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A CONCEPTUAL MODEL OF THE REGIONAL HUMAN CAPITAL DEVELOPMENT

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ABSTRACT

A conceptual model of the regional's human capital development is proposed, which allows describing the dynamic process of its development by investing state, regional and municipal resources, private funds of the enterprise and individuals therein. Lists of directions of investment in regional human capital, indicators of regional human capital, the quality of life of the population and socio-economic development of the regions, and demographic parameters of the region are singled out. The channels of influence and changes in the regional's human capital are described.

1. INTRODUCTION

Under constant and dynamic changes in the processes associated with the transition of the economies of countries to the knowledge economy, most socio-economic systems have to adapt to modern requirements for maintaining and increasing their own market competitiveness. The countries that compete for a share of the implementation of a product in the world market are no exception. In this regard, there is a need to reorient regional social and economic capacities for the production and sale of information and innovative products.

At the same time, in order to implement such a transition, a strategy of social and economic development of the region is required, which will reflect an accurate and rational action plan ("road map") indicating annual goals and targets. Achieving the goals and objectives can be done through the effective use of resources available on the territory. In turn, the knowledge economy places the highest importance on human capital being at the same time a very specific resource of the region (for example, unlike other resources, human capital does not have an accurate measurement system), which significantly complicates the assessment of effects, arising when its value changes.

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In this case, the role of human capital in such an open system as a region is particularly important and specific, the achievement of strategic goals and development objectives directly depends on its economically active population. In this regard, the actual issue is the development of a set of interrelated economic and mathematical tools that allow:

- functionally describing the impact of: public and private investment in the living standards and the human capital of the region on regional human capital; regional human capital on progress in achieving the strategic goals and objectives of the region; level of socio-economic development on the demographic parameters of regional human capital;

- forming an optimal plan of measures to improve the quality of life and the size of the regional human capital according to specified criteria.

2. LITERATURE ANALYSIS AND PROBLEM STATEMENT

A large number of studies over the past decades have been devoted to the problems of the development of regional human capital. For the most part, they address issues of assessing the intellectual capital of the region and improving the quality of labor resources through the development and modification of the education system at its various levels and the health system. We should specifically note here that to this day the question concerning the conceptual component of the development of regional human capital remains open, i.e. at present, there is no single and generally accepted interpretation of the concept of "regional human capital". In turn, the instrumental component of the issue is also incompletely developed, since the existing tools for the development of human capital at the mesolevel are unsystematic, and tools used at the micro- and macrolevels cannot be transferred to the level of regions (this is due, for example, to that no analogues of statistical data used to quantify the country's human capital in the regional level exist). Thus, the first step in the formation of a system of interrelated methods and models for the development of regional human capital is the elaboration of a conceptual model that would address three issues:

- How to estimate the value of regional human capital (including indicators that should be taken into account when calculating the integral indicator)?

- How do public and private investments in the living standards and the human capital of the region affect regional human capital?

- How does the human capital affect the socio-economic development of the region?

Analysis of papers on the first issue showed that most studies use multidirectional statistical data to assess the human capital of the region.

For example, the most common tool for assessing the value of human capital of a country or region is the UN method, based on the evaluation of the Human Development Index (HDI), which includes five components: the human capital index; human development index; gender development index; gender inequality index; and multidimensional poverty index [Human Development Report 2016]. It is worth mentioning the research by O.V. Loseva (2017), who estimates the innovation capital of the region by three aggregate groups of indicators: an assessment of the regional innovative core; an assessment of the institutional and innovative infrastructure of the region; and innovative capital in the scientific and research field. In Lokosov et al. (2015), 63 indicators of

human capital assessment in the region are selected and systematized by seven aggregated groups: economic activity; demographic processes; physical health; culture; social health; education; and attitude of the population to the natural environment. In Zabelina et al. (2013), the human capital index of the region is estimated by four aggregated indicators: the education capital; labor capital; health capital; and social capital. In Gurban (2015), human capital is estimated in terms of the subjects of Russia, including such components as demography, education, labor, science and social culture. In Shepeleva et al. (2016), an indicator of the assessment of the human capital of the industrial region was elaborated, integrating six basic components: health, competence, culture, creativity, motivation and reliability.

At the same time, the key distinguishing features of the tools described above are the list of indicators for calculating the integrated assessment of regional human capital and the model for calculating the value of the regional human capital. It should be noted that most works give priority to professionalism, education, health, science, innovation, culture as the main components of human capital (statistical data are used for their calculation). In our opinion, the second level of decomposition (the component of regional human capital for indicators) has a certain failure, which does not allow us to comprehensively assess the regional human capital. Thus, for example, the scientific component does not fully take into account the activities of employees of scientific and educational organizations, namely scientific publications; the professional component neglects the efficiency of investment in fixed assets and the performance of medium and small businesses; the education component - the share of teaching staff having either PhD or MD degree in the total number of permanent residents, etc.

