HUMAN GEOGRAPHY

APPLICATION OPPORTUNITIES OF THE CLUSTER MODEL IN THE CONSTRUCTION MATERIALS INDUSTRY: IN THE CONTEXT OF THE INDUSTRIAL GEOGRAPHY OF THE BAKU AND ABSHERON-KHIZI ECONOMIC REGIONS

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DOI: 10.59423/gnr.2025.42.54.008

Article history:

Received: February 04, 2025
Dispatched for revise:
April 20, 2025
Accepted: June 10, 2025

Keywords:

construction materials,
cluster model,
spatial organization,
production enterprises,
economic linkages

Abstract

The article provides a scientific analysis of the necessity of applying the cluster model in the spatial organization and development of the construction materials industry within the Baku and Absheron–Khizi economic regions, which are among the leading industrial centers of the Republic. The study focuses on identifying the formation and development opportunities of construction materials clusters in the Garadagh administrative district of the Baku economic region and the city of Sumgayit in the Absheron–Khizi economic region. The research results reveal that strengthening mutual integration and cooperation among industrial enterprises, research institutions, service sectors, and other related structures plays a crucial role in enhancing the efficiency of the construction materials industry. The analysis of international cluster practices in the construction materials sector indicates that the Garadagh district and the city of Sumgayit in the Absheron region possess the highest industrial potential for establishing such a cluster model.

1. Introduction

In the modern era, the sustainable development of the construction materials industry necessitates the strengthening of interrelations between industrial sectors, research institutions, and machinery manufacturing enterprises. The *State Program for the Development of the Construction Materials Industry for the Period up to 2020 and for the Future until 2030*, adopted in Russia in 2016, emphasized that the weakening of linkages among machine-building, production sectors, and research centers had significantly slowed down the pace of industrial growth [17]. Consequently, since 2016, the cluster-based approach has been introduced in Russia's construction materials industry to restore these interconnections.

A similar situation has been observed in the Republic of Azerbaijan, where during the Soviet period, the existing scientific and industrial cooperation played a crucial role in advancing the development of the construction materials industry. Therefore, the formation of clusters in this sector, along with the restoration of technological, economic, and innovative linkages among production enterprises, machine-building plants, and service sectors, represents an important and timely priority for the country's industrial development.

The main aim of the research is to optimize the spatial structure of industrial enterprises by taking into account the economic potential of economic regions, as well as to enhance the efficiency of the sector through the restoration of linkages between research institutions and production facilities.

The objectives of the research are to analyze the current state of cooperation between manufacturing enterprises, service sectors, the machinery industry, and research institutions; to substantiate the advantages of the cluster approach; and to develop strategic recommendations aimed at promoting regional development.

2.Materials and methods

From a methodological perspective, the study employs a comparative-geographical approach, drawing on the experience of structural transformations and clustering processes carried out in Russia's industrial sector since 2016. In addition,

based on the analysis of various statistical and empirical data, general conclusions were derived. To present different conceptual approaches to clustering, several research methods were applied, including the analytical-synthetic method, descriptive statistical analysis, sectoral–structural analysis, and other complementary methodological tools.

3.Analysis and discussion

In recent years, the spatial organization of the construction materials industry in many developed countries has been shaped by new trends. Within this framework, the establishment of "Construction Materials Clusters" is considered one of the key innovations in the industrial sector.

There is no universally accepted definition of the term *cluster*. In 1990, Michael Porter introduced the concept of the "cluster" into economic science, defining it as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" [4]. It should be noted that in some countries, clusters consist of enterprises representing the same industrial sector, while in others, they include enterprises with diverse functions and purposes [15].

An analysis of industrial clusters in modern countries such as Germany, Russia, Georgia, and Turkey reveals that clusters represent a set of interrelated enterprises and organizations located within a specific geographic area that cooperate closely and generate mutual economic benefits.

In the Republic of Azerbaijan, the issues of establishing and developing industrial clusters are extensively addressed in the *State Program on the Development of Industry for 2015–2020* and in the *Strategic Roadmaps for the National Economy and Key Sectors* [16]. The *Strategic Roadmap* emphasizes that industrial parks, estates, and technoparks cannot be considered fully-fledged clusters, as they do not possess all the fundamental characteristics of clustering. These areas are primarily limited to technological linkages covering different stages of production, while economic integration among participants remains weak [1].

