

The Role of Human Capital in the Development of Industry in Russia

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Abstract. The article reveals the role of human capital in the development of the modern industry of the Russian Federation. The analysis of the basic concepts is given; the place of human capital is determined as a factor in the country's competitiveness in the global economic space. It is shown that human capital is a factor in the intensification of economic development and scientific and technological progress. Key trends and problems in the development of the industrial sector of the Russian Federation are highlighted. The work determined that a number of significant problems in the Russian industry are associated with problems in the human capital management system (shortage of highly qualified personnel, decline in the popularity of industrial worker jobs, high rates of outflow of personnel from the industrial sector, isolation of industrial enterprises from educational institutions, low wages in a number of industrial sectors, etc.). The main directions of improving the human capital management system in the industrial sector of Russia, including in the field of improving education and innovation activity, developing labour motivation systems, etc., are proposed.

1. Introduction

Today it is becoming more obvious that the potential of the state is determined not only by natural, industrial, technological or financial resources but also by human resources, which are a component of the human capital of a modern state. The recognition of the role of the human factor in the development of the country occurred relatively recently, in the 60s of the 20th century. Prior to this, for a long time, the leading role in achieving economic development was assigned to the accumulation of tangible wealth and capital. However, in the 21st century, the individual was recognized as the main goal and the main subject - the beneficiary of economic development and social progress [1], and highly developed countries were the first to recognize the human factor as one of the competitive advantages in various sectors of social production. This, in its turn, changed the attitude to an individual in the economy, led to an understanding of the relevance of the development of an individual, not only one's necessary qualifications, but also one's creative abilities, as well as the identification of needs and values for the purpose of further motivation to more productive work. The creative, intellectual, physical, spiritual potential of an individual has become the most important object of study both in scientific circles and in the business environment.

Studies of human capital and its role in the economic growth of the state have been most actively conducted since the second half of the last century. First of all, among the recognized researchers should be noted Romer P. [2], Solow R. [3], Lucas R. [4], Aguionon F. [5], J. Grossman [6] and E. Helpman [7] that highlighted the direct dependence of economic growth on the level of development of the country's human capital.

Today, a significant part of the human capital work is more focused on identifying ways of its effective development, increasing the motivation of employees in the company to work, identifying their needs and motives. Among domestic authors who have recently made a definite contribution to the study of human capital, it is necessary to mention the following authors: Maslova, U.A. [8], Shamuratova N.B., Zhetesova M.T, Bermuhanbetova B.B. [9], Khokonov A.A. [10], Bryukhov A.M. [11], Grechko M.V., Goncharov I.V. [12] Konchakova L.N., Chugunova S.V. [13] etc. Nevertheless, despite a certain range of works on this topic, there are still few publications in the field of studying the role of human capital in the development of individual sectors of the economy, including industry.

The purpose of this work was to determine the role of human capital in the development of industry in Russia. In accordance with the goal, the following tasks were identified: to determine the role of human capital in the economic development of the modern state, to identify key concepts of human capital in economics, to consider the main problems and development trends of the industry of the Russian Federation, to highlight personnel problems in Russian industry, to develop basic directions for eliminating negative trends in human capital in the industrial sector of the Russian economy, etc.

In this paper, the methods of generalization, grouping, a statistical method for studying economic processes, a method of information analysis, and graphic methods were used as research methods.

2. The role of human capital in the economic development of the state

The first mentions of human capital as a certain body of knowledge, skills and abilities of a person are found in W. Petty, A. Smith, D. Ricardo, K. Marx, J.M. Clark. The emergence of the theory of human capital in its modern form, economic science is obliged to the works of J. Mincer, who first proposed the term "human capital" in 1958 [14]. His approach was developed by T. Schulz [15] and G. Becker [16], who in 1979 and 1992 respectively received Nobel Prizes in Economics. A significant contribution to the development of the modern theory of human capital was made by a number of Western European and American economists, including L. Thurow, W. Bowen, M. Fisher, J. Weissy. In the future, this theory has been widely spread and studied in the framework of numerous approaches.

Thus, in the theory of the competitive advantages of the country of M. Porter, among the factors for ensuring competitiveness was the effective use of human capital [17]. In his research, Porter emphasizes that the factor of the intensification of economic development and scientific and technological progress are the high qualitative and quantitative characteristics of the national human capital.

