

## Artículo de investigación

## Evaluation of universities' intellectual capital influence on the intellectual capital of the regions of their location

Evaluación de la influencia del capital intelectual de las universidades en el capital intelectual de las regiones de su ubicación

Avaliação da influência do capital intelectual das universidades sobre o capital intelectual das regiões de sua localização

### Оценка влияния интеллектуального капитала вузов на интеллектуальный капитал регионов их локации

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#### Abstract

The paper presents the study's results, which allow to reveal the role and importance of universities' intellectual capital in the formation of a comprehensive assessment of the indicators of regional intellectual capital.

Based on the study of theoretical materials and methods on the problems of intellectual capital of universities and regions, systems of indicators of their evaluation were composed. Hypotheses about the mutual influence of the intellectual capital of the region and universities, as well as their individual elements were put forward.

As a result of hypothesis testing, based on the results of correlation-regression analysis, hypotheses about the influence of the universities' intellectual capital as well as their individual elements (human and reputational capital) on the regions' intellectual capital, as well as the influence of the universities' intellectual

#### Resumen

El documento presenta los resultados del estudio, que permiten revelar el papel y la importancia del capital intelectual de las universidades en la formación de una evaluación integral de los indicadores del capital intelectual regional.

Sobre la base del estudio de los materiales y métodos teóricos sobre los problemas del capital intelectual de las universidades y regiones, se compusieron sistemas de indicadores de su evaluación. Se expusieron hipótesis sobre la influencia mutua del capital intelectual de la región y las universidades, así como sus elementos individuales.

Como resultado de la prueba de hipótesis, basada en los resultados del análisis de correlación-regresión, las hipótesis sobre la influencia del capital intelectual de las universidades y sus elementos individuales (capital humano y reputacional) en el capital

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capital on regions' human capital were confirmed with an above-average level.

**Keywords:** intellectual capital, region, university, human capital, reputation capital, infrastructural capital, capital of intellectual property.

intelectual de las regiones, así como en La influencia del capital intelectual de las universidades en el capital humano de las regiones se confirmó con un nivel superior al promedio.

**Palabras clave:** capital intelectual, región, universidad, capital humano, capital de reputación, capital de infraestructura, capital de propiedad intelectual.

## Resumo

O artigo apresenta os resultados do estudo, que permitem revelar o papel e a importância do capital intelectual das universidades na formação de uma avaliação abrangente dos indicadores do capital intelectual regional.

Com base no estudo de materiais e métodos teóricos sobre os problemas de capital intelectual de universidades e regiões, foram constituídos sistemas de indicadores de sua avaliação. Hipóteses sobre a influência mútua do capital intelectual da região e das universidades, bem como seus elementos individuais foram apresentadas.

Como resultado do teste de hipóteses, baseado nos resultados da análise de correlação-regressão, hipóteses sobre a influência do capital intelectual das universidades, bem como seus elementos individuais (capital humano e reputacional) sobre o capital intelectual das regiões, bem como a influência do capital intelectual das universidades sobre o capital humano das regiões foi confirmada com um nível acima da média.

**Palavras-chave:** capital intelectual, região, universidade, capital humano, capital de reputação, capital infraestrutural, capital de propriedade intelectual.

## Аннотация

В работе представлены результаты исследования, которые позволяют выявить роль и значение интеллектуального капитала вузов в формировании комплексной оценки показателей регионального интеллектуального капитала.

На основе изучения теоретических материалов и методов по проблематике интеллектуального капитала университетов и регионов были выделены системы показателей их оценки. Были выдвинуты гипотезы о взаимном влиянии интеллектуального капитала региона и вузов, а также их отдельных элементов.

В результате проверки гипотез на основании обработки результатов корреляционно-регрессионного анализа были подтверждены гипотезы с уровнем выше среднего о наличии влияния интеллектуального капитала вузов, а также отдельных их элементов (человеческого и репутационного капитала) на интеллектуальный капитал регионов, а также интеллектуального капитала вузов на человеческий капитал регионов.

**Ключевые слова:** интеллектуальный капитал, регион, университет, человеческий капитал, репутационный капитал, инфраструктурный капитал, капитал интеллектуальной собственности

## Introduction

The study urgency of intellectual capital issues is due to the essential role of intangible factors in the current conditions of the knowledge economy in order to achieve the competitive

advantages of the territories. The economic effect of meso-level systems is increasingly determined by the level of generation, transfer

and use of knowledge within the boundaries of their territorial location.

The subject of region's intellectual capital and its significance in modern conditions is actively raised both in scientists and specialists researches, and in state documents of various levels.

Ensuring country's independence and competitiveness through the creation of an effective system of building up and making full use of the nation's intellectual potential was determined as the goal of country's scientific and technological development in the Strategy for Scientific and Technological Development of the Russian Federation (2016).

In the Strategy (2016) among the fundamental principles of state scientific and technological policy allocate a concentration of resources: the concentration of intellectual, financial, organizational and infrastructural resources to support R&D, the creation of products and services.

It is the concentration of intellectual potential as one of the most significant resources within the boundaries of a particular territory that provides it with the additional competitive advantages necessary to meet the great challenges facing the country.

Among these challenges are the exhaustion of the opportunities for the economy's "raw" growth, that requires the development of a competitive sector of industry and services in the regions; a demographic transition, including among other things new social and medical problems and stipulating the development of the territorial health care system on a fundamentally new level; an increase in anthropogenic pressures on the environment, which are prerequisites for improving environmental management at the regional level; the need for food security, which can be provided in the regions with the involvement of highly qualified specialists and innovative technologies to solve problems; a qualitative change in the nature of global and local energy systems, which requires the development of energy conservation within the boundaries of specific territories, and a number of others.