However, in a genuine industrial cluster, at least ten enterprises should participate, including a final product manufacturer, and each of the other enterprises must consume at least 50% of the products or services produced by one or more of the cluster participants. Therefore, the main distinguishing feature of clusters lies in the simultaneous existence of both technological and economic interconnections.

It should be noted that since 2016, significant progress and clustering processes have been observed in the field of construction materials production in Russia. At present, there are more than 150 clusters across the country, encompassing over 2,000 enterprises. Among them, the Volgograd Construction Materials Production Cluster, which brings together 10 member enterprises, is considered one of the most successful examples of an industrial cluster in this sector.

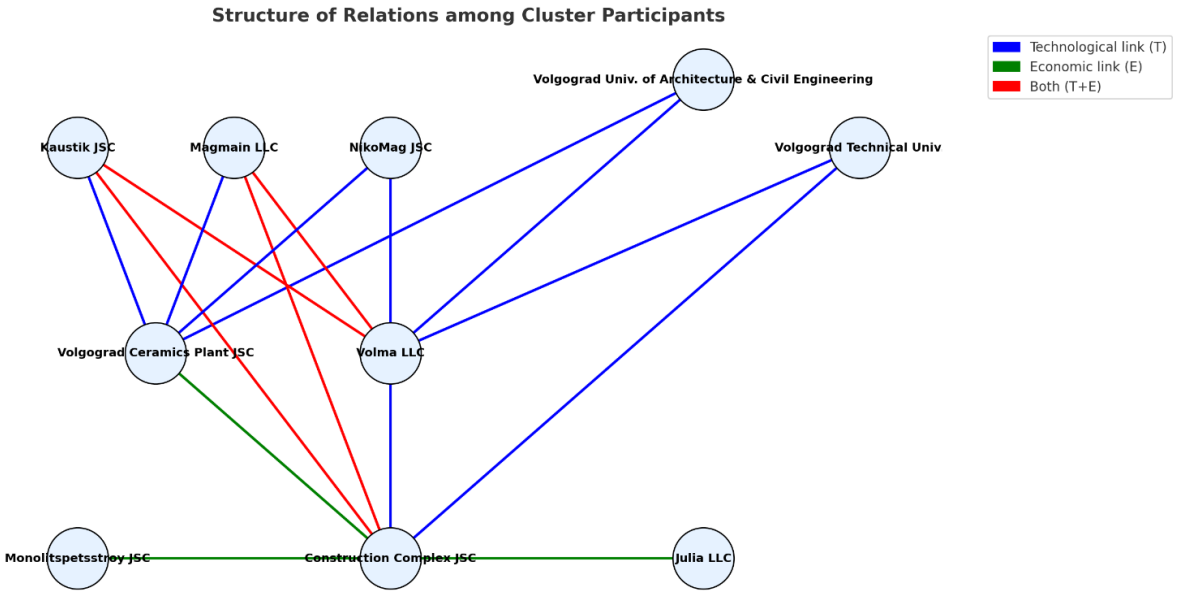


Figure 1. The structure of interrelations among the participants of the Volgograd Construction Materials Cluster. *Source:* Compiled by the author based on the data of the Russian Cluster Observatory, Institute for Statistical Research and the Economics of Knowledge (ISSEK) [14].

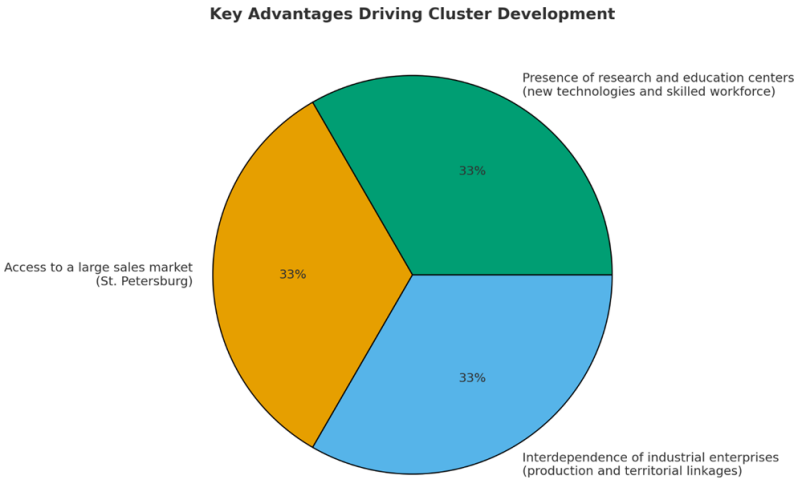


Figure 2. Structural distribution of the key factors ensuring the development of the Leningrad Construction Materials Cluster. *Source:* Compiled by the author based on the data of the Russian Cluster Observatory, Institute for Statistical Research and the Economics of Knowledge (ISSEK) [10, 14]