A special place for human capital as a factor in the economic development of modern countries is also given in a number of ratings of reputable organizations. For example, in the Global Competitiveness Index rating of the world, the country's competitiveness is assessed according to more than 380 criteria, including the efficiency of using natural resources, the stability of the legal and political systems, the flexibility of the financial system, the high life expectancy of the population, inflation, features of export, scientific and technical potential, economic potential, quality of infrastructure, level of education of the population, etc. Among the most important criteria for assessing In this index, a special place is given to the competitiveness of labour resources.

In the process of scientific and technological revolution, the need for highly qualified personnel, such qualitative characteristics of the individual as high professionalism, competence, innovation, adaptability has increased. The combination of the necessary qualitative characteristics of the individual as one of the factors for the development of socio-economic systems can increase the value of any product or company and ensure the development of the state as a whole. Thus, it becomes

obvious that the role of the human factor in economic development is recognized both in the scientific community and at the level of modern states and interstate organizations.

3. The concept of human capital in economics

Today, not only the science of demography, which examines the patterns of processes in the structure of the population on the basis of social, geographical and economic factors, is engaged in the study of state human capital. The study and evaluation of human capital, its comparison with the human capital of other countries, forecasting its development, as well as exploring the possibilities of its strengthening in order to enhance economic growth is carried out in the framework of other sciences: sociology, political science, economics, psychology, social psychology, a number of management sciences and so forth.

Therefore, due to the consideration of the essence of human capital from the point of view of different approaches, the definition of the concept "human capital" is a rather complicated task. Attempts to give a universal definition of this concept have been made by both foreign scientists and Russian authors, but to date, a single definition has not yet been developed.

Initially, human capital was understood only as the volume of investments in education, science, health, safety and quality of life. The World Bank first proposed to calculate human capital as consumer spending (food, housing, education, health, etc.) [18] Later, this approach to the concept of human capital was significantly expanded.

Thus, T.Schultz proposed to consider human capital from the position of the statement that all human resources and abilities are either innate or acquired (each individual is born with a particular complex of genes that determine one's innate human potential). Schultz called the valuable qualities acquired by an individual, which can be strengthened by appropriate investments, human capital [15].

Russian researcher V.V. Kafidov proposes to consider human capital as mentality, professional habits and people's health, as well as their labour efficiency [19].

In the Manual on the Measurement of Human Capital, the United Nations cites the definition of human capital proposed by the OECD as being "comprehensive": "human capital is knowledge, skills, competencies and other qualities embodied in people and contributing to personal, social and economic well-being" [20].

Human capital, as a rule, is divided into three components: individual human capital (when considering the total of knowledge, skills, physical health, competencies, and so on, of an individual); human capital of the company (a set of characteristics inherent in the individual human capital, but for all employees of the company); national human capital (considered within the country's population).

Thereby, in a broader sense, it is possible to define human capital as an innate and accumulated level of knowledge, skills, competencies, health, and motivation of both an individual and a group of individuals (when it comes to national human capital). Obviously, with this approach, human capital can be considered as the most important factor in the economic development of a state, including its individual industries. In this article, in particular, it is proposed to study the role of human capital in the development of the industrial sector of the Russian Federation.

4. Problems and tendencies of development of Russian industry

Currently, the Russian industry can be represented in the form of a number of industries, including oil refining, mining, metallurgy, chemical and light industries, pharmaceuticals, electric power, building materials industry, food industry, nanotechnology, mechanical engineering etc. Some of these industries have a number of sub-sectors: for example, the mechanical engineering industry includes the military-industrial complex, automobile structure, shipbuilding, aerospace industry, agricultural and railway engineering and electronics industry; and the electric power industry includes hydropower, nuclear power, geothermal power and wind power. Thus, the industry of the Russian Federation has a branched structure, and the industries seriously differ among themselves in a number of factors. First of all, they are different in the financial capacity of the segment, which is one of the factors of the heterogeneity of the development of innovations in the sectors of the Russian industry.

For example, in the oil and gas industry, one of the most financially capacious industries, the highest level of application of innovative technologies is recorded.

It is also important to emphasize another key tendency of the last decades in the Russian industry - the coexistence, on the one hand, of high-tech industries, and on the other, backward technologies that have been preserved since Soviet times. Such a gap in the level of technology of various enterprises of a particular industry, as well as at the level of individual industries, is today a differentiating feature of Russian industry. Basically, the most advanced technologies are purchased by domestic industrialists from the leading developed countries of the world: the USA, Germany, Japan, etc. Among these technologies are high-tech equipment, software, as well as high-tech materials and components.

