

Management of Formation of Human Capital in Digital Economy of the Region

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Abstract — The object of the study is the institutional and infrastructural environment for managing the formation and development of human capital in cooperation with the regional labor market in the context of digitalization. The subject of the study is the organizational and economic relations associated with the process of human capital management in the socio-economic development of the region. The purpose of the study is to generalize and develop theoretical principles and develop guidelines for innovative management of the formation of human capital in the digital economy of the region. As a result of the study, the following tasks were solved: justify the need for a mechanism for using new business models for transforming traditional sectors of the digital economy of the region; explore the labor market and staff competencies in the digital era of the region's development; evaluate the contribution of digitalization to the economic growth of innovative management of the formation of human capital development; to form an idea of the impact of quality education on the development of human capital; to analyze the effectiveness of higher education institutions as one of the fundamental factors in the formation of human capital. The article presents the average annual values of the additional contribution of growth factors to the added value of economic sectors as a result of digitalization. The article assesses the contribution of digitalization to GDP growth as an accumulated result, estimates the contribution of digitalization to GDP growth. The proposed methodology for assessing the effectiveness of universities, consisting of six different indicators: educational, research, international, financial and economic activity, the salary of faculty and employment, allows reflecting all categories of indicators that have median values. The problem of managing the formation of human capital in a digital economy is being addressed.

Keywords — *human capital, digital economy, formation of human capital, regulation of the formation of human capital, region, digital economy of the region.*

I. INTRODUCTION

Digital economy sets the path for the transformation of traditional sectors of the economy, the emergence of new markets and niches. New business models are customer-

oriented, which completely determines their structure: from a value proposition aimed at solving the predicted needs of the client, timely delivery, and to revenue streams based on the time the client used the product. The key source of value creation is high-speed processing of big data, as transactions occur in real time and often simultaneously. Big data analysis technologies and artificial intelligence help find new sources of value creation based on the study of digital portraits of consumers and patterns of their economic behavior. Customer data is becoming the main asset of digital companies, and access to large arrays of them increases the assessment of market value. The current trend is the development of open data platforms, stimulating the emergence and spread of innovative business models in the economy. In the financial sector, the implementation of this concept is the Open Banking system, which provides third parties with the opportunity to analyze or use data, integrate various applications and services, thereby improving the quality of customer service.

The main parameter of the competitiveness of new business models is the speed of launching a new product on the market. Modern approaches to development and production based on advanced production technologies reduce the time to market for the product and use an iterative approach to updates and improvements, adapting to changing customer needs due to the ease of changing suppliers and testing new concepts and products (Tesla launches new options and fixes claims in real time remotely through software updates; Facebook tests and launches updates for individual groups by zovateley twice a day, etc.). The most important task of today's business model is to create a space

New digital technologies are expanding business opportunities for the optimization of many processes and improve the quality of decision making. Thus, the Internet of Things and cloud computing to optimize the collection and storage of data, technology and methods of machine learning and AI allow their deep processing algorithms to build predictive models and behavior. Internet of Things

applications are also a driver of development model, as it allows estimating the parameters of use of products and achieving the effect. On this principle popular model car sharing, payment of car insurance depends on overcoming kilometers in the industry – the payment time use equipment or manufactured products on it. Kaiser Company invoices its customers not for compressors, and for the compressed air produced. As part of the Rolls-Royce TotalCare company supplies customers with aircraft engines, but the payment is made for the hours during which the engine is running. The service provided includes the monitoring work of the Rolls-Royce of the data center and engine maintenance.

Prevalence of new business models in Russia varies considerably by economic sector: the most common digital platform in markets characterized by a close interaction between suppliers and consumers – in retail, financial services, consumer goods and services, which are actively developing platform solutions.

II. LITERATURE REVIEW

The theoretical basis for the formation of human capital in economic and social development set out in the fundamental works of prominent representatives of economic science: M. Blaug, E. Dennison, J. Kendrick, F. Machlup, J. Mintzer, L. Thurow, E. Flamholttsa et al.; works of domestic scientists: V.S. Goyle, A.V. Dobrynin, R.I. Kopelyushnikova, M.M. Kritskii, V.I. Marcinkiewicz, D.A. Nesterova, K.I. Sabirianova et al.

General questions of methodological support of the formation of the region's human capital are the object of study of domestic and foreign economists, such as O.V. Bondarenko, V.I. Gurov, E.V. Erokhin, O.A. Gold particles, E.A. Okounkov, B.G. Transfiguration, N.V. Sirotkina, N.N. Trufanova, E.A. Ugnich, E.V. Kharchenko, G.F. Shafranov-Kutsev.

