, increase the effectiveness of interaction of economic subjects with a perspective of transition for innovational path of development, and strengthen financial and economic situation in the region on the basis of application of economic and mathematical methods.

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