All big challenges facing the Russian Federation are being conveying on regional social and economic systems and require the formation and implementation of specific approaches to

overcome them. Due to the limited material resources, non-material factors can become the real panacea that will provide the significant competitive advantages and economic growth for specific territories that successfully accumulate and use their intellectual capital.

The identification of the mutual influence of the intellectual capital of the region and the universities located on its territory has the great importance for ensuring their development.

Higher education institutions within the framework of the "University 4.0" concept can ensure the formation and development of the territories' intellectual capital, which in turn is the source and element of their own intellectual capital, taking into account the formed ties with other subjects of the regional economy. All this, with proper management, can create the synergy effect from the interaction of the parties, which strengthens the role of intellectual capital of territory's individual subjects, as well as the multiplier effect that arises during development of a university's intellectual capital, which increases a region's intellectual capital, that can be ensured only with active participation and involvement of a territory's intangible resources in a university's activity.

### Literature review

At the present stage the problems of the theory and methodology of intellectual capital management in the regions are the subject of a rather large number of studies, yet they remain insufficiently studied.

Currently, the literature presents various points of view on the definition of "region's intellectual capital" concept which directly follows from the very term "intellectual capital", which has many interpretations and is deeply analyzed in other works of the authors (Maltseva, Monakhov, Klyushnikova, 2015); and it also takes into account the specifics of the meso- or macrolevel system.

The key characteristics of the definitions of intellectual capital, which together provide a comprehensive understanding of its essence are highlighted below:

- it has intangible nature (Matos and Vairinhos, 2015; Andriessen and Stam, 2004);
- it refers to spatial region's formations allocated according to the administrative-territorial

character (Chub and Makarov, 2015), as well as the structural components of the region and individual subjects (individuals);

- it characterized by different levels (individual, group, sectoral, region-wide, etc.) (Serdyukova, 2013);
- it is an attribute of region's various social and economic systems, which may have different objectives of functioning and specific features (Lubacha-Sember, 2016);
- it is appeared, among other things, in the process of interaction of social and economic systems or region's subjects with each other, providing a synergy effect (Lubacha-Sember, 2016);
- it is a regional resource that is characterized by self-increasing value (Serdyukova, 2013);
- it is the region's potential to create values, transforming tangible and intangible values into wealth (Kireeva, 2015, Serdyukova, 2013; Bontis, 2004; Antoljak, 2014);
- it has both current and prospective value (Bontis, 2004, Malhotra, 2000);
- consists of individual components that are defined in accordance with classical approaches (for example, structural, human and client capital, knowledge, experience, competencies, etc.) or supplemented by specific types (eg. ecological, tourist capital, etc.) (Serdyukova, 2013);
- it provides a region with additional competitive advantages, investment attractiveness, economic growth, contributes to the improvement of population's life quality, the production of new material goods and the generation of income (Serdyukova, 2013; Andriessen and Stam, 2004);
- it represents the identity of the region, in each case it has specific features (Antoljak, 2014).

As the authors believe, it seems appropriate, based on the most significant aspects of the above definitions, to formulate the definition of the region's intellectual capital, ensuring its clear identification and determining the current and potential result of its influence on the regional social and economic system as a whole.

Region's intellectual capital is a set of intangible resources which the carriers are separate regional social and economic systems, structures and individuals that has, along with physical capital, a direct or indirect influence on the achievement of current and promising results by the socio-economic system of the region as a whole.

The need to determine the structure of a region's intellectual capital is due to the high heterogeneity of its elements. Approaches to the classification of intellectual capital types at the organization level are widely presented in the literature (a detailed analysis was carried out in authors' other works (Maltseva, Monakhov, Klyushnikova, 2015), which are the basis for identifying the structural components of a region's intellectual capital.

The analysis results demonstrate the fact that most authors took T. Stewart's classical approach as a basis and include the human, structural and consumer capital (capital of relations) in the classification of intellectual capital types (Chub and Makarov, 2015; Khuzina, 2016; Monakhov et al., 2016; Liu Chao et al., 2015; Bronisz et al., 2012; Lubacha-Sember, 2016; Minasov, 2012).

Other authors interpret it with a very close structure, described in the works of Scandia Navigator: intellectual capital includes human and structural capital, which in turn is subdivided into client and organizational capital, consisting of innovative and process capital (Alexandrov and Fedorova, 2017; Kireeva, 2015).

The classification of intellectual capital with respect to regional specifics in the works of Edvinsson and Yeh-Yun Lin C. (2011) was refined. Structural capital is a combination of technological, commercial, marketing, research and innovation, social and environmental capital.

In a number of cases, classical classifications of intellectual capital types are supplemented by its specific types, the expediency of singling out them is determined by the specifics of the region as an object of investigation. Thus, individual authors singled out market capital (Lisichenok, 2004; Sanchez Medina et al., 2007; Bontis, 2004), social capital (Lisichenok, 2004; Kireeva, 2015), development capital (renewal capital) (Lubacha-Sember, 2016; Bontis, 2004; Sanchez Medina et al., 2007), the capital of intellectual property (Monakhov et al, 2016).

We should mention separately the classification of intellectual capital types proposed by Sanchez Medina et al. (2007). The authors identify specific types of intellectual capital, tourism capital, economic capital, social, environmental capital, state capital, the capital of education and development, the capital of result which are

corresponding to the structural elements of a region's social and economic system.

The above classification, as well as the more refined Edvinsson's classification, does not fully ensure the study of intellectual capital as an integral phenomenon, since in it, along with the system-wide types of intellectual capital (the capital of learning and development, the capital of result), there are types defined on the basis of responsibility centers (economic activity by types, tourism, public administration).