We have also mention a number of generally accepted tools that are used to assess the country's human capital. For example, the WEF method, which calculates the human capital index consisting of four components: capacity, development, deployment and know-how [The Global Human Capital Report 2017]. The method has been developed by the World Bank, in terms of which the knowledge economy index is calculated including four aggregated groups of indicators: the economic and institutional regime; education; innovation; information and communication technologies (2017 Knowledge Economy Report). The method of the European Commission, which calculates the regional competitiveness index and consists of: basic measures (institutions, macroeconomic stability, infrastructure, health, basic education); efficiency measures (higher education and self-education, labor market efficiency, market size); and innovative measures (technological availability, business complexity, innovations) (Annoni et al., 2017).

The distinctive features of the above described tools are similar to the previous ones. In this case, it is rather difficult to modify them for the mesolevel. This is due to the fact that a number of statistical data used to calculate the value of the country's human capital has no analogues at the regional level.

The analysis of works on the second issue showed that one of the ways to develop the regional human capital is to invest public and private financial resources in the regional socio-economic environment. Thus, in Burgess (2016), the mutual influence of improving the quality of the education system in the country and the development of human capital is analyzed. In Percoco (2016), the influence of factors contributing to the deterioration of the health of the population of the region (for

example, mass diseases), on the accumulation of human capital is investigated. The work [Soubjaki, M. (2017)] describes the impact of private direct investment in the human capital of the region on the productivity of individuals. The work of Gracinskaya and Puchkov (2014) deals with the impact of targeted investments that ensure the necessary level of birth rate and establish both a system of training specialists at the required level and the social security system on regional human capital.

The analysis showed that, despite a significant number of studies devoted to the development of human capital through investment therein, currently there is no generally accepted list of directions for investing in human capital at the regional level. Moreover, most papers consider the impact of aggregate investments in the human capital of the region on its development, i.e. different directions of investment equally affect the development of regional human capital. According to the authors, insufficient attention is paid too to the impact of the living standards in the region on the change in human capital (although it is the quality of life that forms a favorable living environment for the population and, for example, leads to migratory influx of highly qualified specialists into the region).

The analysis of works on the third question showed that the accumulation of regional human capital directly affects the socio-economic development of the region. For example, in Pelinescu (2014), the influence of indicators describing regional human capital on the GRP per capita is assessed. In Khalafalla et al. (2013), a regression model of the dependence of the index of human development on a number of indicators of socio-economic development of the region was built (for example, the number of doctors per 100,000 people, the consumer price index, the total number of crimes, etc.). In Terekhin et al. (2014), the models of GRP dependencies on the human development index for all subjects of Russia were built.

It should be noted that most of the studies examine the relationship between regional human capital and the socio-economic development of the region. At the same time, multiple of studies calculate regional human capital as an index of human development. In this regard, it is difficult to assess which components of human capital need to be developed in order to maximize the economic and social environment of the region.

Thus, we can talk about the existing shortage of tools that can be used as a basis for a conceptual model for the development of regional human capital, and which allow:

- assessing the value of regional human capital subject to its versatility, expressed in a set of indicators;

- describing the impact of public and private investment in the living standards and the human capital of the region on regional human capital and the regional human capital on the socio-economic development of the region.

3. OBJECTIVE AND TASKS OF THE RESEARCH

Objective of this research is to elaborate a conceptual model of the regional's human capital development.

For this purpose, the following specific tasks have been pursued:

- the analysis of the genesis of theoretical approaches to the concept of " regional human capital" and tools for assessing its magnitude and development dynamics;

- the formation of a system of indicators that describe the regional human capital, and further development of a model on its basis for assessing the regional human capital;

- the identification of factors affecting the development of human capital in the region, as well as factors influenced by the regional human capital;

- the formation of ratings of subjects of the Russian Federation by the size of human capital in the region and their clustering in terms of the regional human capital.

4. THE CONCEPTUAL MODEL OF THE REGIONAL HUMAN CAPITAL DEVELOPMENT

To assess the impact of both public and private investment in the region on its human capital, one shall understand the development of regional human capital and tools that allow quantifying this development. In this regard, there is a need to develop a conceptual model that allows assessing the development of regional human capital by investing public and private financial resources therein.

As noted above, there is no universally accepted definition of regional human capital. In this regard, the authors of the paper propose to use the following definition: regional human capital is a formed stock of the inborn and acquired abilities of the population of the region (health, knowledge, skills, motivation, talent), the rational use of which in the relevant sphere of social reproduction will ultimately promote the growth of labor productivity and production in the region, and the improvement of the quality of life of the population.

