Assessment of housing construction dynamics in Russia on the basis of neural network modeling

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Abstract — This article discusses the application of neural network modeling to analyze the dynamics of housing construction in Russia. The analysis of construction for the period of 2015-2018 is carried out. The main economic factors affecting the pace of construction are determined. The article presents a brief overview of the software and tools used for data mining, self-organizing Kohonen maps, and describes the technique of neural network modeling of construction activities. The study is limited to the period of 4 years and the identified several key economic indicators. Statistical information from official sources was used as the initial data for construction of the model. As a result of the study, there was an overall decline in the rate of housing construction during the period under review. The impact of income on the pace of construction is identified. Regions of Russia with high rates of housing construction by 2018 have been named, as well as regions with potential opportunities to increase the volume of housing construction in the near future. Thus, the results of the study are of practical importance and can help in the implementation of the planned plans of housing construction in Russia.

Keywords — neural networks, Kohonen maps, modeling, digital technology, data processing, housing construction.

I. INTRODUCTION

In modern times, the use of digital technologies is present in all spheres of life. Information technology is used at different levels of management to solve problems such as planning, forecasting, control, and analysis. In the economic sphere, analysis tools such as Big Data, Data mining and OLAP technologies are increasingly used. The national program "Digital economy of the Russian Federation" [1] defines the development of such basic end-to-end digital technologies as "big data; neuro technologies and artificial intelligence; distributed registry systems; quantum technologies; new production technologies; industrial Internet; robotics and sensor components; wireless communication technologies; virtual and augmented reality technologies". The use of neural network modeling tools in problems of economic analysis allows to obtain qualitatively new results. Such studies are often conducted in marketing to determine further development paths, for example in labor [2-5], and other areas, for example [6]. The analysis of housing construction as one of the important directions of economic research, it can be found in the labor [7-8]. However, the approaches to the study differ from those proposed in this paper. We will carry out research of such branches of economy as construction and analyze housing construction in Russia on the basis of neural network modeling. In future plans [9] in Russia it is necessary to build 120 million square meters of housing annually. This corresponds to 800 square meters per 1000 people. Of particular interest is the study of various factors affecting the implementation of plans.

The purpose of this study is to determine the main factors affecting the pace of housing construction in Russia, based on the analysis of construction volumes over the period 2015-2018.

II. INPUTS AND METHODOLOGY

The initial information for the analysis is taken from the State statistics website [10]. The unified interdepartmental information and statistical system (EMISS) is a state information resource that combines official state information statistical resources. Available via the internet to various authorities and individuals, the system contains official statistical information, including metadata generated in accordance with the statistical work plan. Access to official statistical information is free of charge.

MS Excel and Deductor applications are used as an analysis tool. Deductor is an analytical platform for creating complete application solutions in the field of data analysis [11]. It includes a complete set of tools for solving Data Mining problems [12]. In this work we use the Data Mining tool Kohonen self-organizing maps (TSO) [13]. TSO Kohonen is a special type of neural network consisting only of input and output layers of neurons. The multidimensional input space is mapped as a neural map, usually two-dimensional.

In this paper, neural network modeling of the dynamics of housing construction in different regions of Russia for the period 2015-2018 is based on the following indicators [8]:

K1 – the total area of residential buildings. Units of measurement are thousand square meters of residential space. The total area of the residential space is defined as the sum of the areas of all parts of premises, including the area of premises of auxiliary use. The total area of the entered residential buildings does not include the area of lobbies, vestibules, stairwells, elevator halls, shared corridors.

K2 – the average price of 1 sq. m. of the total area of apartments within the housing market, the primary housing market. Unit of measurement – thousand rubles. The average price of 1 square meter of total apartment area with a certain
number of rooms of each type of housing is determined on the basis of data of actual transaction prices.

K3 – the ratio of average per capita income of the population to the subsistence minimum. Measurement units – percentage. Is determined by dividing per capita monetary incomes of the population in the whole of the Russian Federation, as well as in the whole of the subject of the Russian Federation, by the subsistence minimum in the whole of the Russian Federation.

K4 – the total area of houses per 1000 people of the population. The unit of measurement is square meter. It is defined as the ratio of the total area of residential buildings to the average annual number of permanent population (per 1000 people).

Indicators K1-K4 were used to build clusters.

The following indicators were used for analysis:

P1 – permanent population per year on average. Unit of measure – people. The average annual population is the arithmetic average of the population at the beginning and end of the corresponding year in the region.

