RESEARCH OF YOUTH SPORTS IN THE RUSSIAN FEDERATION AS A FACTOR OF HUMAN CAPITAL FORMATION USING NEURAL NETWORKS

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ABSTRACT

With the use of neural network modeling, the authors analyzed the current state of youth sports in rural areas of Russian regions, which characterizes human capital. The simulation uses neural networks implemented in the Deductor package – self-organizing Kohonen maps. As a result of the analysis, the authors obtained a distribution of regions in five clusters. The composition and characteristics of each cluster are presented. The regions with the highest indicators of sports development in rural areas have been identified. This paper shows the influence of the indicators considered on human capital, which is one of the dominant internal factors of socio-economic potential of territories. The results of the research are of practical significance for a comparative analysis of the development of children's and youth sports in the regions of Russia and can be taken into account in the strategic planning of the development of the sports industry in the context of increasing the quality of human capital.

Keywords: physical culture, sports, youth sports, human capital, rural areas, territorial development, cluster analysis, neural networks, self-organizing Kohonen maps.

Introduction

At the present stage, one of the main tasks of economic development of the regions of the Russian Federation and ensuring their national security, including economic security (Mityakov et al., 2013; Lapaev, 2016), is

the development of physical culture and sport. According to Yang et al. (2020) the development of physical culture and the sports industry contributes to regional sustainable development, as well as the accumulation of human capital (Makarov and Kleiner, 2007; Kuznetsov, 2012; Perova et al., 2019). Human capital as one of the foundations of innovative development of the economy of a country characterizes the population's quality of life. Human capital includes the knowledge, skills, and health that people accumulate over the course of their lives, enabling them to realize their potential as useful members of society (Adams et al., 2018; Khodzhaevich et al., 2020).

Various indices are used to quantify the quality of life of the population, and the human development index proved to be the most informative among them. This is noted in the works of Ayasreh (2016), Soboleva (2007), and Naydenov (2019). This index is used in in relation to various countries as a whole and to individual regions. The human development index, being an integral indicator, includes three main components: income, education and longevity indices, which are used to assess the development of a person – the core subject and the leading object of the state's national security system. These components show three fundamental qualities of the country's development: a healthy life that leads to the longevity of the population; the level of education received; and material prosperity that is appropriate for a person. The longevity of the population is determined by life expectancy, which, in turn, is directly related to the level of development of physical culture and sports in each region of the country.

It should be noted that the development of physical culture and sports in the Russian regions is characterized by the presence of imbalances, which are caused by a wide variety of regions in terms of infrastructure levels, availability of qualified personnel, investment, technical improvement and innovative approaches to the construction of sports facilities, correlation of competitive advantages and drawbacks and several other factors. This issue was researched in the papers of Letiagina et al. (2018, 2019).

Methodology and Materials

The article presents a cluster analysis of multidimensional data based on neural networks, a promising data mining tool that offers new approaches to the study of multidimensional problems (Khrustalev and Shramko, 2017; Checkin and Pirogov, 2009; Gorban and Rossiev, 1996; Milov et al., 2010; Haikin, 2006).

Among neural networks, we note neural networks with unsupervised learning, which are used for clustering multidimensional data, as well as visualization and reducing their dimension. This class of neural networks

includes the Kohonen self-organizing maps described in the works of Kohonen (1990), Hajek and colleagues (2014), Carboni and Russu (2015).

In this paper, we used for our research the data from the Federal state statistics service of Russia on the development of children's and youth sports in rural areas of the Russian regions. The reason for choosing this type of data was the fact that one of the target indicators of the state program "Development of physical culture and sports of the Russian Federation" is the share of the rural population that is systematically engaged in physical culture and sports in the total rural population of the Russian Federation aged 3-19 years. The program provides for an increase in this indicator from 26 % in 2017 up to 35 % by 2024. The study included 82 regions of Russia.

Results and Discussion

We used the following figures for 2018 as classification features:
- X1 – the number of organizations for additional general developmental programs for children in the field of physical culture and sport (units);
- X2 – the number of attendees of the additional general developmental programs for children in the field of physical culture and sports (persons).
- X3 – the number of children's and youth sports schools (including branches) (units);
- X4 – the number of those attending children's and youth sports schools (persons);
- X5 – stadiums with stands (units);
- X6 – open-air sports facilities (units);
- X7 – gyms (units);
- X8 – swimming pools (units);
- X9 – the number of attendees of additional pre-vocational programs for children in the field of physical culture and sports financed from the Federal budget (persons);
- X10 – the number of attendees of additional pre-vocational programs for children in the field of physical culture and sports financed from the budget of a constituent entity of the Russian Federation (persons);
- X11 – the number of attendees of additional pre-vocational programs for children in the field of physical culture and sports financed from the local budget (persons);
- X12 – the number of attendees of additional pre-vocational programs for children in the field of physical culture and sport funded under contracts on rendering paid educational services (persons);
- X13 – average income per capita (RUB).

