Neural network modeling of tourism development as a factor of sustainable economic growth in Russian regions

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Abstract. The features of the development of the tourism sector in the regions of the Russian Federation, which have an impact on the socio-economic development of the country, have been investigated. Analysis of the current state of the tourism sector, classified as the main types of economic activity, is relevant and important for increasing the competitiveness of the regions of the Russian Federation and ensuring the economic security of the state. The study is aimed to model and analyze tourist cluster formations in Russia. The study of tourist activity in the regions of Russia based on the indicators of the database of the Federal State Statistics Service was carried out using a new promising approach - cluster analysis using the scientific and methodological apparatus of artificial neural networks. The distribution of Russian regions into five tourist clusters has been obtained as a result of clustering multidimensional data using neural networks - self-organizing Kohonen maps, which are focused on self-study, and modern information technologies. In neural network modeling, the six-dimensional space of tourism development indicators was mapped, taking into account the topology, into a two-dimensional space, which made it possible to visualize the results of grouping regions by tourist clusters. The features of the development of the tourism sector in the regions of the Russian Federation have been revealed by the totality of the considered indicators The obtained results state that there is a strong variation in the number of regions by tourist clusters and the ametric nature of the development of tourist activity in the regions of Russia. The results of the study are of practical significance for the strategic planning of the tourism sector development, which ensures the development of domestic and inbound tourism. Analysis of the functioning of the tourism sector in the regions of the Russian Federation allows concluding the necessity to take a set of measures to stimulate effective investment activity in a number of tourism clusters, harmonizing the strategies of the state and business, which will contribute to the renewal and competitiveness of this type of economic activity.

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1 Introduction

Ensuring sustainable economic growth in each region of the Russian Federation and the country as a whole corresponds to one of the main directions in solving the key tasks of economic policy [1]. The development of the tourism sector [2, 3] is a significant factor contributing to the sustainable development and competitiveness of the regional economy.

The tourism sector is associated with various industries that integrate and form the provision of the tourism industry and travel: hotel business, transport, catering, arts and crafts, utilities and other activities. This industry is significant for the sustainable development of the economy taking into account the number of organizations, entrepreneurs, and the population involved in the tourism industry, as well as the associated social and economic effect. Tourism also plays an important role in protecting the natural and cultural heritage of the territories. As one of the largest and fastest growing economic sectors in the world, tourism promotes economic growth and socio-economic development of the regions, including through the creation of jobs. Increased investment in tourism infrastructure leads to an increase in the standard of living of the population and an increase in the attractiveness of cities and rural settlements for tourists. Empirical research results show that an increase in the number of tourists by 1% leads to an increase in economic growth of 0.41% [4]. In the countries of the Organization for Economic Cooperation and Development, the tourism sector accounts for 4.4% of GDP, 6.9% of employment and 21.5% of exports of services [5].

The COVID-19 pandemic has had a significant impact on the tourism industry, with 1 billion fewer tourist trips around the world, and a loss of $ 1.3 trillion in total export revenue from international tourism, from 100 to 120 million jobs are under the threat of cutting [6]

According to a report by the World Travel and Tourism Council, the total contribution of the tourism sector to world GDP is estimated at 10.4 %. The significant contribution of tourism to the GDP of the Russian Federation is shown by the data (Figure 1), which indicate a positive dynamics of the contribution of the tourism sector to the GDP of Russia.

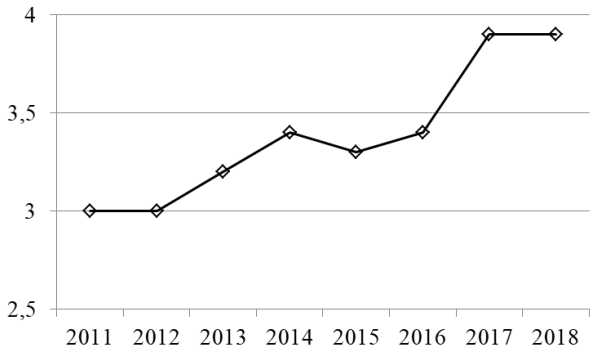

Fig. 1. Dynamics of the contribution of the tourism sector to Russia's GDP, % [16].

It is worth noting that tourism refers to the type of economic activity in which the maximum multiplicative effect is found to accelerate Russian economic growth. Investments in the tourism industry create added value in such economic activities as construction and production of building materials, transport, trade and services. One of the possibilities for further increasing the role of tourism in the socio-economic development of the regions of the Russian Federation can be contained in the creation of favorable conditions for the development of small and medium-sized businesses in the tourism sector. At the same time, it is relevant to study the development of the tourism sector of the

economy, in order to harmonize the strategies of the state and business in the field of tourism.

In the last few years, there has been a growing interest in studying the impact of sustainable tourism development on economic growth.

The works of many scientists are devoted to the development of tourist clusters in Russia, as a rule, the authors propose to form tourist and tourist-recreational zones within one or several neighboring regions [7, 8, 9, 10, 11]. The article features a new approach to modeling tourist areas using the scientific apparatus of artificial neural networks.