For the purposes of the research it seems appropriate to identify the types of a region's intellectual capital depending on their essential characteristics, as well as to identify the responsibility centers - the elements of a region's socio-economic system that are the most significant for further analysis.

As a basic classification, it is proposed to use the group of intellectual capital's types developed in the authors' works (Maltseva, Monakhov, Klyushnikova, 2015). The classification of the region's intellectual capital proposed by the authors in accordance with the essential characteristics is below (Table 1).

Table 1. Classification of region intellectual capital's types

Group of intellectual capital	Content
<b>Human capital</b>	
Knowledge Capital	formalized and non formalized knowledge of a region's inhabitants, related to both professional and everyday life (life experience)
Capital of competences	practical skills, abilities, creative abilities, qualification of a region's inhabitants, related to both professional and everyday life
Capital of professional experience	experience in the professional sphere of a region's inhabitants, ability to effectively use available resources (knowledge, time, financial, material, etc.)
Capital of professional and personal reputation	professional and personal reputation of a region's inhabitants both in the internal and external environment
Health capital	the accumulated potential of a region's inhabitants as a result of investments necessary for the formation, maintenance and improvement of their health and working capacity
<b>Reputational capital</b>	
Image capital	existing in the external and internal environment opinion on various aspects of a region's activity as a whole, as well as enterprises, organizations on its territory, business reputation, investment attractiveness
Customer capital	well-established connections in the external and internal environment of enterprises, organizations of the region and the territory as a whole, regular business and social and cultural contacts
Brand capital	existing opinion about the results of a region's activities (products, services, etc.) in the external and internal environment and the readiness for their consumption (use); companies' well-known brand in a region
<b>Infrastructure capital</b>	
Capital of a regional environment	regional policy, ideology, fashion, the system of formal and informal relations among residents, motivation for action, regional initiatives, culture, norms
Capital of a regional management system	regional system of current and strategic planning, decision-making, analysis results, socio-economic policy, formed and supported intra-regional links between individual economic subjects and individuals, effective norm-setting and law enforcement practice
Capital of a regional infrastructure	formed education and health systems, logistics, innovation, information systems in the region that promote the development of various types of intellectual capital

<b>Innovative capital</b>	
Capital of intellectual property	formalized innovation and technological solutions, technologies that has the potential for commercialization and are capable of bringing an additional effect
Capital of ideas and projects	non formalized and formalized innovative, technical, social projects that can be implemented on a region's territory and can create prerequisites for rapid growth

Literature analysis made it possible to single out publications on the issues of mutual influence of the intellectual capital of territories and universities located within their boundaries, which for the most part has a framework nature. So, Avilova (2013) in her work concentrates more on the universities role in the development of the human potential of the country and the region.

Serdyukova (2011) also mainly considers the role of university education as a determining factor in the formation and development of intellectual capital in the region. She points out the need in this regard for the development of the university's intellectual capital, which is conveying to the region in the process of training.

Bojaeva et al. (2015) consider the university's role in the region and in the formation of its intellectual capital is much broader and argue that it should not be determined only by the training of specialists, be the basis of scientific and technical and socio-economic development of the territory, the foundation, the connecting thread between generations, the keeper of historically accumulated ideas, developments, projects and their active generator at a new historical stage of society's development.

Golubkin and Svetlov (2011) substantiates the universities' importance in the formation of intellectual capital at the regional level, by defragmenting it into separate components. The development of human capital of the subjects of the regional economy is ensured in the process of training personnel in universities, the development of organizational capital is ensured through innovative technologies created in universities. The authors propose to pay special attention to technological networks, which represent a set of economic entities interacting with each other at all stages of the innovation process.

We should separately note the work by Kirsch et al. (2010) where the authors formalized the task of assessing the intellectual capital of a country, region and universities on the basis of

the index of intellectual potential development. For this goal the system of indicators of educational and scientific potentials was singled out, the corresponding calculations were made and a system of measures, aimed at the development of universities, contributing, among other things, to the active growth of the region's intellectual capital was developed.

In foreign literature, the universities' role in the development of a territory of their locations is widely covered in the works by Benneworth et al. (2010).

Thus, in the work "Building Localized Interactions Between Universities and Cities Through University Spatial Development " (Benneworth et al., 2010), it is shown that universities are important participants in the global development of the knowledge economy, and they make a significant contribution to the economic development of cities of their localization, they are both centers of concentration and generation of knowledge, and suppliers of human and intellectual capital on which the knowledge economy depends.

The formalization of the university's role in the development of primarily entrepreneurial activities in the region is presented in the work by Trequattrini et.al (2018). The authors primarily focus on the problem of territories' innovative development and view universities as a significant platform for the commercialization of R&D created on their platform. University of entrepreneurial type is able to create a region's entrepreneurial culture, which is characterized by such indicators as incubation of spin-off companies, provision of professional services, entrepreneurship training. The authors state the necessity of regional investments in the universities development, which can become the basis for outstripping growth of the intellectual capital of the territory as a whole.

Obviously, that as in the case with the analysis of publications on region's intellectual capital, in some cases there is a substitution of concepts. The authors interpret intellectual capital from

the positions of the achieved results, while it represents the potential, the possibilities of university's influence on the region and vice versa. Also noteworthy is the insufficient formalization and structuring of the directions of the mutual influence under consideration, including, in the majority, generalizing formulations.

Thus, there is an active study of the problems of the intellectual capital of the region and universities, as well as their interrelations in literature. At the same time, the works are has occasional non-systemic nature, there are no formalized studies that would ensure establishing the degree of interrelations between the indicators on a sufficient level of research of statistical data.

### **Hypotheses and methods of research**

Within research's framework the task was to determine the influence of universities' intellectual capital on the aggregate indicator of the territory of their localization. The study included establishing the degree of correlation between the indicators of the intellectual capital of universities and the region.