Thousands of industrial enterprises operate in the field of industry of Russia. Among the largest of them are: in mechanical engineering – "AvtoVAZ", "JSC KAMAZ", "JSC Sukhoi Company"; in the metallurgical industry – "Severstal", "Evraz", "United Metallurgical Company", "Magnitogorsk Iron and Steel Works"; in the chemical industry – "SIBUR Holding", "EuroChem", "Acron Group", "Uralkali", etc. The majority of these enterprises not only sells products on the national market but also actively exports them to other countries of the world. This is especially true for companies from the oil and gas sector, as well as chemical, metallurgical and food industries. Thus, in the structure of Russian exports, the share of oil and gas products in 2018 accounted for 64.79% of the total exports to the countries of the world; metallurgical industry - 9.88%, chemical industry - 6.09%, food industry - 5.53% (Table 1).

Table 1. Structure of worldwide exports of the Russian Federation, 2018.

<i>Product Category</i>	<i>The share of goods in the volume of exports in 2018, in %</i>
Mineral commodities	64,79
Metals and products made of them	9,88
Chemical industry products	6,09
Groceries and agricultural raw materials	5,53
Machinery, equipment and vehicles	5,13
Wood, pulp and paper products	3,10
Precious metals and stones	2,24

Source: [24]

In recent years, positive trends have also emerged, including the gradual growth of a number of indicators by which one can assess the level of industrial development. Thus, the Industrial Production Index (IPI), which is one of the most important macroeconomic indicators of the country, in Russia (since 1998, when this indicator fell to its minimum values) began to increase gradually. However, this indicator has not yet reached the level of 1991 (Fig. 1.). The Industrial Production Index characterizes the change in the production process of the following types of economic activity: “Manufacturing production”, “Mining”, “Production and distribution of electricity, gas and water”. The calculation of the index takes into account the change in the physical volume of production, as well as the hours spent and energy consumed.

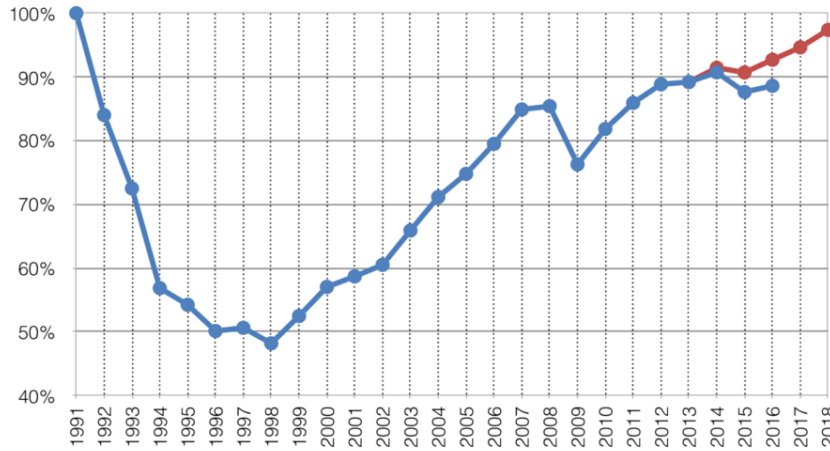


Figure 1. Dynamics of Industrial Production Index in Russia (1991-2018), in% from the 1991 level. Source: [23, 25]

Therefore, the industrial sector in Russia, despite a number of indicators showing positive dynamics, faces the most important tasks in the field of solving problems and negative trends. The problems in the development and rational use of human capital are also evident today in the industrial sectors.

5. Personnel problems in the Russian industry

The problems in the development of human capital in Russia, which today are closely related to the development of the industrial sector of the country, include, first of all, the following: a shortage of highly qualified personnel, a decline in the popularity of industrial worker jobs in society compared to the Soviet period, isolation of industrial enterprises from educational institutions, low wages in a number of industrial sectors. These problems, among others, are a serious obstacle to the further, more active development of the industry of the Russian Federation.

The decline in production in the early 1990’s reduced the demand for qualified personnel in industries and violated the system of their reproduction. The reduction in the number of vocational training schools, as well as the resulting separation of higher educational institutions from industrial enterprises, has led to the fact that today most educational institutions train specialists without taking into account the real needs of the industrial sector. According to the Ministry of Labor of the Russian Federation, at the end of March 2019, the most demanded (by the number of vacancies in employment office) of factory jobs were the following: workers in the metalworking and engineering industry, as well as operators of industrial installations (Table 2).