2 Materials and methods

Tourist as well as sports activities are characterized by multidimensional data sets. The multidimensionality of the initial data determines the use of classical statistical methods of analysis, which demonstrate very high efficiency. In this article, neural networks are used for cluster analysis of multidimensional data – the most important direction of artificial intelligence, which is one of the most advanced and promising tools and provides new approaches to the study of multidimensional problems - Kohonen self-organizing maps (SOM). These neural networks are a representative of the class of unsupervised neural networks [12, 13, 14, 15]. Kohonen SOMs are qualified as an effective tool for cluster analysis and visual representation of multidimensional statistical data [12, 14]. To conduct research, there were used neural networks implemented in the Deductor - analytical software package.

3 Results

The study of the development of the tourism sector of the economy of the Russian regions was conducted on the basis of the statistical database of the Federal State Statistics Service for 2018.

In neural network modeling, the six-dimensional space of tourism development indicators in the regions of Russia was mapped, taking into account the topology, onto a two-dimensional self-organizing map (Fig. 2).

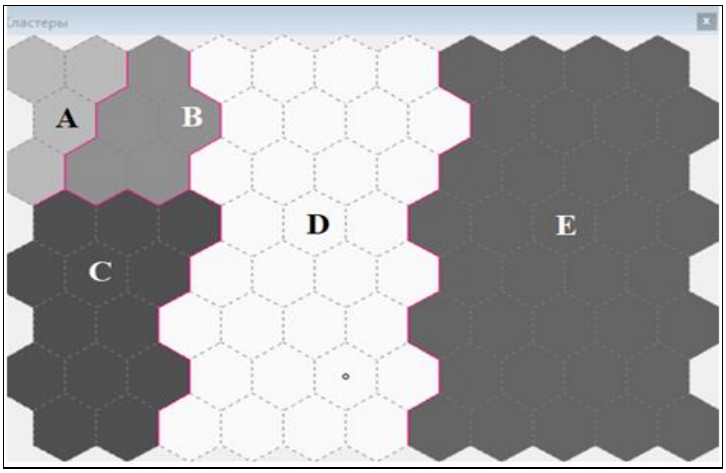

Fig. 2. Self-organizing map of the distribution of Russian regions by cluster in 2018 [17].

Let's consider the descriptive statistics (Table 1), the important mission of which is to discover the distribution law of the studied indicators. Key characteristics: measures of

central tendency, dispersion, and the distribution forms of the indicators, which are presented in table. 1, state the absence of symmetry in their distributions. This confirms the difference in the measures of the central tendency, which are identical for the normal distribution law, distinguished by symmetry and unimodality. Dispersion measures that characterize the spread, i.e. the "width" of the distribution, and the measures of the form of the studied indicators also confirm the asymmetric form of their distributions.

Table 1. Descriptive statistics of indicators of innovative development of the tourism sector of the Russian Federation

Indicators	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**
Measure of central tendency						
Average	330.26	866.97	160.87	53.95	39.71	64.54
Median	187	347	117	22.3	15.1	24.5
Fashion	119	249	100	9.4	5.6	13.1
Interquartile range (IQR)	220	525	149	35.9	35.6	40.4
Measure of dispersion						
Dispersion	438036	4578787	25344.1	18517.1	4665.55	42352.6
Standard deviation	661.84	2139.81	159.20	136.08	68.30	205.80
Standard error of the mean	71.79	232.09	17.27	14.76	7.41	22.32
Variation coefficient	200.40	246.81	98.96	252.23	172.03	318.85
Minimum	5	8.9	2	0	0	0
Maximum	5883	17252	787	1141.1	438.6	1879
Variation range	5878	17243.1	785	1141.1	438.6	1879
Distribution form measures						
Asymmetry	7.32	6.13	1.84	6.71	3.98	8.37
Excess kurtosis	60.50	42.96	3.58	50.75	18.84	74.18

Table 1 shows that the asymmetry is positive for all indicators, therefore, the right tail will be thicker than the left one, and the top is shifted to the left. In the case when the distributions are symmetrical, the skewness is zero.

The values of the kurtosis characterize the shape of the top of the graph of the one-dimensional vertical distribution. The data in Table 1 show that the kurtosis values are also positive for all indicators. This means that their distributions are characterized by a sharp top and thick tails. At the same time, in the distributions of all indicators, except for the indicator X3, where the kurtosis value exceeds 5, more values are concentrated at the edges than near the average value.

Scientific tools and methodology of artificial neural networks were applied for further research of the initial data and analysis of the innovative development of the tourism sector.

The results of the conducted neural network modeling indicate that 85 regions of the Russian Federation formed five tourist clusters according to the studied indicators. Tourist clusters A, B, and C formed regions with high values of the indicators considered. In the regions of the tourist cluster D, there are fluctuations in the values of indicators near their average values in the Russian Federation. The regions of the tourist cluster E are characterized by low values of all indicators.