As shown in Figure 1, universities provide scientific research support and human capital development to the cluster. Within the cluster, producers of chemical raw materials (*Kaustik*, *Magmain*, *NikoMag*) supply technological resources to the main manufacturing enterprises. The final products are produced and delivered to the market by *Volma*, the *Ceramics Plant*, and the *Construction Complex JSC*. Service and infrastructure companies (*Julia LLC*, *Monolitspetsstroy*) complement the cluster through economic integration. Thus, the production chain within the cluster is effectively coordinated, which helps reduce logistics costs and increase overall efficiency.

Based on successful cluster development practices, the *Leningrad Construction Materials Cluster*, which began to be established at the end of 2020, currently comprises more than 30 enterprises [14]. The production volume of construction materials within the cluster traditionally depends on the pace of construction activities in Saint Petersburg - the largest consumer of these materials. The cluster specializes in the production of ready-mixed concrete, Portland cement, aluminous cement and similar hydraulic cements, ceramic tiles and slabs, ceramic construction bricks, building blocks, and other prefabricated construction products. The cluster's competitive advantages are illustrated in Figure 2.

As shown in *Figure 2*, the main advantages stimulating the development of clusters are evenly distributed among three key factors: the presence of scientific and educational infrastructure (33%), the mutual integration of industrial enterprises (33%), and access to a large sales market (33%). This proportional distribution indicates that innovation potential, production cooperation, and market capacity act as complementary factors in shaping the competitiveness of clusters.

A successful example of cluster development is the *Moscow Innovation Cluster*, established in 2018. Within its structure operates the *Moscow Composite Cluster (MCC)*, which unites 44 participants and employs more than 42,000 people. The cluster produces innovative construction materials used not only in Moscow but also in other regions of Russia and neighboring countries.

Analyses show that within such clusters, research centers, equipment suppliers, educational institutions, and logistics service providers integrate to ensure the joint utilization of economic, technological, and infrastructural resources. This integration contributes to cost reduction, profit growth, deeper specialization, and the improvement of production processes through the adoption of innovative technologies.

Research findings indicate that the operational mechanism of successful clusters is determined by a number of fundamental factors. These factors are systematized and presented in Figure 4. The effective implementation of these factors ensures the sustainable development of clusters and enhances the competitiveness of industrial sectors. The results reveal that state support (20%) and transport-logistics capacities (20%) are the most decisive factors in the formation and development of clusters. This demonstrates that both institutional and infrastructural provisions are essential prerequisites for the stable functioning of clusters.

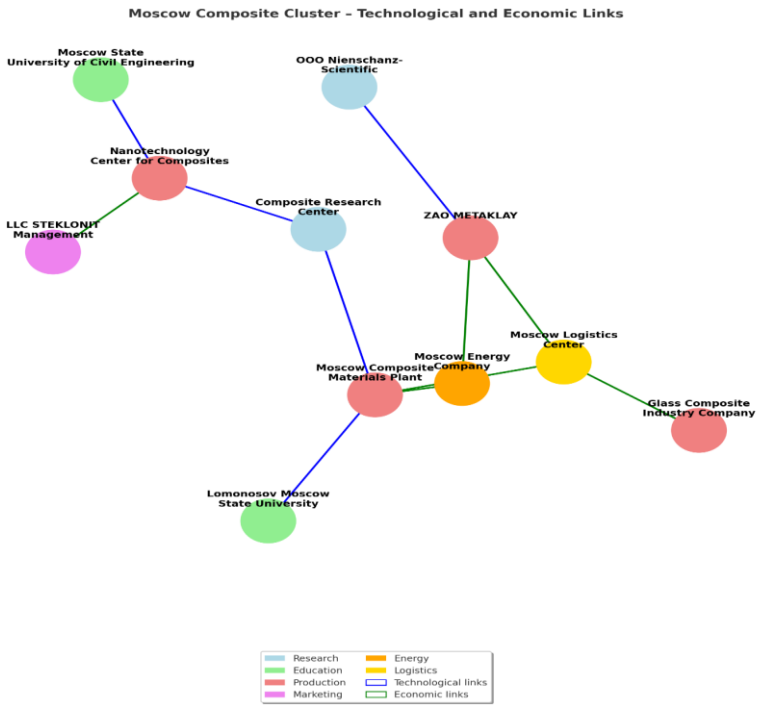


Figure 3. The structure of interrelations among the participants of the Moscow Composite Cluster. *Source:* Compiled by the author based on the data of the Russian Cluster Observatory, Institute for Statistical Research and the Economics of Knowledge (ISSEK) [12].