For the purposes of the study, the following hypotheses were formulated:

- H1 – Universities' intellectual capital influence region's intellectual capital
- H2 - Universities' human capital influence region's intellectual capital
- H3 - Universities' reputational capital influence region's intellectual capital
- H4 - Universities' intellectual capital influence region's human capital
- H5 - Universities' intellectual capital influence region's reputational capital
- H6 - Universities' intellectual capital influence region's infrastructure capital
- H7 - Universities' intellectual capital influence region's intellectual property capital

Correlation analysis was used as the basic method.

Information sources that determine, among other things, the choice of indicators for evaluating the region's intellectual capital are Federal Service of State Statistics' data, as well as official regional ratings, including expert estimates of region's certain characteristics.

The Federal system for monitoring the performance of scientific organizations performing research, development and technological work (FSMSO) and Information and Analytical Materials on the results of monitoring the effectiveness of educational institutions of higher education were used as information sources for analyzing the university's intellectual capital.

Original values were normalized using method of dividing by the maximum value. For each group of indicators that characterize the group of intellectual capital the coefficient of internal consistency (Cronbach's alpha) was calculated separately for each year.

For four enlarged groups of region's intellectual capital and three enlarged groups of university's intellectual capital we calculated subindexes using the distance method and integral indexes as a product of subindexes.

Obtained results made it possible to verify the hypotheses formulated in the framework of the study. The hypotheses were tested by calculating the Pearson's correlation coefficient between the corresponding indexes of intellectual capital.

### **Results of the study**

Various methodical methods that involve the transformation of basic indicators to ensure comparability of results (standardization, standardization, maximin method) and calculation of the integral indicator, using average indicators (arithmetic or geometric), taking into account the specific weights (if available) can be used to assess the region's intellectual capital.

For the purposes of statistical estimation of intellectual capital, it is proposed in this paper to use a system of indicators constructed in accordance with the structural classification of intellectual capital defined above and allowing the most accurate determination of available intellectual capital.

Data from the collected books of Federal Service of State Statistics, the collected book "The rating of innovative development of the Russian Federation's subjects" by the Higher School of Economics (HSE) (2017), and a number of ratings of the Russian Federation's subjects compiled by the Center for Regional Policy Development

(CRPD) (2017), Association of Russia's Innovative Regions (ARIR) (2018), Rating Agency RIA RATING (RIA) (2016, 2017), Rating Agency RAEX (Expert RA) (2017) were selected as

indicators for this study. The period under investigation is 2014 and 2015. The used indicators are given in

Table 2.

The author's approach to the formation of the indicators system for assessing region's intellectual capital is below (Table 2).

Table 2. Indicators of region's intellectual capital

Type of intellectual capital	Indicators	Source	
<b>Human capital</b>			
Knowledge capital	H1	Percent of employed population with higher education	Federal Service of State Statistics
	H2	Number of students studying under the bachelor's, specialist's, magistracy programs for 10 000 population, people	
	H3	Number of teaching staff engaged in educational activities in accordance with higher education programs per 1000 population, people	
	H4	Number of personnel engaged in R&D per 10,000 population, people	
	H5	Number of researchers with academic degrees per 1000 population, people	
	H6	Graduation from the postgraduate program per 10 000 population, people	
	H7	Graduation from the doctoral program for 10 000 population, people	
	H8	Number of employees who received additional vocational education from the number of workers on payroll of the relevant categories of personnel and age, %	
	H9	Number of employees who have undergone vocational training in basic professional education programs from the number of workers on payroll, in%	
	H10	Number of employees who received professional education in basic professional educational programs from the number of workers on payroll, %	
Capital of competences	H11	Graduation of skilled workers and employees per 10 000 population, people	HSE
	H12	Graduation of mid-level specialists for 10,000 population, people	
	H13	Share of employed in high-tech and mid-tech branches of industrial production in the total number of employed in the region's economy	
	H14	Share of employed in knowledge-intensive sectors of the service sector in the total number of employed in the region's economy	
	H15	Use of special software in organizations per 100 organizations, units	
	H16	Use of electronic document management in organizations per 100 organizations, units	
	H17	Used advanced production technologies per 100 organizations, units	



	H18	Share of organizations that carried out technological innovations in the total number of organizations (organizations of industrial production)	
	H19	Share of organizations that carried out non-technological (marketing and / or organizational) innovations, in the total number of organizations (organizations of industrial production)	HSE
	H20	Number of employees who received training in the form of short-term courses, professional trainings, mentoring from the number of workers on payroll, %	Federal Service of State Statistics
Capital of professional experience	H21	Number of articles published in peer-reviewed journals, indexed in Russian Science Citation Index, per 10 researchers, units	HSE
Capital of professional and personal reputation	H22	Rating of governors, point	CRPD
Health Capital	H23	Morbidity per 1000 population, people	Federal Service of State Statistics
<b>Reputational capital</b>			
	R1	Rating of the Russian Federation's subjects by the value of the Russian regional innovation index, index	HSE
	R2	Rating of innovation regions of Russia, index	ARIR
	R3	Rating of the socio-economic situation of the Russian Federation's subjects, index	RIA
Image capital	R4	Rating of Russian regions for life's quality, index	
	R5	Investment climate of regions, index	Expert RA
	R6	Balance of migration growth of persons with higher professional education, persons	Federal Service of State Statistics
	R7	Balance of migration growth of doctors of science; candidates of sciences, persons	Statistics
Customer capital	R8	Share of organizations that participated in joint projects for the implementation of R&D, in the total number of organizations (organizations of industrial production)	HSE
	R9	Share of exports in the total volume of shipped products *	
	R10	Share of exports of technologies and services of a technical nature in total exports *	Federal Service of State Statistics
	R11	Turnover of retail trade per capita, rubles	
	R12	Turnover of wholesale trade in the total volume of shipped products *	
Brand capital	R13	Share of innovative goods, works, services in the total volume of shipped goods, performed works and services (organizations of industrial production)	
	R14	Share of newly introduced or subjected to significant technological changes of innovative goods, works, services, new to the market, in the total volume of shipped goods, performed works and services (organizations of industrial production)	HSE
<b>Infrastructure capital</b>			
	I1	Number of spectators of theaters and number of visits to museums per 1000 population, people	Federal Service of