Regional human capital, as an integral system, consists of certain components. The paper of Mazelis and Lavrenyuk (2017) identifies six basic groups of components, namely levels of professionalism, education, scientific and innovative development, health and culture. In this paper, the list of indicators was updated. Thus, the following system of assessing regional human capital is proposed:

1) the level of professionalism:

- GRP / average number of employees of the organization (z_1);

- GRP / (number of small enterprises + number of medium-sized enterprises) (z_2);

- GRP / investment in fixed assets (z_3);

- average annual number of those involved in the economy / number of unemployed (z_4);

- fixed assets × renewal ratio of fixed assets / investments in fixed assets (z_5);

2) the level of education:

- number of permanent population / total number of children left without parental care (z_6);

- number of students attaining secondary school leaving certificate / number of permanent population (z_7);

- graduates of state and municipal educational institutions of higher education / permanent population (z_8);

- (post-graduates + 2 PhD candidates) / permanent population (z_9);

3) the level of scientific development:

- the number of faculty members holding a PhD or MD degree / number of faculty members (z_{10});

- (2 × number of papers published in the Web of Science and Scopus journals + number of publications in the RICC) / number of faculty members (z_{11});

- number of citations in RINC / number of faculty members (z_{12});

- weighted average impact factor of journals with papers published (z_{13});

- number of staff with scientific developments / average annual number of those involved in the economy (z_{14});

4) the level of innovation development:

- number of patents / number of faculty members (z_{15});

- volume of scientific and technical works and services / GRP (z_{16});

- volume of innovative goods, works and services of organizations / GRP (z_{17});

- volume of innovative goods, works and services of organizations / costs for technological innovation (z_{18});

5) the level of health care:

- number of permanent population / incidence of mental and behavioral disorders (z_{19});

- number of permanent population / incidence of alcoholism and alcoholic psychoses (z_{20});

- life expectancy (z_{21});

- number of permanent population / mortality due to external reasons (z_{22});

- number of registered marriages / number of registered divorces (z_{23});

b) the level of culture:

- (number of professional theater spectators + number of visits to museums) / number of permanent population (z_{24});

- number of permanent population / number of crimes recorded (z_{25});

- number of permanent population / pollutants released into the atmosphere (from stationary sources) (z_{26}).

Further, to enable the integrated use of heterogeneous indicators, we shall perform their normalization using the following formula:

$$K_{in}(t) = \frac{x_{in}(t) - \min\limits_{n}(x_{in}(t))}{\max\limits_{n}(x_{in}(t)) - \min\limits_{n}(x_{in}(t))}, \quad (1),$$

where $x_{in}(t)$ - the value of the i-th indicator of the n-th region at the time t, $i = 1, ..., 26$, $n = 1, ..., N$

(*N* is the number of regions studied). Note that if the minimum and maximum values are the same, then the value of this indicator for all regions will be equal to 1.

The values $x_{in}(t)$ are calculated using the statistical data from the official resources of federal and regional authorities.

Therefore, $K_{in}(t) \in [0; 1]$. To calculate the integral indicator of the value of regional human capital, it is proposed to use the following weighted average formula:

$$R_n(t) = \sum_{i=1}^{26} K_{in}(t) \cdot \alpha_i(t). \quad (2),$$

where $\alpha_i(t)$ - the coefficient of importance of the *i*-th indicator at time *t*.

Given the formulas (1) and (2), the value of regional human capital takes values from 0 to 1. We introduce the scale of human capital measurement from 0 to 1, where $R_n(t) \in [0; 0.2)$ is the region with an extremely low level of human capital, $[0.2; 0.4)$ - with low, $[0.4; 0.6)$ - with medium, $[0.6; 0.8)$ - with high, and $[0.8; 1]$ - with very high.

A competent management of the region means the existence of a strategy and programs for its socio-economic development. The regional development programs and strategy are of a complex nature, aimed primarily at meeting the needs of the basic stakeholders. At the same time, the population is one of the most important stakeholders in the region. One of the priority directions of the development of the region is the accumulation and preservation of human capital. One of the ideas embedded in the programs and strategy of the regional development is that investments in the living standards and human capital should lead to the development of the social and economic environment of the region.

Next, we shall consider the problem with a given planning horizon *T*. At each moment of time *t*, where *t* = 0, 1, , *T*-1, financial resources are invested in the development of regional human capital.

Investment in human capital at the regional level means public and private investments directed both at improving the living standards of the population of the region and at the development of human capital itself. This paper, as an investment in the human capital of the region, deals with all investments that directly or indirectly affect the development of human capital, namely:

- national issues (x_1);
- national defense (x_2);
- national security and law enforcement (x_3);
- national economy (x_4);
- housing and public utilities (x_5);
- environmental protection (x_6);
- education (x_7);
- culture, cinematography (x_8);
- healthcare (x_9);
- social policy (x_{10});

- physical culture and sports (x_{11});

- mass media (x_{12}).