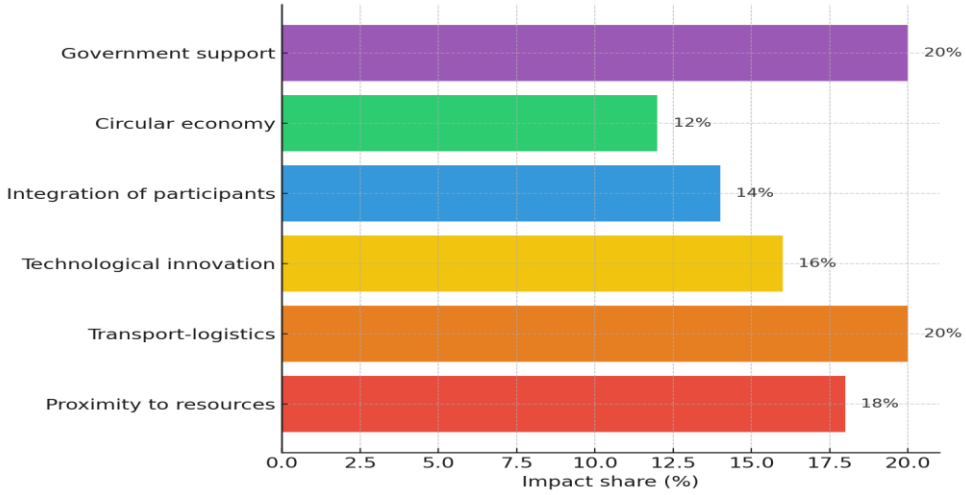


Figure 4. The share of key factors ensuring the successful performance of clusters. *Source:* Compiled by the author based on the data of the Russian Cluster Observatory, Institute for Statistical Research and the Economics of Knowledge (ISSEK) [14].

Proximity to resources (18%) *and* technological innovation (16%) play a crucial role in reducing production costs and increasing competitiveness. Meanwhile, participant integration (14%) and the application of circular economy principles (12%) serve as additional advantages that strengthen the cluster's synergistic effect. This distribution confirms that the development of clusters is based not only on technological interconnections but also on strong economic and institutional support mechanisms.

Based on the analysis of successful cluster models, it can be concluded that the Baku and Absheron–Khizi economic regions are among the areas with the highest industrial potential for the establishment of a construction materials cluster in the Republic of Azerbaijan. Although fully developed industrial clusters have not yet been formed in these regions, the initial signs of cluster development can already be observed in certain sectors. The dense geographical concentration of existing enterprises and the similarity of their production activities create favorable conditions for

the emergence of cluster characteristics. One of the most promising areas in this regard is the construction materials industry.

According to statistical analyses, during the research period (2015-2022), the Baku economic region maintained a dominant share in the overall production of construction materials. On average, during these years, the region accounted for 33.5% of total asphalt production, 7.3% of gravel, crushed stone, and river stone production, 90.4% of cement output, 15.4% of construction sand extraction, 73.0% of limestone for construction, 92.7% of building lime, 58.0% of ready-mixed concrete, 28.3% of glass, 35.4% of metal structures, 19.8% of steel pipe, and 95.1% of rebar production [9, 13].

During the research period, the Absheron–Khizi economic region accounted for 14.4% of asphalt production, 12.4% of gravel, crushed stone, and river stone production, 2.4% of cement production, 1.0% of construction sand extraction, 14.8% of limestone for construction, 0.4% of building lime, 1.5% of ready-mixed concrete, 70.6% of glass production, 12.1% of metal structures, and 80.1% of steel pipe output (*Figure 5*).