			State Statistics
Capital of regional environment	12	Rating of the Russian Federation's subjects by the value of the index "Socio-economic conditions of innovative activity", index	HSE
	13	The labor market index in the regions of the Russian Federation, index	RIA
	14	Rating of the Russian Federation's subjects by the value of the index "Quality of innovation policy", index	
	15	The presence of a strategy (concept) of innovative development (innovation strategy) and / or a profile section on innovation development (innovation support) in the development strategy of the region, the presence / absence	
	16	The presence of the designated zones (territories) of priority development of innovation activity in the scheme of territorial planning, as well as in the materials for its justification, the presence / absence	
Capital of regional management system	17	The presence of a specialized legislative act that defines the basic principles, directions and measures of state support for innovation activities in the region, the presence / absence	HSE
	18	The presence of a specialized program or a set of measures of state support for the development of innovations, innovation activities or subjects of innovation activity, the presence / absence	
	19	The presence of specialized coordination (advisory) bodies on innovation policy (support of innovation) affiliated to the highest official or the highest executive body of state power of the Russian Federation's subject, the presence / absence	
	110	The presence of specialized regional development institutions (funds, agencies, development corporations, etc.) with the functional to support of innovation subjects and / or the implementation of innovative projects, the presence / absence	
	111	Managerial risk (rating), point	Expert RA
	112	Supply of general education organizations *	
	113	Supply of professional educational organizations, which training qualified workers *	
	114	Supply of professional educational organizations, which training mid-level specialists *	
	115	Supply of organizations, which training postgraduate students *	
Capital of regional infrastructure	116	Supply of organizations which training doctoral students *	Federal Service of State Statistics
	117	Population per hospital bed, persons	
	118	The capacity of out-patient polyclinic organizations per 10 000 people, visits per shift	
	119	Number of sports facilities per 10000 population, units	
	120	Library fund per 1000 population, units	
	121	Population coverage by TV and radio broadcasting, %	
	122	The share of trapped and detoxified air pollutants in the total number of waste pollutants from stationary sources	

	I23	Number of active fixed and mobile broadband Internet subscribers per 100 population	
	I24	Number of active fixed and mobile broadband Internet subscribers per 100 population	
	I25	Intensity of use of information and communication technologies in organizations, %	
	I26	Intensity of use of information and communication technologies in organizations, %	
	I27	Percentage of organizations that has a website	
<b>Innovative capital</b>			
Capital of Intellectual Property	IP1	Number of issued patents per 1000 population, units	Federal Service of State Statistics
	IP2	The share of organizations that has ready technological innovations, developed by own strength, in the total number of organizations (organizations of industrial production)	HSE
Capital of ideas and projects	IP3	Number of patent applications per 1000 population, units	Federal Service of State Statistics
	IP4	Rating of the Russian Federation's subjects by the value of the index "Scientific and Technical Potential", index	HSE
	IP5	Rating of the Russian Federation's subjects by the value of the index "innovation activity", index	HSE

For each group of indicators that characterize the group of intellectual capital, the coefficient of internal consistency of Cronbach's alpha was

calculated separately for each year (Table 3), the threshold value of which is set equal to 0.7.

**Table 3** Coefficient of indexes' internal consistency (Cronbach's alpha) of the regions'

The component of intellectual capital	2014	2015
Human capital	0,814	0,777
Reputational capital	0,860	0,852
Infrastructure Capital	0,680	0,750
Capital of intellectual property	0,840	0,860

The obtained values that were above the threshold value are either very close to it (0.680), which allows us to speak about the internal consistency of the indexes of each type of intellectual capital and the appropriateness of studying the selected groups. All indicators, except indicator ones, were investigated for deviation from the normal distribution. Indicators with a distribution different from normal were normalized according to the formula:

$$\tilde{x} = \sqrt[a]{x},$$

where  $x$  is the initial value of the indicator,  $\tilde{x}$  is the normalized value of the indicator,  $a$  is the degree of transformation (determined experimentally from 2 to 4 in such a way that the coefficient of asymmetry is less than 0.5). The coefficients of asymmetry and used degrees of transformation are shown in Table. 4.

Table 4. The coefficients of asymmetry of the initial data and the selected degree of transformation

Indicator	Asymmetry coefficient		$\alpha$
	2014	2015	
H4	0,45	0,49	3
H5	0,44	0,49	3
H6	0,26	0,16	2
H7	0,25	0,48	2
H8	-0,24	0,46	3
H10	0,22	0,21	2
H11	0,49	0,40	3
H14	0,19	0,12	2
H17	-0,44	0,27	3
H22	0,36	0,19	3
H23	0,34	0,37	2
R9	-0,08	0,06	3
R10	0,47	0,49	4
R12	0,32	0,48	3
II	-0,48	-0,49	2
II3	0,32	0,32	2
II4	0,48	0,47	3
II5	0,46	0,44	2
II6	0,21	0,21	2
II7	0,47	0,43	2
II8	0,06	0,17	2
II9	0,12	0,12	2
I20	-0,26	-0,36	2
IPI	0,46	0,31	2
IP3	-0,48	-0,27	3

All initial values were normalized for reduction to a single scale:

$$x' = \frac{\tilde{x} - \tilde{x}_{\min}}{\tilde{x}_{\max} - \tilde{x}_{\min}},$$

where  $\tilde{x}$  is the normalized value of the indicator,  $\tilde{x}_{\min}$  is the minimum value of the indicator,  $\tilde{x}_{\max}$  is the maximum value of the indicator. Indicators H23 ("Morbidity per 1000 population") and III ("Management risk (rating)") after the normalization were inverted as  $1 - x'$ , because they negatively affect the final result. For the four components of intellectual capital, subindexes were calculated using the distance method (Table 5):

$$I_k = \sqrt{\sum (1 - x'_i)^2}.$$

For the distance method, the smallest value of the index is characterizes the greater significance.