According to estimates by the international recruitment company Hays, in Russia, there is a shortage of specialists in the design of high-tech chemical plants (chemical industry), petrophysicists (oil and gas industry), pharmacovigilance specialists (pharmaceuticals) and others [21].

It can also be noted that the total employment of the population began to decrease in Russia – an indicator that also characterizes the labour potential of the country, including in the sphere of industry. Thus, over the past two years, the employment rate decreased to 60% by 2018 (in comparison, in 2014-2017 the indicator was fixed at the level of 66%) [22]. One of the reasons for this situation was the tendency of postponing their employment by University graduates. Young people, not wanting to be employed immediately, affect the rate of young people who do not work and study anywhere (neet-young people, *Not in Education, Employment or Training*), a high proportion of which is an indicator of difficulties including the docking of education and the labor market, and young people in this category are one of the most vulnerable groups in modern societies. The share of the neet group in Spain, Italy, Bulgaria and Ireland is more than 17%, in Russia - 12.7% [23].

Table 2. Number of available jobs and vacancies claimed by employers to employment office (as of March 2019).

<i>Field</i>	<i>Number of vacancies</i>
Construction workers and related workers (except electricians)	167 987
Workers engaged in metalworking and machine-building production, mechanics and repairmen	137 392
Drivers and operators of mobile equipment	132 041
Executives	99 341
Operators of industrial plants and stationary equipment	97 104
Unqualified garbage collection workers and other unskilled workers	74 334
Employees of civil and property security services	68 721
Individual service workers	63 474
Specialists in the field of science and technology	58 241
Doctors	52 712

Source: [26]

Another feature in the Russian industry is the uneven distribution of personnel by industry. So, according to the data of the Federal State Statistics Service of the Russian Federation, the largest number of employees is in the extractive industry - 10.7 million people [23]. For comparison, there are 13.6 million people working in the distributive services, 6.3 million people in construction, 5.5 million people in education, and 1.6 million people in the field of electricity supply [23].

Table 3. Average monthly wage per employee in selected industries of the Russian Federation.

<i>№</i>	<i>Industry</i>	<i>RNCE Code</i>	<i>The average wage in rubles</i>
1	Coal mining	RNCE 5	53 065
2	Crude oil and natural gas production	RNCE 6	104 078
3	Metal ore mining	RNCE 7	61 121
4	Mining of other minerals	RNCE 8	48 619
5	Provision of services in the field of mining	RNCE 9	76 361
6	Food production	RNCE 10	29 920
7	Tobacco production	(RNCE 12)	94 767
8	Textiles manufacture	(RNCE 13)	22 370
9	Leather and leather products manufacture	(RNCE 15)	20 193
10	Production of coke and petroleum products	(RNCE 19)	95 956
11	Production of chemicals and chemical products	(RNCE 20)	45 893
12	Production of medicines and materials used for medical purposes	(RNCE 21)	54 261
13	Metallurgical production	(RNCE 24)	49 496
14	Manufacture of computers, electronic and optical products	(RNCE 26)	46 928
15	Manufacture of motor vehicles, trailers and semi-trailers	(RNCE 29)	38 133

Source: [23,27]

Such unevenness can be traced in the field of labour remuneration of workers in Russian industry. Thus, the highest level of the average monthly wage per employee in the industrial sectors is fixed in the sphere of crude oil and natural gas production (104,078 rubles), production of coke and oil products (95,956 rubles), production of tobacco products (94,767 rubles) and the provision of services in the field of mining (76 361 rub.) The lowest level of average wages is demonstrated by the manufacture of leather and leather goods, the production of textiles and the food industry. On average, in all industries of Russia, the wage level is fixed at 39,167 rubles. (Table 3)

As part of the study of personnel problems in the industrial sector, the indicator of labour productivity, which is calculated by the Organization for Economic Cooperation and Development (OECD), is also of interest. This indicator reflects the volume of GDP generated by each working citizen for one hour of work. The average performance for the OECD countries is \$ 54.8, and for the leaders in the rating, it is \$ 99 per hour. According to the OECD, labour productivity in Russia is \$ 26.5 per hour (Table 4)

Table 4. Labor productivity in the OECD countries and in Russia.