Improvement of state regulation of the interaction between education systems and the organizations of employers offered in his works M.G. Averkin, D.Y. Bottaeva, L.A. Glazyrina, V.P. Dyomkin.

Studying the formation, accumulation and development of human capital in the region's social and economic development are devoted to E.A. Alpeeva, E.A. Bessonova, Y.A. Masalova, I.V. Minakova, A.K. Nesterov, K.A. Noskov, T.O. Thick, R.M. Ustaeva, S.V. Forrester.

In modern economic literature, there are significant developments in relation to the formation of innovative management of human capital in terms of digitization, but at the same time, the mainstreaming of new tendencies and forecasts of development of its organizational and economic mechanism in the domestic economic literature so far neglected.

III. METHODOLOGY

Currently, higher education institutions can achieve a significant increase in competitiveness, not only by increasing the role assigned to the dynamic capabilities of the university, as well as the continuous development of staff throughout their lives, which leads to permanent capacity competence.

Evaluating the effectiveness of the activities of higher education institutions consists of 6 different indicators: education, research, international, financial and economic activities, salaries of the teaching staff and employment. All categories of indicators are median values that reflect the effectiveness of the university in a particular area [1].

In the section "Educational activities" includes indicators to assess the medium and the average score the exam students of bachelors and specialists in various training programs in the full-time, the number of undergraduates and graduate students share per 100 students. In addition, this indicator reflects the number of employees with academic degrees of candidate and doctor of sciences [7].

Index of research activities is calculated based on the number of publications and citations of scientific papers in Russian and international RISC systems, Web of Science / Scopus, R & D spending per PND and other indicators.

For international activities include the indicators characterizing the number of foreign students.

Indicators of financial and economic activity – a university income received per scientific and teaching staff.

Monitoring innovation in 2018 is the section "Wages PPP", which allows assessing the level of wages of the teaching staff of the university.

Group rates "Employment" describes the number of employed and unemployed graduates [9].

To compare the most important criteria need to use paired comparison method, which is a method for producing original data, original survey respondents' method. To reflect the objective results of a survey was conducted among independent experts in the field of education: the heads of schools and teaching staff, heads of state bodies, as well as heads of enterprises and organizations. According to the survey it was calculated the average values of each criterion for evaluating the effectiveness of the university (see Table 1).

TABLE I. CRITERIA FOR EVALUATING THE EFFECTIVENESS OF THE UNIVERSITY

Criterion	Mean	Criterion	Mean
1. Educational activities – (D)	9.7	4. Financial and economic activity – (F)	5.5
2. Research activities – (H)	9.4	5. Wages PPS – (G)	8.6
3. International Activities – (M)	6.3	6. Employment – (T)	7.6

It was found that the efficiency of the integral index is influenced by such criteria as an educational and research activities on the basis of the results obtained.

In order to assess the level of effectiveness of the Central Federal District high schools was held sample 69 schools and conducted a comprehensive performance assessment based on a calculation of an integral indicator of efficiency:

$$K_{eff} = \sum_{i=1}^n X_i \times w_i, \tag{1}$$

where X_i – indicator of the effectiveness of the university, w_i – weighted value of the index in the total population.

IV. ASSESSMENT METHODOLOGY

A key factor in the success of the processes of digitization is the availability of highly qualified personnel in sufficient quantity and of appropriate jobs, as well as specialist training, with certain competences for the development and implementation of digital technologies.

The transition to the digital economy significantly alter the labor market: in addition to the spread of information technology in all areas of digital skills become critical from the standpoint of employers. It is expected a large-scale transformation of the requirements to specialists, since many of the operations that were not affected by the previous waves of the introduction of digital technology can be automated in the near future. Core competence, defining the future competitive advantage of companies, it becomes big data analytics. Ability to work with large sets of structured and unstructured information allows companies to improve the quality of forecasting demand, streamline processes [4].

The introduction of digital technology results in significant changes in staffing needs and requirements to the experts:

- a decrease in demand for occupations related to the implementation of formalized recurring transactions;
- reduction of the life cycle of occupations due to the rapid change of technology;
- transformation of the competency profiles of certain categories of staff (risk analysts, the HR-managers, marketing analysts, operators, contact centers, etc.). In connection with the change of work tools;
- the emergence of new roles and professions;
- increasing demands for flexibility and adaptability of personnel;
- increasing demands for «soft skills» – possess social and emotional intelligence, eventually those abilities that distinguish man from the machine;
- growth in demand for professionals with a "digital agility» (digital dexterity) – the ability and willingness to use new technologies to improve business results.

