The improvement of construction industry innovative potential through the creation of a cluster

Gulsina Zagidullina, Rufina Ivanova, Guzel Nugumanova, Rustem Sirazetdinov and Anna Zaripova

1Kazan State University of Architecture and Engineering, Kazan, Russia
E-mail: guls1955@mail.ru

Abstract. The study is devoted to the analysis of the innovative potential of enterprises in the construction industry. The creation of an effective cluster increases the country's innovative potential, as well as the economic indicators of production activity of the construction industry enterprises. The investment and construction cluster will help to create the competitive advantages that the construction industry enterprises involved into it have. The study considers stages and principles of the investment and construction cluster formation. We propose an algorithm for assessing the innovative potential of the investment and construction cluster based on the results of a SWOT analysis. The study assesses the innovative potential of the investment and construction cluster. Based on multiple correlation and regression analysis, we developed an equation for the dependence of the gross regional product on the system of indicators characterizing the innovation activity of the investment and construction cluster.

Keywords: investment and construction cluster, construction industry enterprises, construction industry innovative potential, construction management systems, construction industry.

1 Introduction

Experience has shown that more favourable conditions in competitive interaction are achieved within the framework of clusters. A key success factor for all competitive clusters is the synergistic effect arising from the unification and interaction of independent organizations. The effect contributes to the increase of innovation activity within the cluster and has a positive impact on the country's economy as a whole [1, 2]. Currently, the most urgent, and yet, little studied problem is the evaluation of the country's innovative potential through the cluster approach, while it could increase productivity and enhance the competitiveness of various sectors of the economy.

The investment and construction cluster will help to create the competitive advantages that the construction industry enterprises involved into it have; it will also help to generate and mix in using diffusion into the innovation flow necessary for the industry competitiveness [3, 4, 5].

Until now, there is no integrated application of the cluster approach in the methodology for assessing innovative potential, which takes into account a variety of factors, as well as information and educational support for cluster development; the mechanisms for investing in innovative cluster development haven't been developed; the risks of reducing innovative potential when creating a cluster haven't been considered.

Currently, in the scientific literature there is a sufficient number of studies reflecting certain aspects of the problem under study.
General theoretical and methodological approaches to the creation of the strategy of innovative development of the economy are considered in the scientific works of foreign researchers: P. Drucker, G. Mensch, R. Nelson, M. Porter, B. Santo, B. Twiss, C. Freeman, J. Schumpeter and others. [6, 7, 8].

The problem of developing the innovative potential of business entities and its assessment is considered in the works of S. Valentey, A. Granberg, V. Gorfinkel and others [9, 10].

The following economists made a significant contribution to solving the problems of innovative development of investment and construction activity: S. Abramov, M. Belyaev, V. Buzyrev, P. Grabovy, M. Kamenetsky, A. Karasev, E. Pankratov, V. Serov and others [11, 12].

In modern economic science, the issues of increasing the innovative potential and enterprises competitiveness based on the cluster formation are considered in the works of foreign and Russian authors [13, 14].

The total scientific potential of the development, which has emerged in Russian and foreign scientific literature, has provided a high theoretical and methodological level of innovative potential research in the system of economic entities relations and mechanisms for its regulation [15, 16, 17]. However, despite the high methodological and theoretical validity of innovative processes research in the economy, there is a need for the scientific development of a comprehensive system for assessing the country's innovative potential based on the cluster approach and identifying priority trends for its development [18, 19]. The relevance of the problem, its insufficient scientific study, and great practical significance determined the setting of the goal and objectives of the study.

In the framework of this study, the following objectives were solved:
1. the investment and construction cluster creation is justified, theoretical approaches to assessing innovative potential based on clustering are analysed;
2. the content and basic methodological approaches to assessing the industry innovative potential are determined;
3. the structure of the industry cluster is formed taking into account its potential innovativeness;
4. indicators of cluster innovation potential are systematized and their modelling is implemented, including using a graphical model;
5. updated indicators of the investment and construction cluster innovative potential are calculated;
6. the algorithm for assessing the investment and construction cluster innovative potential is developed.

The solution of the objectives is aimed at creating an effective cluster, which allows increasing the country’s innovative potential, as well as general indicators of economic activity of enterprises [20].