On average, during the study period, the Baku economic region accounted for approximately 50% of the total volume of construction materials produced in the country, while the Absheron–Khizi economic region contributed around 20%. These economic indicators demonstrate the leading position of the Baku and Absheron–Khizi regions in the production of construction materials. The region's favorable industrial infrastructure and strong raw material base represent key factors stimulating the further development of this sector.

It should be noted that the Absheron region, serving as the central hub of the construction sector, accounted on average for 60.5% of total investments allocated to construction and installation works during the research period (2015–2022), including 52.8% in the Baku economic region and 7.7% in the Absheron-Khizi economic region [5]. This highlights its role as the main center of intensive construction activity in the country. Figure 6 illustrates the spatial distribution of enterprises related to the construction materials industry across regions of the Absheron area, as well as the dynamics of their formation within the framework of state program implementation during the period 2004-2022 [2, 3].

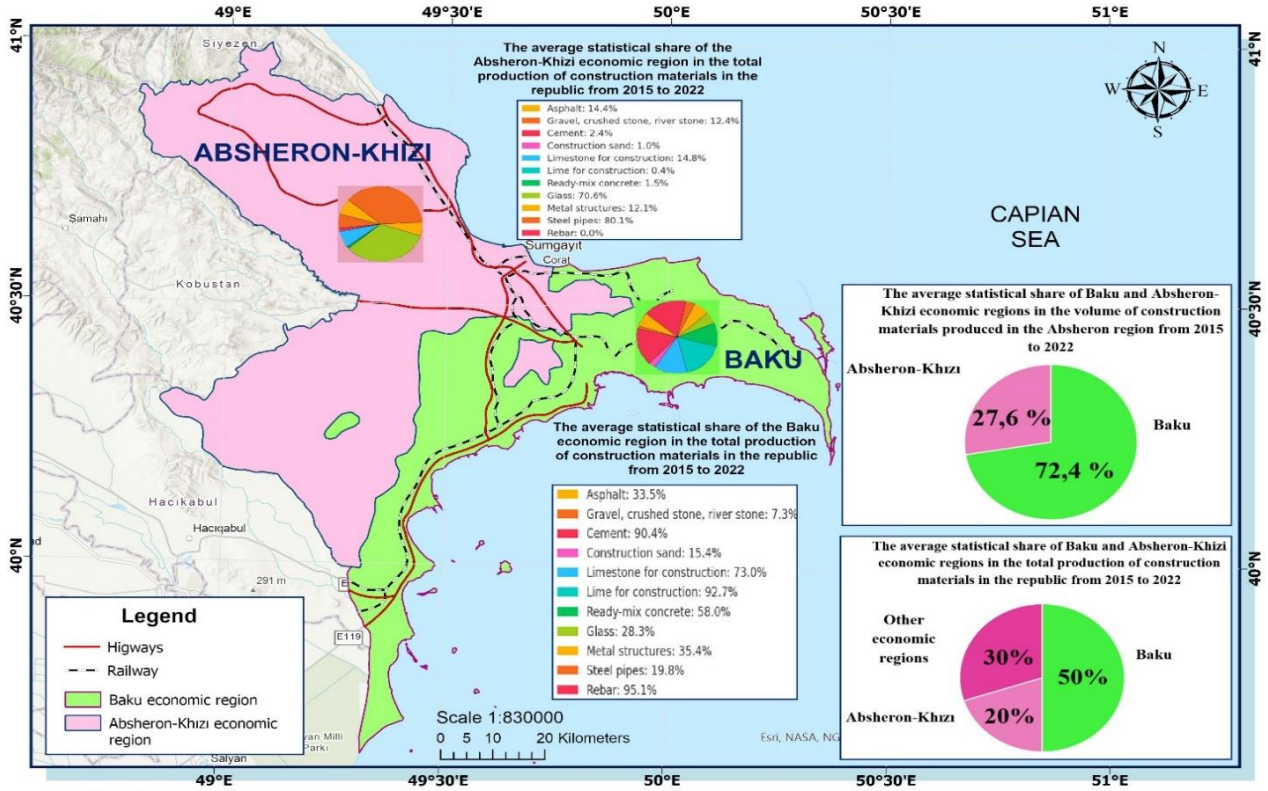
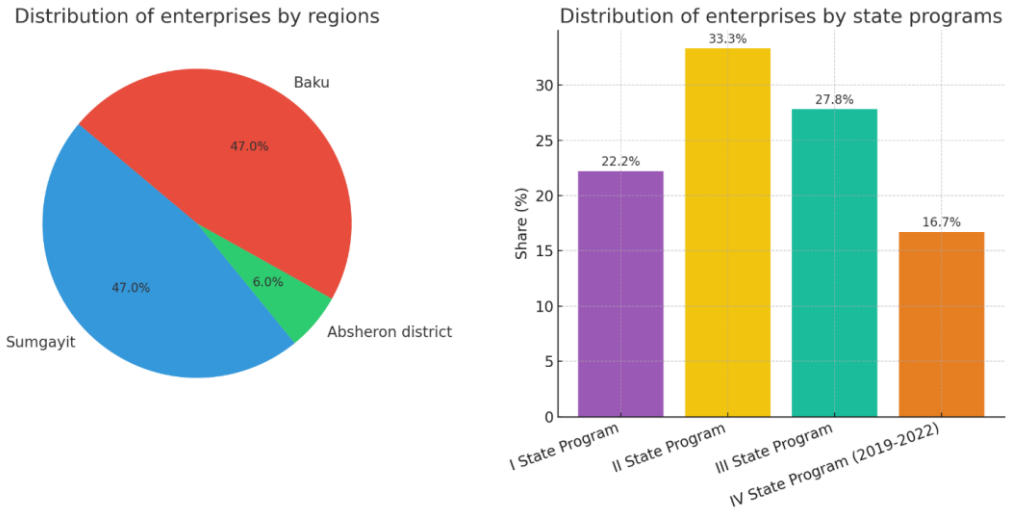