The final index of the regions' intellectual capital is in the Table 5, and it was obtained by the product of the components:

$$I = I_{HC} \cdot I_{RC} \cdot I_{IF} \cdot I_{IP},$$

where  $I_{HC}$  is the index of human capital,  $I_{RC}$  is the index of reputational capital,  $I_{IF}$  is the index of financial capital, and  $I_{IP}$  is the index of capital of intellectual property.

Table 5. Index of regions' intellectual capital (sorting by 2015).

Region	2014		2015	
	score	rank	score	rank
Moscow	6,167	2	4,300	1
Republic of Tatarstan	6,792	3	5,950	2
Saint Petersburg	4,934	1	6,455	3
Tomsk region	13,091	4	11,680	4
Republic of Bashkortostan	15,260	7	13,461	5
Nizhny Novgorod region	14,160	5	13,742	6
Voronezh region	17,452	11	13,947	7
Kaluga region	16,728	9	14,195	8
Sverdlovsk region	14,701	6	14,792	9
Novosibirsk region	17,185	10	14,997	10
Chuvash Republic	18,036	13	15,684	11
Khabarovsk region	16,070	8	16,155	12
Krasnoyarsk region	19,435	17	17,128	13
Lipetsk region	18,937	15	17,368	14
Yaroslavl region	17,673	12	17,504	15
Chelyabinsk region	19,445	18	18,244	16
Republic of Mordovia	20,139	19	18,262	17
Perm region	19,197	16	18,664	18
Rostov region	21,167	21	18,893	19
Moscow region	20,644	20	19,282	20
Tyumen region	23,605	25	19,957	21
Penza region	18,876	14	20,056	22
Kursk region	21,881	22	20,573	23
Belgorod region	23,289	23	20,797	24
Tula region	24,566	28	21,594	25
Ulyanovsk region	23,912	26	21,665	26
Samara Region	24,346	27	22,678	27
Ryazan Oblast	27,293	32	23,753	28
Tambov Region	25,070	29	24,005	29
Vladimir region	23,540	24	24,738	30
Krasnodar region	28,526	34	26,002	31
Stavropol region	28,106	33	26,986	32
Mari El Republic	30,446	41	27,064	33
Saratov region	26,999	30	27,452	34
Murmansk region	29,906	36	27,575	35
Altai region	31,403	44	28,822	36
Omsk Region	27,092	31	29,191	37
Ivanovo region	32,627	49	29,489	38
Republic of Sakha (Yakutia)	30,395	40	29,810	39
Kirov region	30,102	38	30,045	40
Irkutsk region	28,766	35	30,252	41
Oryol Region	32,458	48	30,370	42
Vologda Region	34,888	53	30,439	43
Bryansk region	37,930	56	30,460	44

Magadan region	31,611	45	30,874	45
Kemerovo Region	30,990	43	31,949	46
Tver region	30,233	39	32,001	47
Primorye region	30,083	37	32,227	48
Udmurt republic	32,252	47	32,348	49
Orenburg region	34,924	54	33,271	50
Volgograd region	30,636	42	33,465	51
Novgorod region	31,976	46	33,700	52
Smolensk region	32,763	50	33,707	53
Leningrad region	39,100	60	35,535	54
Republic of Buryatia	32,893	51	35,684	55
Republic of Karelia	37,557	55	36,375	56
Arhangelsk region	38,689	58	37,240	57
Astrakhan Region	39,002	59	37,514	58
Komi Republic	33,921	52	40,532	59
Kurgan region	42,108	61	41,666	60
Kamchatka region	45,377	62	42,483	61
Amur region	38,013	57	42,737	62
Kaliningrad region	47,845	66	43,714	63
Kostroma region	46,645	65	45,381	64
Sakhalin region	48,884	67	46,680	65
Republic of Adygea	45,759	64	46,735	66
Republic of Khakassia	45,735	63	47,927	67
Yamalo-Nenets Autonomous District	50,051	70	48,075	68
Khanty-Mansi Autonomous Area - Yugra	48,907	68	49,342	69
Zabaikalye Territory	51,658	71	50,696	70
Altai Republic	54,527	74	52,718	71
Pskov region	53,808	73	54,299	72
Republic of North Ossetia-Alania	52,980	72	56,571	73
Kabardino-Balkaria Republic	49,732	69	59,550	74
Republic of Dagestan	61,722	75	66,397	75
Republic of Kalmykia	72,416	76	68,748	76
Karachay-Cherkess Republic	77,745	78	69,210	77
Tyva Republic	76,016	77	69,262	78
Jewish Autonomous Region	89,732	80	77,949	79
Chukotka Autonomous District	89,242	79	80,028	80
Chechen Republic	90,481	81	89,597	81
Nenets Autonomous District	98,853	82	103,512	82
Republic of Ingushetia	115,302	83	107,373	83

The presented data show the leading positions of the Moscow, St. Petersburg, Republics of Tatarstan and Bashkortostan, Tomsk and Nizhny Novgorod regions on the integral value of intellectual capital. Fluctuations in the values over periods are evident. It is worth noting the gap between the values of the integrated indicators of the top-10 regions: the first three regions has

very low scores (this corresponds to the ranking rule).