2 Methods

2.1. Stages of investment and construction cluster formation
In the modern economy, clusters are becoming one of the most effective forms of integration of financial and intellectual capital, providing the necessary competitive advantages. Therefore, the creation of an effective cluster increases the country's innovative potential, as well as general indicators of economic activity.

Based on the mentioned above, in the study we propose the stages and principles of forming an investment and construction cluster (table 1)

The investment and construction cluster will help to create the competitive advantages that the construction companies included into the cluster possess. It will also help to generate and mix through diffusion into the innovative flow necessary for the competitiveness of the industry.
### Table 1. Stages and principles of forming an investment and construction cluster.

| Preparatory | Organizational | Final |
|-------------|----------------|-------|
| Identification of the opportunities for the investment and construction cluster | Determination of tasks of investment and construction cluster formation | Development of investment and construction cluster management mechanism |

- **Economic**
- **Resource**
- **Organizational**
- **Innovative**

- Determining the structure and members of the cluster
- Determining the stages of cluster creation and development
- Feasibility Study of investment and construction cluster formation
- Cluster support measures from the formation plan government
- Evaluation of cluster formation effectiveness

**Justification of the advantage of using a cluster form**

**Target-setting Principle**

| Organizational Principles | Principle of Competitiveness | Principle of Consistency |
|---------------------------|-----------------------------|--------------------------|
| Principle of Resource provision | Principle of Competitiveness | Principle of Consistency |

#### 2.2 The system of indicators for assessing the investment and construction cluster innovative potential

The studies and analysis of the coefficients justifying the cluster formation allow us to state that construction industry will contribute to more technologically advanced construction, which is necessary for more successful development of the economy and increased innovative potential, investment attractiveness and competitiveness of the Republic of Tatarstan. The investment and construction cluster formation is justified on the basis of identifying the clustering innovative potential which is fulfilled in two stages (table 2).

**Table 2.** The system of indicators to justify the innovative potential of the investment and construction cluster.

| Identification of cluster innovation potential |
|-----------------------------------------------|
| Stage 1 Identification of clustering potential | Stage 2 Direction of clustering inside investment and construction cluster |

**K1 = 0.06**

- the amount of work performed by the kind of activity "construction"
- volume of goods shipped, work performed, services delivered

**K2 = 0.07**

- The turnover of organizations by kind of activity "construction"
- The turnover of organizations by kind of economic activity of the Republic of Tatarstan

**K1 = 0.06**

- employees average number by the kind of activity "construction"
- average annual number of employees in the Republic of Tatarstan

**K2 = 0.03**

- Patent application for utility model (construction) applications for patent granting to Russian Federal Agency for Intellectual Property, Patents and Trademarks "Rospatent"
When forming an investment and construction cluster, it is necessary to take into account the dynamics of the integral coefficient, since an increase in the indicator shows possible growth prospects for the cluster, and a decrease indicates the absence of prospects for the development of the cluster.

The analysis of the construction industry innovative potential, carried out in the work, showed insufficient use of the available cluster capabilities.

2.3 The principles of forming the investment and construction cluster

It is advisable to assess the innovative potential based on the cluster approach, taking into account the principles of purposefulness, cost-effectiveness, comprehensiveness, innovativeness and dynamism.

The principle of purposefulness involves evaluating innovation activity from the point of view of identifying the resources for economic sectors innovative potential. The principle of cost-effectiveness will make it possible to get a real effect from the application of innovative potential analytical assessments. The principle of comprehensiveness will cover all the resources of innovation activity to ensure the economic sectors innovative potential. The principle of innovativeness will be aimed at using the processes of creating and implementing the innovation activity results to ensure the improvement of the industry innovative potential. The principle of dynamism will allow you to take into account the speed of changes in the development of the industry and the state of its innovative processes.

The identified principles must be taken into account in a comprehensive assessment of the investment and construction cluster innovative potential, which assumes the existence of a justified and scientifically verified system of indicators, the presence of statistical framework, consideration and analysis of the specific character of innovative development of economy individual sectors, taking into account development conditions based on the availability of resources, personnel and infrastructure.

3 Results and discussion

3.1 SWOT-analysis of the construction industry innovative potential

We propose an algorithm for assessing the innovative potential of an investment and construction cluster. The algorithm is based on the results of a SWOT analysis and on the cluster approach and allows determining the innovative orientation of the economy and the potential for clustering the industry.