Russian universities that prepare future professionals – list of programs in the direction of "Big Data" are shown in Table 1, which deals with master's programs and specialty programs universities selection criteria [8]:

1) revealed a system of intelligent data analysis iFORA as a center of competence in the field of big data analysis techniques;

2) participant QS subject rankings in the direction of «Computer Science & Information».

Under the ownership of digital technology can be understood as a variety of skills: working with basic office

software applications to the latest digital techniques, from a purely theoretical knowledge to practical everyday use [6].

In 2018 the HSE ISSEK conducted a survey of more than 2 thousand. Holds degrees from all fields of science and engaged in the academic sector (research institutes and universities) and in the industrial and service organizations. Respondents were asked about familiarity with the most common digital technology. It was found that among respondents PhDs 85 % regularly used to practice the skills to use computers and the Internet, 10 % use them occasionally. Cases where candidates and doctors in their professional activities almost do not work with a computer, a single (usually the senior and middle age, and most of them are employed in high schools) [10].

Skills acquisition and processing using ICT regularly employ 48 % of the holders of an academic degree, another 33 % – from time to time.

TABLE II. RUSSIAN UNIVERSITIES THAT PREPARE FUTURE PROFESSIONALS – LIST OF PROGRAMS IN THE DIRECTION OF "BIG DATA"

University	Program	Where work graduates
Moscow State University	Big Data: infrastructure and methods for solving problems	GIS Energy, IBM, Microsoft
	Intelligent analysis of large data	
National Research University "Higher School of Economics"	Data Mining	Amazon, Apple, Google, Intel, Kaspersky Lab, LATNA, Microsoft, Samsung, Yandex
	Data science	HSE Sberbank, Yandex, E & Y, Google, IBS, LORIA, PWC, TU Dresden
	big data system	MTS, the HSE, IBM, SAS
	Financial technology and data analysis	SAS, IBM, Accenture, Oliver Wyman, KPMG, Deloitte, GlowByte, Double Data, Rubbles, Econophysica, Prognoz, Foresys
Novosibirsk State University	Big Data Analytics	ExpaSoft, Google, Inteks, Intel, Microsoft, Parallels, UniPro, Yandex
Saint Petersburg State University	Business analytics and big data	Auchan, VTB, MTS, Megafon, the Russian Railways, Sberbank, Yandex, Coca-Cola, Danone, Fazer, Henkel, IBM, IKEA, JetBrains, Kelly Services, L'Oreal, McKinsey & Company, PwC, Unilever
Saint Petersburg State University of Information Technologies, Mechanics and Optics	Extra calculation and processing of very large volumes of data	Information-Analytical Center of Saint Petersburg, Research Institute of science intensive computer technologies ITMO University, LLC "ETs Consulting"

As for advanced digital skills that many of the technologies surveyed at least heard of, but the range of their practical use is still very limited.

The most knowledgeable about modern digital technology staff research organizations (for most of the terms in the

proportion who know SRI is higher than in the universities and non-academic sector organizations). More familiar with digital terminology young scientists: the difference in knowledge between the group under the age of 29 years and the average for the entire sample of individual technologies reaches 10 to 15 percentage points [11].