<i>№</i>	<i>Country</i>	<i>Productivity</i>	<i>№</i>	<i>Country</i>	<i>Productivity</i>
1	Ireland	99,5	19	Canada	53,5
2	Luxemburg	98,5	20	Japan	46,2
3	Norway	83,1	21	Slovenia	46,1
4	Belgium	76,8	22	Turkey	43,8
5	Denmark	76,4	23	Slovakia	43,3
6	Austria	72,2	24	Lithuania	43,2
7	Germany	72,2	25	New Zealand	43,2
8	The USA	72	26	Israel	42,7
9	The Netherlands	71,4	27	Czech Republic	42,2
10	Switzerland	71,3	28	Portugal	40,6
11	Sweden	71	29	Greece	38,9
12	France	69,6	30	Poland	38,5
13	Finland	65,5	31	Estonia	37,9
14	Iceland	65,2	32	South Korea	37
15	Great Britain	61,1	33	Latvia	36,6
16	Australia	58,6	34	Hungary	35,7
17	Italy	57,4	35	Chili	27,6
18	Spain	55,2	36	Russia	26,5
			37	Mexico	21,7

Source: Compiled by the author according to [28]

Nevertheless, the human capital of Russia can be assessed positively in the field of education and literacy, which are quite high in the Russian Federation (for example, the level of literacy in the country is 99.7%) [23], and the United Nations Development Program Russia ranks 34th out of all countries of the world [29, 31]. According to the Human Capital Index, which was developed by the World Economic Forum Group in conjunction with Harvard University, quantifies the contribution of health and education to productivity and the income level of the next generation of citizens. The index estimates the future productivity of a person born in a certain year, after reaching 18 years old, Russia also occupies 34th place and is included in the group of countries with a high level of human capital development [30]. However, in order to further develop it and eliminate personnel problems in the industrial sector of the economy, it is important to single out the main areas of work with human capital in Russian industry.

6. Key areas of human capital in the industrial sector

Within the framework of the human capital development programs of the industrial sector of the Russian economy, a number of key areas can be identified: increasing the prestige and quality of engineering education, interaction of industrial enterprises with institutions of higher professional education, stimulation of innovative activity of industrial companies, significant increase in labor motivation of workers in all industries of Russia to prevent the outflow of qualified personnel from this sector of economics, application of advanced foreign experience adapted to the Russian specifics in the field of personnel training for work in the industrial sector, etc.

So, one of the urgent tasks of the Russian Government in the development of the industry is the training of highly qualified personnel, who are not inferior to the best foreign specialists in terms of qualifications, skills and competencies. As part of improving the quality of education in engineering universities, it is important to involve practitioners, the best foreign teachers, including those with unique knowledge, to improve the quality of educational and methodological complexes, etc. It is also important to modernize the system of vocational education, its focused support from the state, as well as the establishment of close cooperation of educational institutions with representatives of industrial companies, the adaptation of training programs to the needs of employers.

Special attention should be paid to work with talented young people, which can be carried out in several directions: identification of the best students studying at the University by companies and their support (within the framework of scholarship programs or internships) until the end of training with the subsequent offer of employment; activation of work with young promising employees in the company (work with the personnel reserve, career planning for young employees, study of their motives and needs and development of an effective system of motivation).

In connection with the risk of outflow of highly qualified personnel abroad, attention should be paid to increasing the income of engineers. To do this, a number of programs should be developed both by the state and by Russian Industrialists themselves. Moreover, for highly qualified labour resources, the level of wages should be comparable with the average level of wages in the developed countries of the world. In addition, the individual approach in the process of labour motivation of each of the specialists with rare competencies and high cost in the labour market becomes relevant. Besides, an individualized approach should be carried out at all stages of the employee's activity in the company: one's adaptation, training, development, etc.

The above-mentioned measures can contribute to the elimination of personnel problems and negative trends in the industrial sector of the Russian economy and increase the role of human capital in achieving sustainable economic development of the Russian Federation.

7. Conclusion

The importance of human capital development for the Russian industry lies in the fact that high-quality human capital: is a factor in improving the efficiency of the company by increasing productivity; demonstrates a higher level of susceptibility to innovation and technological changes in the production; produces new ideas that can bring the company to a higher level of development.

However, today it should be noted that in Russia there is a lag in the development of human capital in comparison with advanced developed countries, including in the field of industrial production. Thus, we can talk about the reduction in recent years of the components of human capital: educational, scientific, technological and industrial.

The main directions of minimizing the negative trends in the industrial sector of Russia were proposed. Among these directions is the activation of innovative activity, especially among the younger generation, the development of effective and individualized systems of work motivation, the study of foreign experience and its adaptation to the Russian specificity of human resource management in industrial companies.

