Factors affecting the parameters of the construction industry

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\textbf{Abstract.} One of the most important directions for the development of the economy of any state is the maintenance of all branches of the national economy at rather a high level. Competition, both on the domestic and world market of industrial production, dictates the need to find modern innovation-oriented technologies, production management systems, use of raw materials, etc., and, consequently, continuous improvement, modernization, and development. The construction industry is a capital-intensive segment of the national economy, which is interconnected with such industries as mining, processing, metallurgy, machine building, etc. The research object of this article is the construction industry, which is the capital-forming industry, engaged in the development of the gross domestic product. The analysis of the industry was carried out using the classical tool of statistical data analysis, namely correlation analysis. The research is based on the analysis of the following industry parameters: GDP structure according to branches of the Russian economy, commissioning of residential houses by organizations of all forms of ownership in the Russian Federation, dynamics of the average actual cost of construction of 1 sq.m. of the total area of residential premises, which reflect tendencies and a state of development within the construction industry in Russia. The foreign experience in the development of the construction industry is presented. The performed analysis allowed formulating recommendations on the development of the Russian construction industry, which include legal, economic, social and environmental aspects.

\textbf{Keywords:} construction, dynamics, parameters, affecting factors, construction indicators, economic development.

1 Introduction

The construction industry plays a significant role in the social and economic development of the country, providing for the vital needs of the society in housing, infrastructure facilities, commercially significant facilities, sites of cultural importance, etc. [1-4]

The purpose of the article is to determine the factors that affect the parameters of the construction industry.

The aforementioned purpose led to the establishment of the following objectives:

1. to consider the dynamics of separate parameters that characterize the construction industry;
2. to propose factors that have an impact on key parameters of the industry;
3. to analyze foreign experience in the field of resource management.

Trends within the construction industry in Russia, in particular, housing construction, are such that the total area of residential premises per 1 resident of Russia in 2018 amounted to 25.8 sq. m. on average, which is 14.2\% higher than in 2010; yet, this figure falls behind the level of some BRICS and CIS countries [5-8]. For instance, in China this figure is 40.8 square meters, in Brazil - 32.3 square meters, in Armenia -31.9 square meters, in Belarus -27.3 square meters. The situation in European countries is as follows: in Germany - 47 sq. m, in Sweden - 41 sq. m, in France - 40 sq. m, in Poland - 27 sq. m. [9]

It should be noted that the institutional component plays a crucial role in the implementation of large development projects, in particular, financial institutions, the significance of which is enormous [10,11]. The development of financial institutions acting as clusters for the implementation of serious urban planning projects in Russia is currently in its formative stage. Investment and innovation components within construction production are venture funds, banks, mutual funds, etc., which
provide an opportunity to carry out projects [12-14]. At the same time, several factors affect the development of the construction industry: economic (inflation rate, the solvency of the population, the stability of the economic situation within the country, etc.), legal (legislative and legal restrictions), social (state support for certain segments of the population through appropriate programs), etc. [15]

Many world powers such as China, the USA, Turkey, and Great Britain in recent years actively invest in the construction industry as a promising long-term project in economic development, which emphasizes the relevance and importance of the development of this area of the national economy [16-20].

2 Methods

The method of factor analysis was used in the article: correlation analysis, in particular, paired correlation method, which represents a multistage process of solution search.

The algorithm proving the hypothesis about the interrelationship of different numerical assemblies includes the following stages:
- preparation of a reliable and sufficient sample of the study;
- calculation of correlation coefficients;
- estimation of the correlation coefficients' significance;
- conclusion about the null hypothesis or proof of the hypothesis.

Correlation represents a feature that indicates the interrelation of a range of numerical sequences, which allows characterizing the strength of the relationship within the data. If it relates to the relationship between two numeric arrays of \( x_i \) and \( y_i \), then it is a pair correlation, which can be documented as follows:

\[
R_{x,y} = \frac{1}{n-1} \sum_{i=1}^{n} (E_i - \bar{E})(\bar{y}_i - \bar{y}) \\
S_x S_y
\]  

(1)

where \( E \) and \( y \) – the current value of the array of numbers;
\( S_x \) and \( S_y \) - mean-square deviation, respectively, for each array of numbers considered;
n - the number of measurements in each set.