The presented assessment of the regions allows us to see the place of each of them in the rating and to evaluate the competitive advantages of the subjects having higher positions for the purpose of benchmarking. At the same time, the strengths and weaknesses themselves can be

studied in terms of specific types of intellectual capital and indicators that characterize them, which provides a detailed analysis.

The following system of indicators was used to assess the universities' intellectual capital (Table 6).

Table 6. Indicators of universities' intellectual capital

Type of intellectual capital		Indicators	Source
<b>Human capital</b>			
Knowledge Capital	H1	Number of organization's publications indexed in WoS	FSMSO
	H2	Number of organization's publications indexed in Scopus	
	H3	Total number of scientific, design and technological products	
Capital of professional experience	H4	Number of grants received for the reporting year	Monitoring
	H5	Number of academic staff who defended candidate and doctoral dissertations for the reporting period in the total number of academic staff	
	H6	Number of candidates of sciences	
Capital of professional and personal reputation	H7	Number of doctors of sciences	FSMSO
	H8	Total citedness of organization's papers indexed in WoS	
	H9	Total citedness of organization's papers indexed in Scopus	
<b>Reputational capital</b>			
Image capital	R1	The number of researchers sent to working in leading Russian and international scientific and scientific-educational organizations	FSMSO
	R2	Number of scientific conferences with international participation held by the organization	
	R3	Number of popular scientific publications performed by organization's employees	
	R4	The number of leading foreign professors, teachers and researchers working in an educational organization for at least 1 semester	Monitoring
	R5	Number of enterprises with which agreements for training specialists have been concluded	
	R6	Number of enterprises that are the bases for practice with which contractual arrangements have been concluded	
	R7	Number of papers prepared jointly with foreign organizations	FSMSO
	R8	Total impact factor of journals where the organization's papers were published	FSMSO
Brand capital	R9	Specific weight of graduates who have found employment in the calendar year following the year of graduation, in the total number of graduates of the educational organization who have studied the main educational programs of higher education	Monitoring
	R10	National rating of universities (overall rating), score (the highest place from all universities in the region)	

	RI	Availability of universities with special status (federal, regional basic, national research universities, 5-100 universities) 1 point for availability	
Capital of intellectual property	IPI	<b>Capital of Intellectual Property</b> Commercialization of patents, obtained by the formula $0.2 * \text{"Number of created results of intellectual activity"} + 0.5 * \text{"Number of created results of intellectual activity that has legal protection outside of Russia"}$	FSMSO

For each group of indicators that characterize the group of intellectual capital the coefficient of internal consistency (Cronbach's alpha) was calculated separately for each year (Table. 7).

The coefficient for capital of intellectual property was not calculated, since this group consists of only one indicator.

Table 7. Coefficient of internal consistency (Cronbach's alpha)

Intellectual capital component	2014	2015
Human capital	0,760	0,740
Reputational capital	0,800	0,780
Capital of Intellectual Property	-	-

The obtained values are above the threshold value (0.7), which allows us to speak about the internal consistency of the indicators.

Since most of the indicators are presented in absolute values that has a very wide spread, they were previously logarithmation.

For the three components of universities' intellectual capital, an index was calculated using the distance method

The final index of region universities' intellectual capital was obtained by the product of components:

$$I = I_{HC} \cdot I_{RC} \cdot I_{IP},$$

where  $I_{HC}$  is the index of human capital,  $I_{RC}$  is the index of reputational capital, and  $I_{IP}$  is the index of capital of intellectual property.

Table. 8 shows the final values of the index of universities' intellectual capital, which are ranked by increasing its value (in view of the fact that as a result of data processing by distance method, indicators with the highest value of intellectual capital has the lowest value of the integral indicator)

Table 8. Index of universities' intellectual capital

Region	2014		2015	
	score	rank	score	rank
Moscow	0,000	1	0,000	1
Saint Petersburg	0,026	2	0,030	2
Tomsk Region	0,087	3	0,089	3
Republic of Tatarstan	0,114	4	0,131	4
Novosibirsk region	0,184	6	0,163	5
Rostov region	0,169	5	0,222	6
Sverdlovsk region	0,308	10	0,253	7
Republic of Bashkortostan	0,336	11	0,283	8
Samara Region	0,269	9	0,283	9



Belgorod region	0,427	17	0,300	10
Nizhny Novgorod Region	0,390	16	0,336	11
Krasnoyarsk region	0,233	7	0,362	12
Chelyabinsk region	0,370	14	0,418	13
Saratov region	0,499	19	0,456	14
Voronezh region	0,263	8	0,457	15
Volgograd region	0,362	13	0,460	16
Krasnodar region	0,346	12	0,465	17
Irkutsk region	0,377	15	0,515	18
Altai region	0,629	23	0,578	19
Kursk region	0,787	24	0,607	20
Perm region	0,493	18	0,654	21
Stavropol region	0,792	25	0,771	22
Tyumen region	0,555	21	0,817	23
Republic of Dagestan	0,898	28	0,830	24
Omsk region	0,587	22	0,849	25
Kemerovo region	0,540	20	0,887	26
Republic of Sakha (Yakutia)	1,421	35	0,927	27
Ulyanovsk region	0,839	27	0,955	28
Ivanovo region	0,931	29	0,985	29
Kaliningrad region	1,351	33	1,112	30
Vladimir region	0,817	26	1,132	31
Yaroslavl region	0,952	30	1,172	32
Khabarovsk region	1,085	31	1,203	33
Tver region	1,354	34	1,287	34
Republic of Karelia	1,696	45	1,336	35
Udmurt republic	1,602	41	1,351	36
Republic of Buryatia	2,196	54	1,374	37
Mari El Republic	1,097	32	1,378	38
Orenburg region	1,663	43	1,402	39
Tambov region	1,624	42	1,418	40
Bryansk region	1,680	44	1,497	41
Republic of Mordovia	2,157	53	1,554	42
Tula region	1,718	46	1,570	43
Lipetsk region	1,587	40	1,590	44
Astrakhan region	1,544	37	1,623	45
Primorye region	1,551	38	1,652	46
Arhangelsk region	1,425	36	1,670	47
Kabardino-Balkaria Republic	1,555	39	1,743	48
Oryol region	3,040	66	1,764	49
Ryazan region	2,474	59	1,785	50
Novgorod region	2,096	52	1,958	51
Kirov region	2,435	57	2,143	52
Republic of North Ossetia-Alania	2,284	55	2,262	53
Khanty-Mansi Autonomous Area - Yugra	2,567	60	2,330	54