Each direction of investing in the human capital of the region leads anyway to its growth due to changes in the components describing the given capital. It is also worth noting that certain areas of investment affect the regional human capital directly, and some contribute to improving the quality of life of the population of the region. At the same time, improving the quality of life to some extent also leads to the development of regional human capital. Within the framework of this work, the following indicators of the living standards of the population of the region are singled out:

1) standards of living:

- volume of GRP per capita (y_1);

- real disposable per capita monetary income (y_2);

- per capita expenditures (y_3);

- the total amount of social payments (y_4);

- share of population with incomes below subsistence level (y_5);

- the amount of investment per resident (y_6);

2) social infrastructure:

- road network length (y_7);

- number of cars per capita (y_8);

- number of mobile phones per capita (y_9);

- number of Internet users per capita (y_{10});

3) state of health:

- average life expectancy (y_{11});

- infant mortality rate (y_{12});

- share of disabled in the total population (y_{13});

- ratio of the incidence of mental and behavioral disorders among population to the total population (y_{14});

- the ratio of the incidence of alcoholism and alcoholic psychosis, drug addiction and substance abuse to the total population (y_{15});

4) safety:

- number of the registered crimes per capita (y_{16});

- number of road accidents per capita (y_{17});

5) education:

- number of places in nursery schools per capita (y_{18});

- number of places in schools per capita (y_{19});

- number of state-funded places in universities for bachelor's program per capita (y_{20});

6) economy:

- the ratio of the number of unemployed to the average annual number of employed in the economy (y_{21});

- number of employees exposed to harmful and hazardous working conditions per capita (y_{22});

- average size of the assigned monthly pension payments (y_{23});

- turnover of public catering per capita (y_{24});

7) healthcare:

- number of hospital beds in the round-the-clock hospitals per capita (y_{25});

- number of doctors of all specialties in organizations providing medical services to the population, per capita (y_{26});

8) housing:

- area of housing per person (y_{27});

- average cost of housing (y_{28});

- share of own housing (y_{29});

- the share of the area of the housing stock equipped with bathrooms (shower), sewerage, water supply, central heating (y_{30})

9) culture and physical culture:

- number of theaters, libraries and cinemas per capita (y_{31});

- the area of parks, squares and beaches per capita (y_{32});

- the area of sports grounds per capita (y_{33});

10) demography:

- the ratio of the number of youth to the total population (y_{34});

- the ratio of the balance of migration to the total population (y_{35});

11) ecology and natural and climatic conditions:

- average annual temperature (y_{36});

- average annual rainfall level (y_{37});

- the ratio of pollutants emitted into the atmosphere to the total population (y_{38});

- level of air, soil, and surface and groundwater pollution (y_{39}).

In turn, the development of the human capital of the region qualitatively affects the change in the current situation in the region (for example, the growth of human capital leads to the development of professional components, and, consequently, to productivity growth in various areas of activity). Thus, in this paper, a hypothesis has been formed that the development of regional human capital influences the socio-economic development of the region. In particular, its impact on the change in the following key indicators of the regional development is examined:

- number of permanent population (w_1);

- average annual number of involved in the economy (w_2);

- per capita monetary income (per month) (w_3);

- average consumer expenditures per capita (per month) (w_4);

- average monthly nominal wage of employees of the organization (w_5);

- gross regional product (w_6);

- fixed assets in the economy (at gross book value, at the end of the year) (w_7);

- investments in fixed assets (w_8);

- volume of shipped goods of own production, works performed and services provided by own means by type of economic activity "Extraction of minerals" (w_9);

- volume of shipped goods of own production, works performed and services provided by own means by type of economic activity “Processing industries" (w_{10});

- volume of shipped goods of own production, works performed and services provided by own means by type of economic activity “Production and distribution of electricity, gas and water" (w_{11});

- agricultural products (total) (w_{12});

- commissioning of residential buildings (w_{13});

- retail trade turnover (w_{14});

- balanced financial performance of the organization (w_{15}).

The development of the region leads to the formation of a favorable living environment for the population, and, consequently, to the change in the following demographic parameters of the region:

- mid-year population (v_1);

- demographic load factor (v_2);

- infant mortality rate (v_3);

- natural population growth rate (v_4);

- life expectancy at birth (v_5);

- ratio of marriages and divorces (v_6);

- migration increase factor (v_7).

Social and economic development, both directly and indirectly (for example, through the demographic parameters of the region), affects the growth of public financing and the improvement of the quality of life in the region. As a result, there is a relationship between regional human capital and the amount of public funding in human capital. A graphic representation of the dynamic description of the influence is given in Figure 1.

Let us note that in order to identify the channels of influence and their quantitative description (various directions of investing on the indicators of the quality of life of the population and the human capital of the region; the indicators of standards of living on regional human capital; the human capital of the region on the indicators of the regional development; the indicators of the regional development on the demographic parameters of the region) to build econometric models of interrelations. Also, mathematical models for a number of functional dependencies (for example, the impact of investment in human capital on a particular indicator of the socio-economic development of

the region) can be built using the artificial neural network method.