Figure 5. Average statistical share of the Baku and Absheron–Khizi economic regions in the total production of construction materials (2015–2022). *Source:* Compiled by the author based on the materials of the State Statistical Committee of the Republic of Azerbaijan [9, 13].



Source: Compiled by the author based on the materials of the State Statistical Committee of the Republic of Azerbaijan [5]

Figure 6. Regional and program-based structural distribution of construction materials enterprises in the Absheron region

During the implementation of the *State Programs on the Socio-Economic Development of the Regions*, 47.0% of all enterprises commissioned for the production of construction materials in the Absheron region were established in the city of Sumgayit, 6.0% in the Absheron administrative district, and 47.0% in the city of Baku (*Figure 6*).

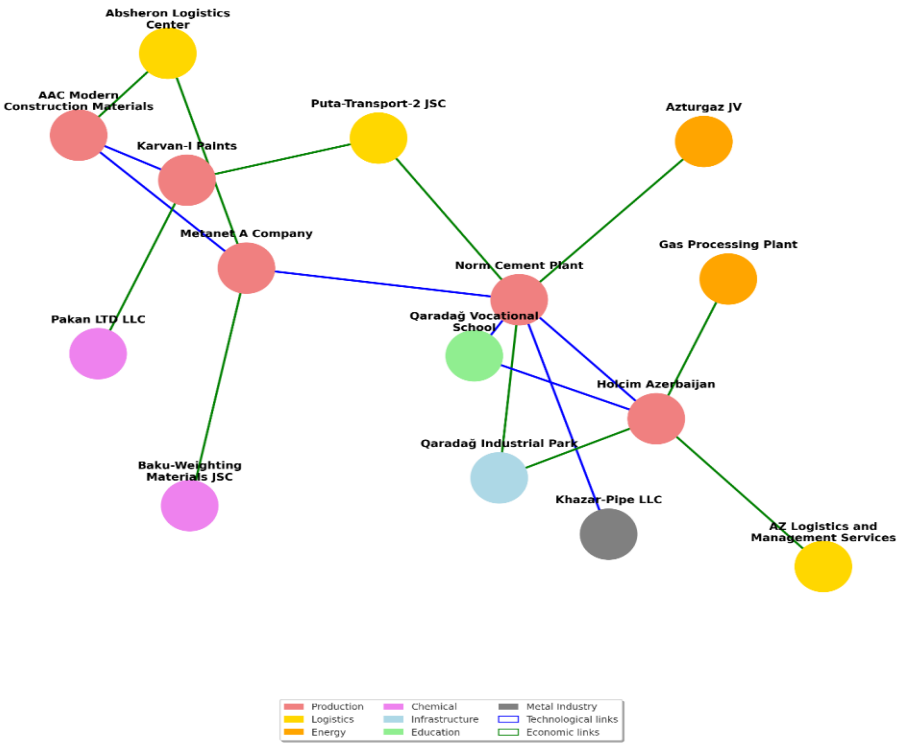
During the implementation of the first state program, 22.2% of enterprises serving construction materials production were commissioned; during the second program — 33.3%; and during the third program - 27.8%. It should be noted that the fourth state program is still ongoing, and 16.7% of the newly built enterprises were commissioned between 2019 and 2022 (*Figure 6*).