P2 – the cost of all built apartments for the year. Unit of measurement – thousand rubles. It is determined by multiplying K2 (average price of 1 sq. m of the total area of apartments in the housing market) by K1 (the total area of residential buildings is put into effect).

III. RESEARCH RESULT

As a result of the analysis, the distribution of Russian regions by clusters was obtained: in 2015, 2016-6 clusters, 2017-5 clusters, 2018-7 clusters (figure 1).

A diagram of the distribution of the number of regions by clusters is shown in figure 2.

Fig. 2. Distribution of the number of regions in the cluster by year.

In 2015, the Moscow region was in cluster 0, and Moscow was in cluster 4.

In 2016, cluster 0 included Kaliningrad region, Leningrad region, Lipetsk region. In cluster 4 Moscow and St. Petersburg were included, Moscow region in cluster 2. In 2017 and 2018, Krasnodar region, Leningrad region, and Moscow regions were included in cluster 0. Moscow and St. Petersburg were in cluster 2.

Let's calculate for each cluster in a certain period the final indicators: K1, K2, K3, K4 and add the total indicators in the cluster P1 (the number of permanent population per year) and P2 (the cost of all built apartments per year). The calculation results are given in tables II-V.

| Year | Cluster 0 | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 | Cluster 5 | Cluster 6 |
|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 2015 | 1         | 9         | 31        | 8         | 1         | 31        | ----      |
| 2016 | 3         | 32        | 8         | 5         | 2         | 31        | ----      |
| 2017 | 3         | 12        | 2         | 23        | 41        | ----      | ----      |
| 2018 | 3         | 10        | 2         | 10        | 23        | 5         | 26        |

The distribution of the number of regions in clusters by year is presented in table 1.
In all clusters there is a tendency – the higher the indicator K3 (the ratio of per capita income of the population to the subsistence minimum), the higher K2 (the average price of 1 sq. m. of the total area of apartments in the housing market) (figure 3).
Evaluation of the impact of K3 on K4 (enacted total area of residential buildings per 1000 people) over the past period has shown that income growth increased the unit number of the input area (figure 4) to a certain level. However, the increase in the cost of housing per square meter with an increase in the welfare of the population reduced the value of the indicator K4.

Clusters with indices K1 (enacted total area of residential houses) and K4 (introduced in the total area of residential buildings per 1000 people) is shown in figure 5.

As can be seen in the figure, only a small part of the clusters is located above the 800 mark of the K4 index. But the figure of 800 square meters per 1000 people is the target for Russia in the near future.

IV. ANALYSIS OF RESULTS

Overall, the total area of residential buildings per 1,000 people (K4) fell from 583 to 515 square meters in the period 2015-2018, which amounted to 12%.

In 2018, 75636 thousand square meters of housing were built in Russia (K1 Russia 2018). At the same time, the indicator K4 (input of areas per 1000 people) above the target value of 800 square meters per 1000 people is observed only in one cluster 0 (figure 5). These are Krasnodar region, Leningrad region, Moscow region. That is, 21% of all housing commissioned in Russia was split among these three regions. A similar figure in 2015 was 37% and accounted for 10 regions of Russia (clusters 0 and 1), including the Moscow region. There is a drop in housing construction in most of Russia.

Potential opportunities for construction of the required amount of residential space are in regions with high income (K3). In 2018, there were 12 such regions, falling into clusters 1 and 2. The total index P1, the permanent population, in these regions is 30% of the total population of Russia. Given the above, the potential for housing construction in these regions is very high. The limiting factor today is pricing (K2). These are the regions: Arkhangelsk region, Belgorod region, Voronezh region, Lipetsk region, Nizhny Novgorod region, Republic of Bashkortostan, Republic of Tatarstan (Tatarstan), Sakhalin region, Sverdlovsk region, Tyumen region, Moscow, St. Petersburg.

V. CONCLUSION

This document analyzes the dynamics of housing construction in Russia on the basis of statistical information for the period 2015-2018. Neural network modeling tools were used. All regions of Russia were divided into clusters, the number of which varied in different periods. The analysis showed that the indicator K3 (the ratio of per capita income to the subsistence minimum) can be used to study the housing market and assess its potential. The distribution of regions by clusters showed that only in one cluster in 2018, the construction rate matches the value of 800 square meters per 1000 people. The remaining clusters were divided into two groups: low-income (K3 less than 300), and high-income. The approach to solving the problem of increasing the pace of housing construction in these clusters will differ. In the case of high-income clusters, a change in the price of housing under construction is sufficient. In another group of clusters, it is necessary to increase the incomes of the population. Regions with potential opportunities to increase the number of housing under construction are identified.
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