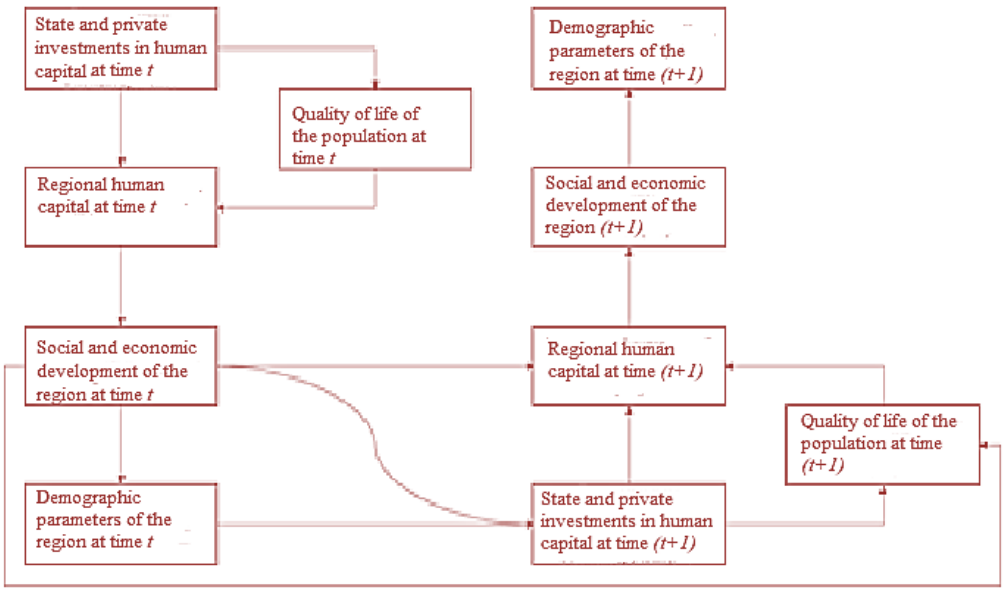

Figure 1: The conceptual model of the regional human capital development.

5. THE RATING OF SUBJECTS OF THE RUSSIAN FEDERATION BY THE SIZE OF HUMAN CAPITAL IN THE REGION AND THEIR CLUSTERING IN TERMS OF THE REGIONAL HUMAN CAPITAL

The basic component of the conceptual model of the development of regional human capital is the model of its evaluation. This model can be used to build the ratings of regions by their human capital. As an example of using the proposed model we shall consider the building of a rating for the regions of the Russian Federation. In the framework of this work, statistics on the list of "human capital indicators" for 2011-2016 were processed for 81 subjects of the Russian Federation (more than 15,000 data). Using the formula (2) for each region, integrated indicators are calculated. This example uses the following weight factors for the components of regional human capital, obtained expertly:

- the level of professionalism - 0.2;
- the level of education - 0.3;
- the level of scientific development - 0.15;
- the level of innovation development - 0.2;
- the level of healthcare - 0.1;
- the level of culture - 0.05;

In this case, the weights of the indicators within each component are equal. A fragment of the results obtained is presented in Table 1.

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Table 1: Fragment of the regions ranting 2011-2016.

Region	2011		2016	
	Human capital	Number in the rating	Human capital	Number in the rating
Altai Krai	0.21	59	0.22	59
Amur region	0.17	68	0.17	70
Arkhangelsk region	0.19	64	0.21	49
Astrakhan region	0.23	49	0.18	62
Belgorod region	0.37	5	0.35	6
Bryansk region	0.26	35	0.26	31
Vladimir region	0.26	32	0.25	35
Volgograd region	0.30	16	0.26	25
Vologda region	0.17	69	0.21	52
Voronezh region	0.32	11	0.28	24
Zabaykalsky Krai	0.19	66	0.15	73
Ivanovo region	0.28	24	0.25	40
Irkutsk region	0.25	37	0.22	54
Kabardino-Balkar Republic	0.27	28	0.26	12
Kaliningrad region	0.22	52	0.18	55

It should be noted that the three leaders among the regions in 2011-2016 were Moscow and Tomsk regions and the Republic of Tatarstan, and in 2016 - Moscow region, the Republic of Dagestan and Novosibirsk region. Among the leading regions in 2016 relative to 2011, Moscow region was the only who consolidated its positions. The change in the situation in the Republic of Dagestan (from the 19th place to 2nd) was affected by the change in the development vector of the region (for example, the adoption in 2015 of a new program for the development of education, etc.). In turn, Novosibirsk region took the lead (from 8th to 3rd) due to the accumulation of results in the educational, innovative and scientific environments. At the same time, none of the regions had the value of the integral indicator exceeding 0.5, which may indicate that these regions either enter the leaders by not more than half of the indicators of regional human capital, or do not have obvious failures by any of them.