Summarizing the results of the study allows us to present a SWOT analysis of innovative potential of the construction industry of the Republic of Tatarstan (table 3).

The proposed SWOT-analysis of construction industry innovative potential of the Republic of Tatarstan is aimed at finding and implementing the reserves of the investment and construction cluster, increasing and evaluating its innovative potential, competitiveness, and ability to adapt to changing conditions.
Table 3. SWOT-analysis of construction industry innovative potential of the Republic of Tatarstan.

| Strengths                                                                 | Weaknesses                                                                 |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1. Stable socio-economic growth as a condition of innovative processes resourcing and the intensification of construction industry innovative activity. | 1. Insufficiently developed regulatory support of construction industry innovative activities, leading to a combination of criteria for investment and innovative projects. |
| 2. The Republic of Tatarstan supports innovations in business, effective state support of construction industry innovative activity. | 2. Support of the later stages of the construction industry innovation process. |
| 3. A significant venture capital resource, which allows reorienting investment portfolios and reducing innovative risks in construction industry. | 3. The dominance of profit earning interests over the strategy of financing risky, radical innovative projects of construction industry. |
| 4. System recruitment policy, application of the advanced experience, creation of an information field for innovative activity of construction industry. | 4. Low motivation of the construction industry business to conduct its own R&D; lack of resources for full participation in the venture business. |

| Opportunities                                                                 | Threats                                                                 |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1. Enhancing the interaction of the scientific and investment sectors, small and medium-sized businesses and large construction industry enterprises by creating a cluster | 1. Reducing the competitiveness of the scientific sector, the exhaustion of scientific potential. |
| 2. Participation in investment competitions, attracting venture capital to construction industry. | 2. Increasing dependence on foreign technology, widening the gap between science and industry. |

3.2 Multiple correlation and regression analysis of the gross regional product dependence on the innovation activity indicators

The paper evaluates the innovative potential of the investment and construction cluster, based on the calculation of GRP depending on the indicators of innovative activity of the construction industry enterprises: investment in fixed assets (x1), the amount of work under construction contracts (x2), investment in construction (x3), the number of enterprises (x4), the cost of innovation activity (x5), the volume of shipped innovative products (x6), the percentage of innovative products (x7), the number of innovatively active enterprises and organizations (x8), the number of obtained authorship certificates and patents for inventions (x9), the costs of technological innovations (x10), the volume of newly introduced and improved innovative products (x11), fixed assets value (x12); the number of people employed in the field of innovation (x13), etc.

Based on multiple correlation and regression analysis, calculation and enumeration of various models, we identified and explained the equation of dependence of the gross regional product on the system of indicators characterizing the innovation activity of the investment and construction cluster. The equation meets the established criteria.

Using the sequential inclusion method, we found that the most acceptable is the 5-factor model, having the following form:

\[ Y = 193749 + 9269x_1 + 14.73x_2 + 3.52x_4 + 735.12x_5 + 97.36x_6. \]  (1)

A close relationship between the identified factors and gross regional product is evidenced by a high level of correlation coefficient \(R = 0.98\). The variability \(Y\) is by 96% explained by the changes in the indicators-factors \(x_1, x_2, x_4, x_5\) and \(x_6\) included in the model, this fact can be judged by the determination coefficient \(D = 0.9583\). Other factors not included in the regression equation constitute only 4%.
3.3 Assessment of the investment and construction cluster innovative potential

The major tasks of the proposed algorithm are the collection and analysis of statistical information on innovative activities of the Russian Federation; selection of regions with high innovative potential; analysis of economic activity types capable of cluster formation and assessment of the industry innovative potential. The algorithm is implemented in several stages, each of which involves the study and evaluation of the results, and also uses a public statistical database and takes into account the current practice of evaluating the country's innovative capacity and economic sectors.

The algorithm for assessing the innovative potential of the investment and construction cluster is given in figure 1.

**Figure 1.** Algorithm for assessing the innovative potential of the investment and construction cluster.
The proposed algorithm allows us to determine the level of innovative activity of the economy in order to select regions and industries capable of developing innovative potential based on a cluster approach; identify clustering potential; assess the innovative potential of the industry based on the cluster approach.

3.4 The chart for innovative potential assessment

We implemented a graphic model for assessing innovation potential, which involves the use of quantitative parameters of innovation activity to explain the volume of investment and innovation processes financing.