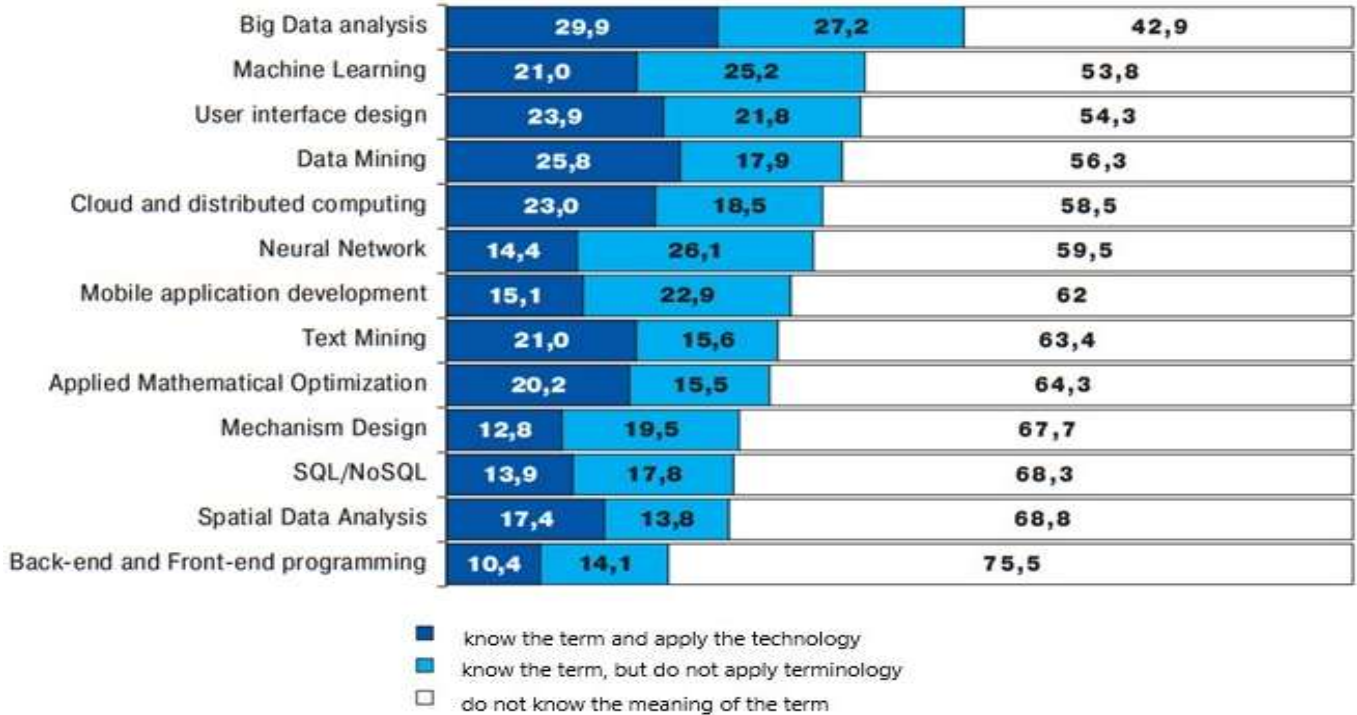


Fig. 1. Application of digital terms PhDs (%)

V. ANALYSIS

One of the main conditions for the implementation of large-scale government investment in the deployment of digital technology is to assess the contribution of the relevant events in the economic growth in terms of cost-effectiveness.

Regardless of the scenario of economic development require guarantees sufficient return on such investments to support the feasibility of their implementation. The introduction of digital technology – one of the key drivers of economic growth. The cost structure of sectors of the Russian economy products and services of the ICT sector is already a significant share. In some industries (machine-building, chemical industry), the intensity of the costs of ICT products conform to the US level, and in science, education, public health, the financial sector and the transport sector even exceeds it. However, in such a large proportion of Russia's GDP in sectors such as trade and timber industry complex, and in some service sectors are observed significantly lower values of intensity of ICT costs [2].

In engineering, in recent years the level of ICT expenditures (relative to the release) is about 8 %, which is comparable to the costs of the transport sector. In general, the intensity of the products the cost of ICT in Russia lags behind the US level (2.46 % vs. 3.08 %). To a large extent the

backlog of individual segments of the Russian economy on the level of digitalization is related to low levels of investment in the digital infrastructure (software, electronic component base and others.), which in Russia (1.46 % of GDP) is far behind the US level (2.80 % GDP). In terms of sanctions more expensive imported technology is slowly replaced with domestic, constraining the pace of upgrading the digital infrastructure.

Digitalization of industry leads to a change in demand for the factors of production. Under the influence of digital technologies and the associated new business models transform not only individual sector, but the whole structure of the economy and the cross-industry interactions. Calculations ISSEK the HSE show that in the baseline scenario with moderately favorable macroeconomic and institutional conditions (primarily faster growth of investment activity in all sectors of the Russian economy and maximize the effect of scientific and technological development), digitalization can significantly improve factor productivity as the industries and the service sector (table 3).

TABLE III. AVERAGE VALUE OF THE ADDITIONAL CONTRIBUTION OF THE GROWTH FACTORS IN THE VALUE-ADDED SECTORS OF THE ECONOMY AS A RESULT OF DIGITALIZATION IN THE PERIOD 2019-2020

Sector	Contribution productivity (TFP), %	Capital contribution %	Labor contribution %	Result %
Financial sector	0.92	1.20	0.93	3.04
Transport	1.29	1.20	0.55	3.03
Construction	0.98	1.02	0.88	2.88
Education	1.00	1.20	0.57	2.77
Chemical industry	1.64	1.40	-0.43	2.61
Engineering	1.52	1.48	-0.46	2.54
Other services	0.93	0.79	0.24	1.95
Health	0.81	0.58	0.25	1.65
Light industry	1.02	0.96	-0.65	1.32
Electrical power	0.32	0.83	0.04	1.19
Trade	0.60	0.36	0.04	1.00
AIC	0.78	0.69	-0.56	0.91
State administration	0.58	0.24	-0.40	0.41
Timber industry complex	0.31	0.14	-0.53	-0.08
Metallurgy	0.25	0.10	-0.55	-0.21
Production	0.08	0.04	-0.46	-0.35