Consequently, correlation analysis allows concluding about the strength of the relationship between \( x \) and \( y \) pairs of data [21]

2.1 The foreign experience in the development of the construction industry

Many world powers have been actively investing in the construction industry in recent years, in particular, large and medium-sized development projects, both as a way of improving the quality of life of the population and in connection with the investment attractiveness of such projects. As a result of budget incentives, in 2010, China became the largest construction market in the world. Since the beginning of 2000, China has been intensively developing its construction industry, which resulted in a 23% revenue growth. Later on, since 2013, the pace of the industry development and the volume of investments began to decline. [16]

The catalyst for the construction industry in the United States is a program supporting financial institutions, which alleviates the requirements for borrowers and helps reduce interest rates on mortgage loans. According to world experts, an increase in the volume of construction work carried out on average by 3-5% per year will be observed in the American construction sector within the coming years. If the realization of projects becomes successful and in high demand, favorable changes should be expected in the economy as a whole [17]

The construction sector accounts for around 6% of GDP in the UK, which is slightly higher on average than in other countries within the European community. It is worth noting that the UK has emerged as an international financial and investment center in Europe, counting the segment of real estate finance transactions. However, due to the UK's exit from the EU in 2016, the intensity of operations within the UK construction sector has slightly decreased due to the wait-and-see approach of large investors [10].
The volume of investment in construction within India in 2010 increased 10-fold to 593 million dollars, largely as a result of the fact that 2010 was marked by an unprecedented volume of direct investment into the country's economy amounting to 24.7 billion dollars. According to world economists, India is among the five developing countries considered most attractive for real estate investments, along with China, Brazil, Mexico and Turkey [22].

Today, Turkey is a country that has a professional workforce capable of implementing various construction projects. This is evidenced by the demand for construction personnel in the international market. For instance, between 1972 and 2015, the average share of Turkish construction companies in Russia was about 20 %, in Turkmenistan about 16 %, in Kazakhstan - 6.6 %, in Azerbaijan - 3.5 %, and in the Middle East: in the UAE - 2.9 %, in Qatar - 3.7 %, in Saudi Arabia - 5.3 %, in Iraq - 7.4 %, in Libya - 9.4 %, in Algeria - 3.9 %. The total share in other countries (states in Africa, Australia, the EU, and the Far East) amounted to 22.5 %. Besides, Russia ranks as Turkey's second-largest trading partner, a major export market for Turkish food products and a major partner in tourism [12].

In addition, it is worth noting that the Turkish government has decided to diversify the construction sector: the priority of construction is given to strategically important and infrastructure facilities necessary for the favorable functioning of the state at the expense of the construction of residential facilities. The development of the construction industry in Turkey during 1980-2013 was also facilitated by the favorable conditions for domestic and foreign investors, who subsequently had "fast" economic returns from construction projects.

The experience of some countries such as the USA, Germany, Finland, Japan, Canada, where the state represented by its bodies controls the pledged profit rate during construction and installation works, is quite interesting. If an excess of the average profit norm (10-12 %) is registered, the reasons for such growth are examined and in case of inconsistency, the state carries out regulation by force. The situation on the regulation of market value for the finished real estate object is somewhat different in Russia. The project is unlikely to be implemented if according to the investor's point of view a proper profit rate is absent [15, 16].

Each state has many features, traditions, resource conditions that determine the trends and opportunities for the development of both the economy as a whole and the construction industry in particular. However, there are certain principles and basic tenets for the development of the construction sector that are relevant and applicable to any state regardless of its distinctive characteristics.