Analyzing data by components, we can note that:

- in terms of professionalism, the leaders in 2011 were Tyumen region (0.68), Sakhalin region (0.6) and Moscow Region (0.5), and in 2016 - Tyumen region (0.61), Moscow region (0.53) and Sakhalin region (0.52);

- in terms of education level, the leaders in 2011 were Tomsk region (0.6), the Republic of Tatarstan (0.46) and Kursk region (0.43), and in 2016 - the Republic of Adygea (0.47), Tomsk region (0.41) and Smolensk region (0.39);

- in terms of scientific development, the leaders in 2011 were Moscow region (0.76), Tomsk region (0.58) and Novosibirsk region (0.57), and in 2016 - Novosibirsk region (0.73), Nizhny Novgorod region (0.67) and Tomsk region (0.61);

- in terms of innovation development, the leaders in 2011 were Ulyanovsk region (0.69), Moscow region (0.57) and Nizhny Novgorod region (0.51), and in 2016 - Nizhny Novgorod region (0.59) Moscow region (0.48) and Ulyanovsk region (0.47);

- in terms of healthcare level the leaders in 2011 were the Republic of Dagestan (0.87), the

Republic of North Ossetia (0.65) and the Karachaevo-Cherkess Republic (0.65), and in 2016 - the Republic of Dagestan (0.87), the Republic of North Ossetia (0.65) and the Kabardino-Balkaria Republic (0.59);

- in terms of the level of culture, the leaders in 2011 were the Republic of Dagestan (0.53), the Kabardino-Balkaria Republic (0.47) and Yaroslavl region (0.40), and in 2016 - the Republic of Dagestan (0.68), the Kabardino-Balkaria Republic (0.54) and the Republic of North Ossetia (0.41).

It is also worth noting that splitting into enlarged groups makes it possible to identify the most problematic fields for a given region. This will further allow addressing current problems and increasing the value of regional human capital on the basis of the formation of an optimal portfolio of strategic activities aimed at the development of human capital.

6. DISCUSSION OF THE RESULTS: THE FORMATION OF CLUSTERS FOR THE DEVELOPMENT OF REGIONAL HUMAN CAPITAL

To simplify the further processing of the above data and to make decisions on the development of regional human capital, it is useful to split the presented sample into groups (clusters). In the framework of this work, a cluster analysis of the data in question was conducted in RStudio, which is a free software development environment with open source for the R programming language. During the first step, based on the analysis of dendrograms of hierarchical clustering based on the values of 26 indicators of the development of regional human capital in 2011-2016 for 81 regions, where Euclidean distance is used as a measure of proximity, it was decided to split the sample for each year into 5 clusters. Next, using the *k*-mean method (the Hartigan-Wong algorithm), we formed splits of samples into 5 clusters for each year under study. The validity of clustering was verified using the Davis-Baldwin criterion, the values of which for different clustering variants were from 0.74 to 0.86. The composition of clusters for 2016 is shown in Table 2.

Table 2: Composition of clusters for 2016

Cluster No.	Content of the cluster
1	Kaluga region, Moscow region, Nizhny Novgorod region, Novosibirsk region, Sverdlovsk region, Tomsk region
2	Kabardino-Balkarian Republic, Republic of Dagestan, Republic of North Ossetia (Alania), Karachay-Cherkess Republic
3	Belgorod region, Bryansk region, Voronezh region, Krasnodar Krai, Kursk region, Lipetsk region, Penza region, Perm Krai, Republic of Adygea, Republic of Bashkortostan, Republic of Mari El, Republic of Mordovia, Republic of Tatarstan, Rostov region, Ryazan region, Samara region, Saratov region, Stavropol Krai, Tambov region, Tula region, Ulyanovsk region
4	Kamchatsky krai, Sakhalin region, Magadan region, Sakha Republic, Tyumen region, Komi Republic
5	AltaiKrai, Amurregion, Arkhangelskregion, Astrakhanregion, Vladimirregion, Volgogradregion, ZabaikalskyKrai, Ivanovoregion, Irkutskregion, Kaliningradregion, Kemerovoregion, Kirovregion, Kostromaregion, KrasnoyarskKrai, Kurganregion, Murmanskregion, Novgorodregion, Omskregion, Orenburgregion, Oryolregion, PrimorskyKrai, Pskovregion, RepublicofAltai, RepublicofBuryatia, RepublicofKalmykia, RepublicofKarelia, RepublicofTyva, RepublicofKhakassia, Smolenskregion, Tverregion, UdmurtRepublic, KhabarovskKrai, Chelyabinskregion, ChuvashRepublic, Yaroslavlregion

The most sizable fifth cluster included 36 subjects, the smallest - the second (4 subjects). As can be seen from the results, there is no explicit geographical pattern in the allocation of clusters; each of

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them (except for the second) contains regions from different federal districts. To assess and highlight the relationships in groups of regions by indicators, descriptive statistics was used. Medians, mean values, variance, sigma, and confidence intervals were calculated, indicating which cluster and by what indicator is significantly different from the others.