Detailed results of the entry of the Russian regions into a particular tourist cluster in 2018 (table. 2) show that the aggregation of regions by cluster does not depend on their belonging to the federal districts.

Table. 2. Integration of regions by tourist clusters.

Cluster	Cluster composition
A	Moscow, St. Petersburg
B	Krasnodar Territory
C	Moscow region, Rostov region, Republic of Tatarstan, Perm region, Nizhny Novgorod region, Sverdlovsk region, Chelyabinsk region, Krasnoyarsk Territory, Novosibirsk region
D	Vladimir region, Kaluga region, Tver region, Tula region, Yaroslavl region, Republic of Karelia, Arkhangelsk region, Vologda region, Republic of Crimea, Astrakhan region, Volgograd region, Sevastopol, Stavropol territory, Republic of Bashkortostan, Udmurt Republic, Kirov region, Orenburg region, Samara region, Saratov region, Khanty-Mansiysk Autonomous district - Yugra, Tyumen region, Altay Kray, Irkutsk region, Kemerovo region, Omsk region, Primorsky Kray, Khabarovsky Kray
E	Belgorod region, Bryansk region, Voronezh region, Ivanovo region, Kostroma region, Kursk region, Lipetsk region, Oryol region, Ryazan region, Smolensk region, Tambov region, Komi Republic, Nenets Autonomous district, Kaliningrad region, Leningrad region, Murmansk region, Novgorod region, Pskov region, Republic of Adygea, Republic of Kalmykia, Republic of Dagestan, Republic of Ingushetia, Kabardino-Balkar Republic, Karachay-Cherkess Republic, Republic of North Ossetia - Alania, Chechen Republic, Republic of Mari El, Republic of Mordovia, Chuvash Republic, Penza region, Ulyanovsk region, Kurgan region, Yamalo-Nenets Autonomous district, Altay Republic, Tyva Republic, Khakassia Republic, Tomsk region, Republic of Buryatia, Republic of Sakha (Yakutia), Trans-Baikal Territory, Kamchatka Territory, Amur region, Magadan oblast, Sakhalin oblast, Jewish Autonomous district, Chukotka Autonomous district

Source: Author's development - the result of neural network modeling based on data from the Federal State Statistics Service of the Russian Federation (URL: http://gks.ru)

Table 3 illustrates the analysis of statistics results of the average values of indicators for 2018 for the regions of Russia by tourist clusters and the general average values of indicators for the Russian Federation. The following indicators were investigated: X1 – the number of collective accommodation facilities, units; X2 – the number of accommodated persons, thousand people; X3 - the number of organizations carrying out tour operator and travel agency activities, units; X4 - the number of tour packages sold to the population, thousand; X5 – the number of Russian tourists sent by organizations of the tourism industry on tours around Russia, thousand people; X6 – the number of Russian tourists sent by organizations of the tourism industry on foreign tours, thousand people.

Table 3. Statistics of the average values of indicators of the tourism sector development of the economy of the Russian regions by cluster for 2018.

Clusters	Average					
	X1	X2	X3	X4	X5	X6
A	1325	11606.50	678	830.00	399.45	1069.65
B	5883	8051.00	595	168.10	227.00	126.40
C	502	1544.67	432	104.04	82.65	132.95
D	336	667.33	186	42.63	45.50	43.27
E	129	228.45	61	14.57	8.19	18.60
Average for the Russian Federation	**330**	**866.97**	**161**	**53.95**	**39.70**	**64.54**

Source: Author's development - the result of neural network modeling based on data from the Federal State Statistics Service of the Russian Federation (URL: http://gks.ru)

It is noteworthy that according to Table 3, the regions of the Northwestern Federal District were divided into clusters as follows: one region joined cluster A, three regions –

cluster D, and seven regions – cluster E. Three regions joined Cluster C, six regions– cluster D, and five regions – cluster E from the fourteen regions of the Volga Federal District.

The results (Table 3) indicate that all the studied indicators X1 - X6 take maximum values in the regions of the tourist cluster A (Moscow and St. Petersburg), both in comparison with their values in other tourist clusters, and in comparison with the all-Russian values. All indicators of regional tourism development in the subjects of the Russian Federation included in tourist clusters B and C exceed the national average, and in the regions of the tourist cluster E, the indicators are less than the national average. The state indicators of the tourism sector in the regions included in the tourist cluster D demonstrate multidirectional development.

4 Conclusion

The conducted research made it possible to assess the state of socio-economic activity of Russian regions in the tourism sector and showed the effectiveness of using the method of clustering multidimensional data based on a new approach – neural networks. The presented method of data analysis with the use of neural networks and the results obtained showed the uneven nature of the development of tourist activity in the regions of the Russian Federation.

In the context of the research carried out, the results of the work can help to justify and improve the quality of management decisions in the field of tourism to create favorable conditions for conducting tourist activities that ensure the development of domestic and inbound tourism, which serve as sources of significant revenue to the budget, strengthening the national security of the country.

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