Chuvash Republic	1,952	48	2,354	55
Amur region	2,728	62	2,401	56
Chechen Republic	2,035	50	2,472	57
Moscow region	2,327	56	2,538	58
Komi Republic	1,966	49	2,675	59
Vologda region	1,919	47	2,811	60
Kostroma region	2,749	63	2,838	61
Penza region	2,044	51	2,907	62
Republic of Adygea	3,233	67	3,060	63
Zabaikalye Territory	2,570	61	3,179	64
Republic of Kalmykia	3,029	65	3,183	65
Murmansk region	2,920	64	3,280	66
Pskov region	2,455	58	3,656	67
Republic of Khakassia	3,775	69	4,331	68
Smolensk region	6,078	76	4,481	69
Kaluga region	5,490	73	4,696	70
Kurgan region	3,732	68	4,712	71
Altai Republic	5,738	75	4,820	72
Republic of Ingushetia	4,407	71	5,274	73
Jewish Autonomous Region	4,029	70	5,416	74
Tyva Republic	5,227	72	5,951	75
Karachay-Cherkess Republic	7,673	78	6,299	76
Kamchatka region	6,628	77	6,708	77
Sakhalin region	5,601	74	7,085	78

The table data allow us to allocate regions, universities' intellectual capital which is the highest. These include Moscow, St. Petersburg, Republics of Tatarstan, Bashkortostan, Tomsk, Novosibirsk, Rostov, Sverdlovsk, Samara regions. It is noted that the values of integral indicators of the leading regions are rather close, which indicates adequate comparability of the value of universities' intellectual capital in each region. As already indicated, the value of intellectual capital estimated in the analysis is measured in absolute values, i.e. leading regions demonstrate the comparability of the intellectual capital concentrated on their territory without assessing the influence of the territory factor, population size, universities, etc. It is obvious that the largest number of universities is concentrated in the territory of the Moscow and St. Petersburg, while the indicators of the regions

included in the top-10, are comparable with the leaders, i.e. apparently the level of development intensity of intellectual capital of these universities is on average higher than of the capital ones. All this is due to the objective need to find ways to increase the competitiveness of universities and spreading of their influence on the location region.

Expectedly low indicators of regions in the closing dozen are also associated with a low number of universities concentrated on their territories and with a low quality of their intellectual capital.

The hypotheses were tested by calculating the Pearson's correlation coefficient between the corresponding indexes of intellectual capital (Table 9).

Table 9. Correlation coefficients of intellectual capital of the university and the region and their significance

Hypothesis	Correlation coefficient	2014		2015		
		t-criterion	p	Correlation coefficient	t-criterion	p
H1	0,563	5,993	6,23E-08	0,599	6,727	2,26E-09
H2	0,621	6,979	9,13E-10	0,661	7,936	1,03E-11
H3	0,620	6,955	1,01E-09	0,647	7,627	4,05E-11
H4	0,528	5,462	5,56E-07	0,634	7,376	1,26E-10
H5	0,530	5,482	5,13E-07	0,502	5,219	1,36E-06
H6	0,361	3,439	9,46E-04	0,419	4,152	8,10E-05
H7	0,600	6,577	5,20E-09	0,575	6,331	1,28E-08

As we can be seen from Table. 9, the connection between the indexes characterizing the hypothesis is average, the significance is high.

As the data of the table show, the connection between the indexes characterizing the hypothesis is average (interval 0.3-0.7), the significance is high.

The values of the correlation coefficients for the two studied periods for the H2, H3, and H4 hypotheses are close to the limiting value 0.7, which corresponds to a high correlation level. That allows us to conclude that the degree of influence of universities' human capital on region's intellectual capital is higher than the average; universities' reputational capital influence region's intellectual capital; universities' intellectual capital in general influence the region's human capital.

### Conclusions

The results listed above allow us to draw conclusions about essential role of universities for regional development.

Higher indicators of influence of universities' human capital on the region's intellectual capital are interpreted in connection with the implementation of the main mission of universities for the regions - training and knowledge transfer. All this forms the region's additional intellectual capital, which is used for the purposes of socio-economic development.

Universities' reputational capital is a source for attracting additional client capital to the region, as well as its positioning as a territory with a high scientific and educational potential.

Region' human capital is formed under the influence of the universities' cumulative intellectual capital, which is expressed in the conveying of knowledge, creation of R&D, development of entrepreneurial activity, etc. All this ensures the transformation of available human capital into a regional asset of new quality.

Thus, in the process of research we found out that universities' intellectual capital as a whole and its individual elements create the basis for the development of the region's intellectual capital as an asset for their future growth.

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