The difficulty in diagnosing the quantitative parameters of innovation activity lies in the need to take into account multivariate factors, one of which is the integration of investment and innovation processes that take into account the interaction between participants in the investment and construction cluster. In this regard, the study considers a radar chart, demonstrating the parameters for assessing innovative potential through a statistical description of the integration of investment and innovation processes.

The radar chart for assessing innovative potential (figure 2) shows the extent of the lag in the quality and depth of innovative processes. Each beam of the radar chart will correspond to a selected indicator and reflect its contribution to the total indicator of the innovative potential of the Russian Federation.

![Radar Chart for Innovative Potential Assessment](image)

**Figure 2.** The radar chart for innovative potential assessment. The comparison of the Russian Federation with the international level.

The innovation potential assessment chart shows the extent of the lag in the quality and depth of innovation processes. In particular, the main indicator is the percentage of organizations implementing technological innovations, by the total number of organizations the indicator is about 7-9%, which is 7 times less than the average for the Organization for Economic Cooperation and Development (OECD).

The radar chart for assessing innovative potential, developed on the basis of systematized indicators, allows us to compare the state of the scientific, technological and innovative spheres of Russia and the OECD to determine the amount of financing for innovative activities, as well as making managerial decisions to stimulate the innovative activity of constituent entities of the Russian Federation. Low values of the proposed indicators of innovation activity show a low level potential of the Russian economy sectors in the field of innovation, the development of technological and socio-economic structures.
3.5 The study of the dependence of the region innovative potential on the indicators of construction industry innovative activity

We calculated the updated indicators of the innovative potential of the investment and construction cluster and explained the possibility of integrating enterprises and intersectoral complexes taking into account territorial proportions.

In the research we studied the effectiveness of creating an investment and construction cluster in the Republic of Tatarstan. The creation of the investment and construction cluster is justified on the basis of identifying the innovative potential of clustering.

To identify the dependence of the innovative potential of the Republic of Tatarstan on the indicators of construction industry innovative activity and to determine the degree of its innovativeness, a study was carried out using Statistical Package for the Social Science data analysis (figure 3).

Figure 3. Equal level surfaces and equal level lines of factors mutual influence: investment in construction (x3) and the volume of newly introduced and improved innovative products (x11) on GRP.

The relationship between the studied parameters of the Surface and the line of equal level allows us to assess the combined influence of factors Y and x3 on the function x11: with an increase in both factors, the function also increases. The same conclusion follows from the linear regression equation.

The formalization of the relationships between investment, innovation and production opportunities allowed the authors to formulate the conditions for the innovative functioning of enterprises of the investment and construction cluster, taking into account both the internal and external effects appearing in the process of sectoral production.

4 Conclusions

1. We expanded and supplemented the assessment of innovative potential on the basis of the cluster approach. The assessment is based on the following principles application: purposefulness, comprehensiveness, dynamism, cost-effectiveness and innovation, taking into account industry sector characteristics;

2. We determined the industry cluster structure explaining the principles of the formation of the cluster investment flow, which allows having an integrated approach to investment in innovation activity;

3. We calculated the updated indicators of investment and construction cluster innovative potential and justified the possibility of integrating enterprises and intersectoral complexes taking into account territorial proportions;

4. We proposed an algorithm for assessing investment and construction cluster innovative potential, based on the results of SWOT analysis and on the cluster approach. The algorithm allows determining the innovative orientation of the economy and the industry clustering potential.
References

[1] Kuzovleva I, Alekseenko V, Filippova T, Kudryavtseva T 2019 Efficiency of construction cluster innovative potential management. *IOP Conference Series: Materials Science and Engineering* 497(1), 012033. doi: 10.1088/1757-899X/497/1/012033

[2] Lazareva N 2018 Innovative components of sustainable development in construction. *MATEC Web of Conferences* 196, 04001. doi: 10.1051/matecconf/201819604001

[3] Okolelova E, Shibaeva M, Shalnev O. 2018 Development of innovative methods for risk assessment in high-rise construction based on clustering of risk factors. *E3S Web of Conferences* 33, 03015. doi: 10.1051/e3sconf/20183303015

[4] Zariyova A V Analysis of the Republic of Tatarstan construction industry innovative potential *News of Kazan State University of Architecture and Engineering* № 1(19), 2012. pp. 280-286.