2.2 Performance indicators of construction industry development in the Russian Federation

Despite the high social and economic importance of the construction industry within the country's economy, its structure in GDP remains at a rather low level compared to other sectors of the economy (Figure 1).
It should be noted that, despite the small values of the construction share in the country's GDP in 2018, there was a serious dynamics of growth of this figure from 3% to 6% in the period from 2016, which indicates a positive trend of development within this direction of the investment plan [24].

The construction of commercial facilities has always been a financially attractive way to invest in Russia, which has allowed for the significant development of both infrastructure facilities and industry (Figure 2).

The dynamics of change in the share of industrial facilities construction in the first half of 2019 was 129% versus the values of 2018. Such a noticeable increase in the share of industrial facilities construction is caused by the growth of industrial production, which fact is reported by Rosstat. For instance, in 2018 Russian industrial production increased by 2.9%, while in 2019 it grew by 2.4%. Meanwhile, Russia ranks 4th in the world by industrial output as of 2017, ahead of Japan and behind
only to China, the USA and India. [25]. The construction of educational buildings (21 %) during the period under analysis also demonstrates a slight increase.

We shall analyze the dynamics of residential housing launched by organizations of all forms of ownership in Russia (Figure 3).

![Figure 3. Residential housing launched by organizations of all forms of ownership in Russia (million sq. m.)](image)

The trend of residential housing launching in Russia has an exponential character with positive trend line dynamics, which ensures the feasibility and demand for the implementation of housing projects. Furthermore, the economic situation in Russia during the 2017-2019 was quite stable. The inflation rate in Russia during December 2019 was 0.36 %, which is 0.08 more than in November 2019 and 0.48 less than in December 2018. At the same time, inflation since the beginning of 2019 was 3.05 %, and in annual terms amounted to 3.05 %. [27]. News about the reduction of interest rates on mortgage loans became a significant moment in the implementation of the housing stock since it purchased apartments and residential houses more accessible for citizens. This fact also contributed to the successful accomplishment of residential construction projects. However, the dynamics of growth in the cost of 1 sq. m. of the total area of residential premises in the commissioned residential buildings is excessive because it demonstrates a significant growth in the cost by almost 10 times over 17 years (Figure 4).

In accordance with the "Strategy for the development of the construction industry within the Russian Federation until 2030", more than 50 % of total investment in fixed assets falls on the construction of buildings (residential and non-residential) and structures, thus, the construction industry generates 6 % of the total gross value added to the economy as a whole. According to Rosstat data, the number of operating construction organizations within the Russian Federation was more than 270 thousand as of 2017, approximately 260 thousand or 94 % of which relate to the small and micro-enterprises. The profitability of construction companies is assessed steadily below the average for the economy. In particular, the profitability of construction organizations in terms of sold goods and services in 2010-2018 was in the range of 5-7.5 %, while the average economic figure was 7.7-12.3 %. [28]
The rise in construction costs for both residential and other urban infrastructure facilities over time is due to several economic, legal and industrial reasons. The process of object construction involves various production, industrial enterprises, which supply building materials, equipment for construction and installation works, machinery, etc., and this overall affect the actual cost of 1 square meter of the launched facility.

3 Results and Discussion

We shall conduct further research using the tool of factor analysis, namely correlation analysis. In this case, we shall establish a correlation between the average actual cost of construction of 1 sq. m. of the total area of residential premises within commissioned residential buildings during 2000 and 2017 represented by \( Cap \) and \( E \) factors using formula (1)

Usage of tools of mathematical modeling is necessary for proving the following hypothesis:

H1: The impact of financing sources on the actual construction cost is differentiated.