As a result of neural network modeling, 82 regions of the Russian Federation were distributed in five clusters.

The multidimensional space of indicators of youth sports development in the regions is analyzed by means of data mining, a modern and effective method for multidimensional data processing. Neural network modeling involves the use of artificial neural networks – Kohonen self-organizing maps and information technologies (Deductor). The authors show that youth sports development of Russian regions is non-uniform. When clustering data on a set of youth sports development indicators, the regions were divided into five clusters. This research contributes to a better understanding of youth sports in each region and helps to determine the direction of future development strategies and regional policies.

The number of Russian regions in clusters is shown in Table 1.

Table 1. Statistics of average values of indicators and distribution of Russian regions for clusters

Average value	The cluster number					Average for Russia
	1	2	3	4	5	
X1	49	51	115	246	485	169
X2	3400	28775	7551	21667	59270	14025
X3	3	5	10	22	62	16
X4	670	2469	2900	11165	38272	6995
X5	0	6	3	11	22	6
X6	32	237	504	1092	2276	706
X7	32	104	231	513	903	317
X8	2	9	5	10	24	7
X9	65	16	6	45	461	53
X10	511	631	422	1716	10599	1450
X11	3435	25630	5446	20455	20601	10233
X12	14	1533	79	434	183	208
X13	62666	43401,9	24726,9	27696,2	27226,7	29447,3
Number of regions	7	3	49	16	6	

One can see from Table 1 that the smallest numbers of regions were included in cluster 2, and the largest number – in cluster 3. Table 1 show the average values of the indicators for clusters and the overall average indicators for the Russian Federation.

It follows from Table 1 that:

1. The number of organizations for additional general developmental programs for children in the field of physical culture and sports (X1), the number of youth sports schools (including branches) (X3), the number of attendees of children's and youth sports schools (X4), stadiums with stands (X5), open-air sports facilities (X6), gyms (X7) and the number of attendees of additional pre-vocational programs for children in the field of physical culture and sports financed from the budget of a constituent entity of the Russian Federation (X10) is higher than their overall average values for Russia in the regions included in clusters 4 and 5.

2. The number of stadiums with stands (X5) is at the level of the overall average values for Russia in the regions of cluster 2.

3. The number of pupils on the additional general developmental programs for children in the field of physical culture and sports (X2), the number of swimming pools (X8) and the number of attendees of additional pre-vocational programs for children in the field of physical culture and sports financed from the local budget (X11) is higher than average Russian Federation values in the regions of clusters 2, 4 and 5.

4. The number of attendees of additional pre-vocational programs for children in the field of physical culture and sports financed from the Federal budget (X9) is above the average for Russia in the regions of clusters 1, 4 and 5.

5. The number of attendees of additional pre-vocational programs for children in the field of physical culture and sport funded under contracts on rendering paid educational services (X12) is higher than the average for Russia in the regions included in clusters 2 and 4.

6. The average per capita income of the population (X13) exceeds the average values for the Russian Federation in the regions that make up clusters 1 and 2.

It should be noted that in the regions of cluster 1, there is a minimum number of attendees of additional pre-professional programs for children in the field of physical culture and sports funded under agreements on the provision of paid educational services. At the same time, in the regions that make up this cluster, we have the maximum value of the average per capita income of the population.

The leaders in terms of the indicators under consideration are the regions of cluster 5 for maximum indicators X1–X10, the regions of cluster 2 for maximum indicators X11 and X12, as well as the regions of cluster 1 for maximum indicators X13.

Conclusion

The research performed with the use of neural network modeling allowed us to assess the state of children's and youth sports in rural areas of the regions of the Russian Federation. The main difference between the method of neural network modeling and other methods, such as expert systems, is that neural networks – self-organizing Kohonen maps – build the model themselves only on the basis of the information presented to them. It is found that the presence of significant differences in the size of clusters indicates an uneven development of children's and youth sports in rural areas of Russia. The results of data clustering show that the composition of clusters does no coincide with the composition of Federal districts to which these regions belong. The regions that are promising in the development of this area of activity have been identified. These are the regions of the Russian Federation that formed cluster 5 with the highest values of indicators X1–X10, cluster 2 – with the highest values of indicators X11 and X12, and cluster 1 – with the highest value of indicator X13.

From the point of view of the future state of children's and youth sports in Russia's regions and ensuring the development of human capital, it is important to bring about convergence in the levels of regional development indicators.

The method of analysis presented in this paper using neural networks and the results obtained are of practical significance. They can be used for comparative analysis of the development of children's and youth sports in different regions and for strategic planning in the field of physical culture and sports for subsequent periods. This will contribute to improving the validity of management decisions in the field of physical culture and sports at the regional level in order to increase the quality of human capital and improve the country's economic security.

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