During the research period (2015–2022), the development of the construction materials industry (CMI) in the Absheron region was supported by the availability of raw material reserves, technological capacity, transport infrastructure, and an adequate labor force - the region accounted, on average, for 31.0% of the total labor force in the country during the study years. This represents a positive condition for industrial growth.

It has been substantiated that the natural resource potential of the study area offers far greater opportunities for the efficient spatial organization of the construction materials industry than those currently utilized. Specifically, only 34% of the total construction raw material deposits in the region (100 deposits categorized as "A") are currently under exploitation - including 50% of limestone deposits and 30% of clay deposits - while the remaining 64% remain as reserves [12].

Advantages of Transforming Garadagh into a Cluster. The Garadagh administrative district of the Baku economic region plays a crucial role in the production of construction materials in the Republic of Azerbaijan. The region possesses strong potential for the formation of the *Garadagh Construction Materials Cluster*. More than 30 manufacturing enterprises, service sectors, and logistics centers operate within the district.

The concentration of enterprises engaged in the production of limestone, cement, concrete, and other construction materials significantly enhances the cluster potential of the area. It should be noted that approximately 80% of all construction materials production enterprises in the country are concentrated within the Absheron region. Although around 85% of the region's total construction materials output is concentrated in the Garadagh district, the limited level of technological cooperation among enterprises indicates the necessity of implementing integrated cluster-based models. Figure 7 illustrates the potential cluster model of the construction materials industry within the Garadagh economic zone. In this model, major manufacturing enterprises such as Norm Cement, Holcim Azerbaijan, Mətanət A, AAC Modern Construction Materials Plant, *and* Karvan-L Paint Company are represented as the central elements. The production activities of these enterprises are carried out in close integration with raw material and energy supply sectors *(*Azturqaz, Gas Processing Plant*)*, chemical industry enterprises *(*Pakan LTD, Baku Weighting Agents JSC*)*, the metal industry *(*Khazar-Boru LLC*)*, and logistics centers *(*Puta-Transport-2, AZ Logistics, Absheron Logistics Center*)*.



Source: Compiled by the author based on the data of the official website of the Executive Power of Garadagh District, Baku [7].

Figure 7. Model of inter-enterprise economic and technological integration for the formation of a construction materials cluster in the Garadagh industrial zone

Although the Garadagh district, with its vast territory, rich raw material base, developed transport infrastructure, and industrial park, possesses substantial potential for cluster formation, it does not currently function as a cluster. The absence of a *Garadagh Construction Materials Cluster* can be explained by the following factors:

- Weak interconnections – the synergy and integration among enterprises remain insufficient;
- Lack of formal structure – there is no state-supported infrastructure or established management mechanism for cluster coordination;
- Innovation gap – the limited number of research and educational centers restricts the cluster's innovation potential;
- Human resource constraints – the system for training and upskilling professional workers is underdeveloped.

The establishment of a construction materials cluster in the Garadagh administrative district could contribute to the full realization of the district's economic potential and enhance its recognition in international markets. In this regard, *state support* and the *active participation of the private sector* play a decisive role. Some researchers argue that, under conditions of globalization and increasing international competition, the most effective way to ensure the survival of small firms is through their integration within cluster structures [11]. Overall, the selection of potential areas for the establishment of a construction materials cluster in the Absheron region can be carried out based on several key criteria. These include the proximity of existing infrastructure, accessibility of raw material resources, availability of transport networks, population density, and the economic-geographical characteristics of the area.

One of the most promising areas in this respect is the city of Sumgayit, located within the Absheron–Khizi economic region. The presence of a well-developed chemical industrial zone, easy access to petrochemical products and various construction raw materials, a developed transport infrastructure, and the existence of higher and vocational education institutions that train qualified specialists all indicate the strong potential for cluster formation in the region (*Table 1*).

Although the *Chemical Industrial Park* and the *Sumgayit Technologies Park* currently operate in the city of Sumgayit, there remains a need to establish a *Construction Materials Cluster*, as its objectives and areas of activity differ from those of the existing industrial parks.