Table 3 shows indicators by which each cluster occupies leading and lagging positions.

Table 3: Indicators by which each cluster leads or lags

Cluster No.	Leading indicator No.	Lagging indicator No.
1	Level of professionalism (z_3, z_5) Level of education (z_8) Level of scientific development (z_{10}, z_{13}, z_{14}) Level of innovation development (z_{15}, z_{16}) Level of culture (z_{24})	Level of education (z_7)
2	Level of education (z_7) Level of innovation development (z_{18}) Level of healthcare (z_{19}, z_{20}, z_{21}, z_{22}, z_{23}) Level of culture (z_{25}, z_{26})	Level of professionalism (z_1, z_4, z_5) Level of scientific development (z_{11}) Level of innovation development (z_{16}, z_{17}) Level of culture (z_{24})
3	Level of professionalism (z_4) Level of education (z_6, z_9) Level of scientific development (z_{11}, z_{12}) Level of innovation development (z_{17})	Level of professionalism (z_2)
4	Level of professionalism (z_1, z_2)	Level of professionalism (z_3) Level of education (z_6, z_8, z_9) Level of scientific development (z_{12}, z_{13}) Level of innovation development (z_{15}, z_{18}) Level of healthcare (z_{20}, z_{21}, z_{22}, z_{23}) Level of culture (z_{25}, z_{26})
5		Level of scientific development (z_{10}, z_{14}) Level of healthcare (z_{19})

Analyzing the data in Table 3, we can draw the following conclusions:

1. Cluster No.1 - Scientific cluster - includes regions with developed scientific and innovative spheres. For example:

- in Kaluga region there is Obninsk science city, where research is conducted in the field of nuclear power engineering, telemechanical devices, space technology, instrumentation and radio equipment;

- in Moscow region there are scientific defense cities, namely Zhukovsky (aviation equipment), Fryazino (microwave electronics), Reutov (rocket engineering), Korolyov (space technology), etc.;

- in Novosibirsk region there is Koltsovo science center, where research is carried out in epidemiology, virology, bacteriology, genetic engineering, biotechnology, ecology and biosecurity;

- in Sverdlovsk region there are the following technical parks: Instrument making (Ekaterinburg), Averon (Ekaterinburg), IntelNedra (Ekaterinburg), VMZ (Nizhny Tagil), Medtekhpark (Novouralsk), and Energia (Sredneuralsk);

- in Tomsk and Nizhny Novgorod regions there is a significant number of scientific organizations and research units, as well as industry research institutes.

It should be noted that this cluster lags behind in terms of the ratio of the number of students being awarded a certificate of secondary (complete) general education, to the number of permanent residents. This is due to the fact that the human resource of the regions included in this cluster is largely formed due to the internal migration mobility of the population, i.e. due to immigration of the most talented youth from other regions.

2. Cluster No.2 - Environmental cluster - includes regions with a high level of health care and culture, geographically located in the northern part of the Caucasus. It is also worth noting that these regions are characterized by low level of industrial development and environmental pollution. A significant part of the territory of these regions belongs to nature protection zones (for example, the Republic of Dagestan: the Dagestan State Reserve, the Tlaratinsky, Samursky, Agrakhansky reserves, etc., Kabardino-Balkaria Republics: the Kabardino-Balkarian Highland Reserve, the National Park "Elbrus", etc., Republic of North Ossetia: North Ossetian Reserve, Karachaevo-Cherkess Republic: Caucasian Reserve, Teberda State Reserve, etc.). At the same time, this cluster is one of the main points of outflow of youth to the central regions of Russia. Also, we shall note that the leadership in terms of the ratio of the volume of innovative goods, works and services of organizations to the costs of technological innovation is associated with an extremely low level of the relevant costs.

3. Cluster No.3 - Industrial cluster - includes industrial-agrarian regions, which are the main "suppliers" of permanent jobs in the country. Most regions have well-developed machine building, metallurgy, power engineering and the food industry. Thus, for example, the industrial park "Severny" was created in Belgorod region, in the Republic of Tatarstan special economic zones "Alabuga" and "Innopolis" operate, in the Orel region an international leasing project "Wheat-2000" is being implemented, etc. At the same time, the ratio by which this cluster lags behind is GRP to the number of small and medium-sized enterprises. This is due to the fact that there is a certain monopoly in these regions created by large agrarian and industrial enterprises.

4. Cluster No.4 - Resource cluster - includes the regions associated with the extraction and primary processing of minerals (oil, gas, coal, bauxite, gems, etc.). However, these regions belong to the territories of people's stay, i.e. the economically active population comes to these regions for shift work. This leads to a minimization of the need for the development of the educational, scientific, innovative and cultural segments, which is indicated by the indicators by which this cluster lags behind.