Since a strong direct correlation between the actual cost of construction of 1 sq. m. of the total area of residential premises and investments in fixed assets has been established within the framework of the conducted analysis (\( R_{\text{corr}}=0.9857 \) with a critical value of \( t_{\text{crit}}=0.754 \)), to prove the proposed hypothesis it is reasonable to carry out a detailed study of funding sources for fixed assets of construction organizations:
Table 1. Results of the correlation analysis for the actual cost of construction of 1 sq.m. of the total area of residential premises*.

| Parameter to analyze | Analysis factors (x) | \( R_{\text{calculated}} \) | \( R_{\text{critical}} \) | Evaluation of the significance and correlation ratio |
|----------------------|----------------------|-----------------------------|-----------------------------|---------------------------------------------------|
|                      | Investments into the net worth | 0.9857                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Cost of the primary housing | 0.9874                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Cost of secondary housing | 0.8679                     |                             | Signif., strong correlation ratio                  |
|                      | Own means of organization | 0.9375                     | 0.754                       | Signif., incredibly strong correlation ratio       |
|                      | Banks | 0.9052                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Budget financing | 0.9653                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Non-budgetary financing | 0.9399                     |                             | Signif., strong correlation ratio                  |
|                      | Construction co-investment | 0.8761                     |                             | Signif., strong correlation ratio                  |

* - Calculated by the authors

Significantly high values of correlation coefficients with the overall strong correlation of parameters have been obtained. The calculation has shown that the budget financing has the greatest impact on the cost of residential construction (0.9653), as well as the organization's own means (0.9375) and non-budgetary funding (0.9399).

Table 2. The results of the correlated analysis of the scope of work carried out according to the type of economic activity named "Construction".

| Parameter to analyze | Analysis factors (x) | \( R_{\text{calculated}} \) | \( R_{\text{critical}} \) | Evaluation of the significance and correlation ratio |
|----------------------|----------------------|-----------------------------|-----------------------------|---------------------------------------------------|
|                      | Investments into the net worth | 0.9637                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Cost of the primary housing | 0.9459                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Cost of secondary housing | 0.9893                     |                             | Signif., incredibly strong correlation ratio       |
|                      | Own means of organization | 0.7413                     | 0.754                       | Not significant                                   |
|                      | Banks | 0.7022                     |                             | Not significant                                   |
|                      | Budget financing | 0.8730                     |                             | Signif., strong correlation ratio                  |
|                      | Non-budgetary financing | 0.8479                     |                             | Signif., strong correlation ratio                  |
|                      | Construction co-investment | 0.6421                     |                             | Not significant                                   |

* - Calculated by the authors

The conducted correlation analysis has shown the absence of a correlation connection between the scope of construction work regardless of the purpose of the object with the following sources of financing: own means of the organization, bank loans and money resources of the construction co-
investors. There is a possibility that the sample was not complete enough within the framework of this research, however, the role of investments in such a capital-intensive sector of the economy is high.

4 Conclusions
Based on the conducted calculation, which used the paired correlation method, let us formulate the following conclusions:
1. the increase in investments to fixed assets ensures a proportional growth of the actual cost of construction of 1 sq. m of the total area of residential premises and, as a consequence, the cost of primary housing;
2. the scope of work carried out according to the type of economic activity named "Construction" has a strong direct proportional relation to the investments into the net worth;
3. the high linear ratio of the connection between the scope of work carried out according to the type of economic activity named "Construction" and budget and non-budgetary financing was established;
4. it was established that there is no correlation between the indicator of the scope of work carried out according to the type of economic activity named "Construction" and the organization's own means, borrowed funds (banks) and co-investment in the construction project.

Based on the conducted analysis of foreign experience and calculations of the factor analysis, it is reasonable to formulate recommendations for the development of the construction industry in the Russian Federation:
1. due to the high capital intensity of the construction industry, the length of the production cycle and, as a consequence, high financial risks for investors and project owners, it is advisable to provide state support (a program) to reduce them, as well as the possibility of increasing the share of financial participation of the state in the projects;
2. to improve the legislative base within the construction field (clear regulation of relations between rights and obligations of design and construction process participants, the establishment of maximum profit norms for socially significant and other projects);
3. to update normative and technical base for design and construction works focused on world trends;
4. to carry out the greening of the construction industry in accordance with the needs of society by introducing sustainability standards and sustainable construction;
5. to increase the innovative activity of organizations within the field of creation and implementation of new building materials and construction technologies, which meet the world trends.

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