The main conclusions and provisions of this work reflect the goal and the objectives of the research. The obtained results can be used both for further theoretical studies of the role of human

capital in the development of the industrial sector of the Russian Federation and as tools for improving the efficiency of human capital management in industrial enterprises.

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References

- [1] Doktorovich A B 2015 Paradigm of Socio-Innovative Development: Human Potential and Intellectual Capital of Social and Economic Changes 1st-2nd ed *Space and time* p 84
- [2] Romer P M 1990 Endogenous Technological Change. 98th (5) ed. *Journal of Political Economy* p 71
- [3] Solow R M 2002 Growth theory Panorama of Economic Thought of the End of XX Century 1st ed. (Saint-Petersburg: School of Economics) p 600
- [4] Lucas R E 2002 Lectures on Economic Growth *Harvard University Press* p 204
- [5] Aghion P and Williamson J 2015 Growth, Inequality and Globalization: Theory, History and Policy *Delo* p 287
- [6] Grossman S J and Hart O D 2019 An Analysis of the Principal Agent problem *Econometrica* 51st ed. *The Econometric Society* pp 7-46
- [7] Helpman E 2011 The Mystery of Economic Growth (Moscow: Gaidar Institute for Economic Policy) p 240
- [8] Masalova U A 2015 Human Resource Quality Management System 1st ed. (Omsk) *Omsk University Bulletin Economy series* p 82
- [9] Shamuratova N B, Zhetesova M T and Bermuhambetova B B 2015 Human Capital as a Sign of Innovative Development of the Economy 7th ed. *Innovation Science* p 166
- [10] Khokonov A A 2015 On the Question of the Importance of the “Human Capital” Factor in the Innovative Development of the Country. 1st (21) ed. *MIR Modernization. Innovations. Development* pp 76-80
- [11] Bryukhov A M 2012 Scientific Analysis of the Concepts of "Human Capital" and "Human Capital Management" 1st (18) ed. (Chelyabinsk: Chelyabinsk Humanitarian) pp 23-26
- [12] Grechko M V and Goncharov I V 2016 Human Capital, Human Resources, Intellectual Capital: Interrelationship and Category Distinction 2-2(67) ed. *Economy and Entrepreneurship* pp 243-249
- [13] Konchakova L and Chugunova S 2019 Human Capital and Investments in the Human Capital of an Enterprise Actual problems of aviation and cosmonautics Reshetnev *Siberian State University of Science and Technology* 13 pp 48-50
- [14] Blaug M 2009 Great Economists since Keynes: An introduction to the Lives & Works of One Hundred Great Economists of the Past (Saint-Petersburg: Ekonomikus) pp 200-202
- [15] Shultz T 1968 Human Capital in the International Encyclopedia of the Social Sciences (N.Y.) vol 6
- [16] Becker Gary S 1964 Human Capital (N.Y: Columbia University Press)
- [17] Porter M 1993 International Competition (Moscow: International Relations) p 895
- [18] The official website of the World Bank <https://www.worldbank.org/>
- [19] Kafidov V V 2011 Human Resource Management (Saint-Petersburg: Piter) p 93
- [20] 2016 Guide to Measuring Human Capital United Nations Economic Commission for Europe New York and Geneva
- [21] Hays official website in Russia <https://hays.ru/>
- [22] The official website of the RBC Company https://www.rbc.ru/own_business/03/12/2018/5c050bde9a7947be2dd961ac
- [23] Federal State Statistics Service of the Russian Federation <http://www.gks.ru>
- [24] Federal Customs Service of the Russian Federation

- http://www.customs.ru/index2.php?option=com_content&view=article&id=24928&Itemid=1977
- [25] Portal on Financial Markets Equity.today <https://equity.today/indeks-promyshlennogo-proizvodstva.html>
- [26] Ministry of Labor of Russia <https://rosmintrud.ru/ministry/programms/inform/3>
- [27] Portal Audit-IT https://www.audit-it.ru/inform/zarplata/index.php?id_region=27
- [28] Organization of Countries of Economic Cooperation and Development (OECD) <https://www.oecd.org/>
- [29] Education Index United Nations Development Program <http://hdr.undp.org/en/content/education-index>
- [30] Human Development Indices and Indicators - 2018 United Nations Development Program http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf
- [31] Solovev D B, Shadrin A S 2015 Instrument current transducers with Rogowski coils in protective relaying applications *International Journal of Electrical Power and Energy Systems* **73** pp. 107-113. [Online]. Available: <http://dx.doi.org/10.1016/j.ijepes.2015.04.011>.