5. Cluster No.5 - Small cluster - includes regions without an explicit industry affiliation, i.e. almost all indicators of regional human capital are at an average level. For the most part, small and medium-scale businesses have developed in these regions.

To identify the stable elements of clusters (regions belonging to a particular cluster for several years), the transition matrices of regions from one cluster to another for different years have been compiled and analyzed. As a result, stable cluster cores were obtained, presented in Table 4.

Table 4: Stable cluster cores

Cluster No.	Content of the cluster
1	Kaluga region, Moscow region, Nizhny Novgorod region, Novosibirsk region
2	Kabardino-Balkarian Republic, Republic of Dagestan, Republic of North Ossetia (Alania), Karachay-Cherkess Republic
3	Belgorodregion, Voronezhregion, KrasnodarKrai, Kurskregion, Penzaregion, RepublicofMordovia, RepublicofTatarstan, Rostovregion, Ryazanregion, Samararegion, Saratovregion, StavropolKrai, Tambovregion, Ulyanovskregion
4	Sakhalin region, Magadan region, Republic of Sakha, Tyumen region, Komi Republic
5	AltaiKrai, Astrakhanregion, Vladimirregion, Ivanovoregion, Irkutskregion, Kaliningradregion, Kirovregion, Kostromaregion, KrasnoyarskKrai, Kurganregion, Murmanskregion, Novgorodregion, Omskregion, Orenburgregion, PrimorskyKrai, Pskovregion, RepublicofKarelia, RepublicofKhakassia, Smolenskregion, Tverregion, UdmurtRepublic, Chelyabinskregion, ChuvashRepublic, Yaroslavlregion

It should be noted that the "floating" of regions from one cluster to another is due to a number of factors, for example, a new strategy for the social and economic development of the region, new state programs, the creation of new special economic zones in their territories, etc.

Summarizing the above, we should say that the cluster No.1 is the leader in terms of regional human capital (in particular, leaders in terms of innovation and scientific development). Cluster No.3 is on the second place - this is due to the high level of education and professionalism. Cluster No.5 ranks third - it has average values for most indicators. The fourth is cluster No.2 due to the high level of healthcare and culture. The last place belongs to the resource cluster (cluster No.4).

7. SUMMARY

1. The analysis of theoretical approaches to the concept of "regional human capital" was conducted, based on which the author's interpretation of this concept was formed: regional human capital is understood as the formed stock of innate and acquired abilities of the population of the region, rational use of which in the relevant sphere of social reproduction will ultimately promote the growth of labor productivity and production in the region, and the improvement of the living standards of the population. The analysis of existing methods and models of estimation and development of regional human capital was conducted, which revealed a shortage of tools that can be used as a basis for a conceptual model for the development of regional human capital.

2. A list of indicators describing human capital at the regional level was formed. It includes six enlarged groups of components of regional human capital, namely: the level of professionalism; the level of education; the level of scientific development; the level of innovative development; the level of healthcare; and the level of culture. The model of quantitative estimation of the regional human capital, allowing to take into account heterogeneity of indicators of the human capital is developed.

3. A conceptual model was developed, based on a description of the impact of: public and private investment, directly and indirectly (through the living standards of the population) affecting the development of human capital; human capital of the region on the socio-economic development of the region; social and economic development of the region on the demographic parameters of the region, the amount of public and private investment in human capital and the quality of life of the population of the region; demographic parameters of the region on the amount of investment in the

human capital of the region. It should be noted that we made the lists of directions of investing in human capital, indicators of the quality of life of the population of the region, indicators of social and economic development of the region and demographic parameters of the region.

4. The ratings of regions in 2011-2016 were formed in terms of the level of human capital. Thus, the three leaders in the development of human capital in 2016 are: Moscow region, the Republic of Dagestan and Novosibirsk region. By the level of professionalism, the leader in 2016 was Tyumen region; by the level of education - the Republic of Adygea; by the level of scientific development - Novosibirsk region; by the level of innovation development - Nizhny Novgorod region; by the level of health and culture - the Republic of Dagestan. Understanding the strengths and weaknesses of the region in the development of human capital allows us to formulate a sound strategy for the socio-economic development of the region, aimed at eliminating (pulling) the weak sides.

5. Clustering of regions in terms of human capital indicators was carried out. It allowed us to allocate 5 clusters: scientific, environmental, industrial, resource and small. This clustering makes it possible to understand the similarities of the way of development of certain clusters and their socio-economic specifics of development. This will make it possible to further formulate the most effective and efficient development programs and strategies for social and economic development for a given region, subject to their specification. At the same time, a cluster leader for the development of human capital (the "scientific cluster") was singled out, whose development experience, for example, can be considered as the best practice and applied to other regions.

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