Table 1

Some enterprises operating in the city of Sumgayit that could become potential participants of the construction materials cluster

No.	Name of the Enterprise	Field of Activity
1	Sumgayit Technologies Park	Production of energy products and various types of construction materials
2	Sumgayit Chemical Industrial Park	An industrial park bringing together more than 20 enterprises operating in various fields, primarily in the petrochemical industry, including construction materials production
3	Steel Pipe Plant of Azertechnoline LLC	Production of steel pipes based on Turkish, German, Italian, and Chinese technologies
4	Concrete Products Manufacturing Plant	Production of high-quality concrete products (concrete pipes and paving stones)
5	Institute of Polymer Materials of the Azerbaijan National Academy of Sciences, 'Neftqazavtomat' Scientific-Industrial Enterprise of the Ministry of Defense Industry of Azerbaijan	Enterprise specialized in the design, production, and technical maintenance of automation systems for the oil and gas industry
6	"Ethylene-Polyethylene" Plant of Azerikimya Production Union	Production of chemical products such as ethylene and polyethylene

Source: Compiled by the author based on the data from the official website of the Executive Power of Sumgayit City [8].

4.Conclusion

The conducted research has revealed that during the period 2015–2022, the Baku and Absheron–Khizi economic regions accounted for 50% and 20%, respectively, of the total construction materials production in the Republic of Azerbaijan. In particular, the concentration of 85% of production in the Garadagh administrative district and 47% of newly established enterprises in the city of Sumgayit demonstrates the high spatial density of industrial enterprises and the optimal geo-economic conditions for clustering in these territories.

The analysis indicates that the establishment of technological and economic linkages between numerous cement, lime, concrete, and paint manufacturing enterprises operating in Garadagh and the chemical and polymer industry facilities located in Sumgayit will create favorable conditions for the formation of an integrated cluster model of the construction materials industry in the region.

International experience - particularly the examples of cluster development in Russia and European countries - confirms that such integration has the potential to increase production efficiency by 15–20% and innovation turnover by 25–30%. Similarly, the formation of a Garadagh–Sumgayit–centered cluster would be of significant scientific and practical importance, as it would contribute to reducing production costs, ensuring the rational use of resources, expanding export opportunities, and enhancing the industrial competitiveness of the region.

Consequently, the application of the cluster model in the construction materials industry can foster new synergistic linkages within the industrial system of the Baku and Absheron–Khizi economic regions, thereby ensuring the sustainability of both regional and national economic development.

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TİKİNTİ MATERİALLARI SƏNAYESİNDƏ KLASTER MODELİNİN TƏTBİQ İMKANLARI: BAKI VƏ ABŞERON-XIZI İQTİSADİ RAYONLARININ SƏNAYE COĞRAFİYASI KONTEKSTİNDƏ

N.Ə.Paşayev, N.K.Abdullayeva

Xülasə. Məqalədə Azərbaycan Respublikasının aparıcı sənaye mərkəzlərindən olan Bakı və Abşeron-Xızı iqtisadi rayonlarında tikinti materialları sənayesinin məkan təşkilində və inkişafında klaster modelinin tətbiqinin zəruriliyi elmi baxımdan təhlil olunur. Tədqiqatda Bakı iqtisadi rayonunun Qaradağ inzibati rayonu və Abşeron–Xızı iqtisadi rayonuna daxil olan Sumqayıt şəhərində tikinti materialları klasterlərinin formalaşması və inkişaf imkanlarının müəyyənləşdirilməsi əsas diqqət mərkəzindədir. Tədqiqat nəticələri göstərir ki, sənaye müəssisələri, elmi-tədqiqat institutları, xidmət sahələri və digər əlaqəli strukturlar arasında qarşılıqlı inteqrasiyanın və əməkdaşlığın gücləndirilməsi tikinti materialları sənayesinin səmərəliliyinin artırılmasında mühüm rol oynayır. Tikinti materialları sahəsində beynəlxalq klaster təcrübələrinin təhlili göstərir ki, Qaradağ rayonu və Abşeron-Xızı iqtisadi rayonunda yerləşən Sumqayıt şəhəri belə bir klaster modelinin yaradılması üçün yüksək sənaye potensialına malikdir.

Açar sözlər: Tikinti materialları, klaster modeli, məkan təşkilatı, istehsal müəssisələri, iqtisadi əlaqələr.