[5] Knyazeva N V 2017 Information support for automation systems for the organization of construction. *International Review of Civil Engineering* 8(4), pp. 125-132. doi: 10.15866/irece.v8i4.12344

[6] Almeida A, Figueiredo A, Silva M R 2011 From concept to policy: Building regional innovation systems in follower regions. *European Planning Studies* 19(7), pp. 1331-1356. doi: 10.1080/09654313.2011.573140

[7] Vorobyov Y N, Burkaltseva D D, Kovalyova I N, Borsch L M, Gerasimova S V 2018 Sustainable development of the regional economy: Indicators, analysis, systematization. *Journal of Advanced Research in Law and Economics* 9(2), pp. 729-739. doi: 10.14505/jarle.v92(32).35

[8] Naumov I V 2019 Investigation of the interregional relationships in the processes of shaping the territories' investment potential using the methods of spatial modelling. *Economy of Region* 15(3), pp. 720-735.

[9] Bellintani S, Ciaramella G, Celani A 2018 A new frontier in construction investments: Data Centres and technical factors affecting risk profile. *MATEC Web of Conferences* 251, 06009. doi: 10.1051/matecconf/201825106009

[10] Zhang J, Xie H, Li H, (...), Deng Q, Jin W 2018 Integrated framework of growth management for identification of service innovation levels and priorities. *Sustainability (Switzerland)* 10(9), 3319. doi: 10.3390/su10093319

[11] Acar E, Koçak I, Sey Y, Arditi D 2005 Use of information and communication technologies by small and medium-sized enterprises (SMEs) in building construction. *Construction Management and Economics* 23(7), pp. 713-722. doi: 10.1080/01446190501271112

[12] Zagidullina G M, Mavlyutova A R 2018 Environmental standardization of residential real estate according to “Green standards” In: International Scientific Conference Environmental Science for Construction Industry, ESCI, EDP Sciences, vol. 193. 16 p. doi: 10.1051/matecconf/201819303001

[13] Okolelova E, Shibaeva M, Shalnev O, Efimyev A 2019 Risk Assessment Models of the Use of Innovative Technologies in Construction as a Factor in the Development of Energy Management Advances in *Intelligent Systems and Computing* 983, pp. 22-35. doi: 10.1007/978-3-030-19868-8_3

[14] Zhang J, Xie H, Schmidt K, Li H 2016 A new systematic approach to vulnerability assessment of innovation capability of construction enterprises. *Sustainability (Switzerland)* 8(1), pp 1-25. doi: 10.3390/su8010017

[15] Subbotin A, Subbotina D 2018 Features of formation and functioning of the integrated structures in construction. *IOP Conference Series: Materials Science and Engineering* 365(5), 052007. doi: 10.1088/1757-899X/365/5/052007

[16] Alexeenko V V, Seredina N S 2018 Factor interrelation system of integrated business structure development in construction. *Materials Science Forum* 931 MSF, pp 1142-1147. doi: 10.4028/www.scientific.net/MSF.931.1142

[17] Lee K-W, Han S H, Park C Y 2016 A Data-Driven Approach to Country Classifications in the
International Construction Market. Construction Research Congress 2016: Old and New Construction Technologies Converge in Historic San Juan – Proceedings of the 2016 Construction Research Congress, CRC 2016 pp 1332-1342. doi: 10.1061/9780784479827.134

[18] Romanova A I, Zagidullina G M, Ivanova R M, Kleshcheva O A, Sirazetdinov R M 2013 Peculiarities of Housing Construction Development in the Region. Middle-East Journal of Scientific Research Vol. 16 (4), pp 490-495. doi: 10.5829/idosi.mejsr.2013.16.04.11754

[19] Kudryavtseva S S, Shinkevich A I, Volov V T, Yusupova G F, Torkunova J V, Khairullina E R, Klimova N V, Irina Y, Sirazetdinov R M 2015 A Design of Innovative Development in the Industrial Types of Economic Activity. International Review of Management and Marketing, vol. 5(4), pp 265-270, Turkey.

[20] Smirnova Olga P, Barbakov Oleg M, Ponomareva Alena O, Vinogradova Marina V 2019 Modeling of the Innovation Activity of Russia’s Regions. WSEAS transactions on business and economics. Vol. 16 pp 403-413.