The greatest effect of digitization can be achieved in the high technology service sectors and high-tech industries, the effectiveness of which can grow faster than other sectors of the economy [3]. Digitalization will require not only increased investment in digital technologies, but also a radical

modernization of the infrastructure of almost all sectors of the economy (with the exception of mining, where this process is to a large extent already occurred), which will ensure a high rate of capital contribution factor of growth in value added. In some sectors of the influx of highly qualified personnel will not be able to compensate for the release of low-skilled staff, which will lead to a negative contribution of the labor factor in the growth of individual sectors of the economy.

VI. DISCUSSION

According to our estimates, in 2030 GDP growth will be more than half related to digitization (1.47 % from 2.75 % of the annual GDP growth), primarily as a result of increasing the efficiency and competitiveness of all sectors of the economy. Some growth will provide additional effect information industry (Figure 2).

With accelerated socio-economic development (4.35 % GDP growth per year) growth at the expense of digitization should be more than 2 % per year (Figure 4). Maximum economic benefits can be achieved by radically increasing performance and investment activity in the economy [5].

Thus, in the long run digitalization can become a significant structural factor of economic growth under different scenarios of development of the Russian economy.

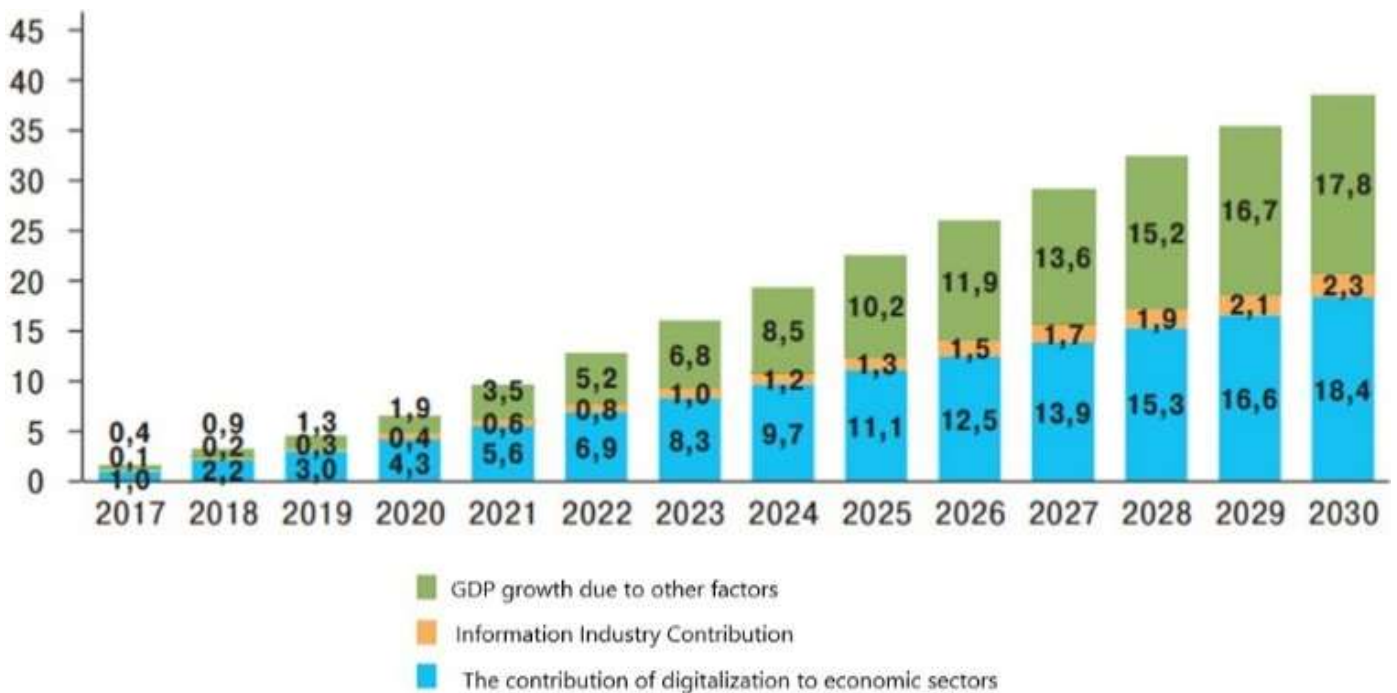


Fig. 2. Evaluation digitalization contribution to GDP cumulative (%)

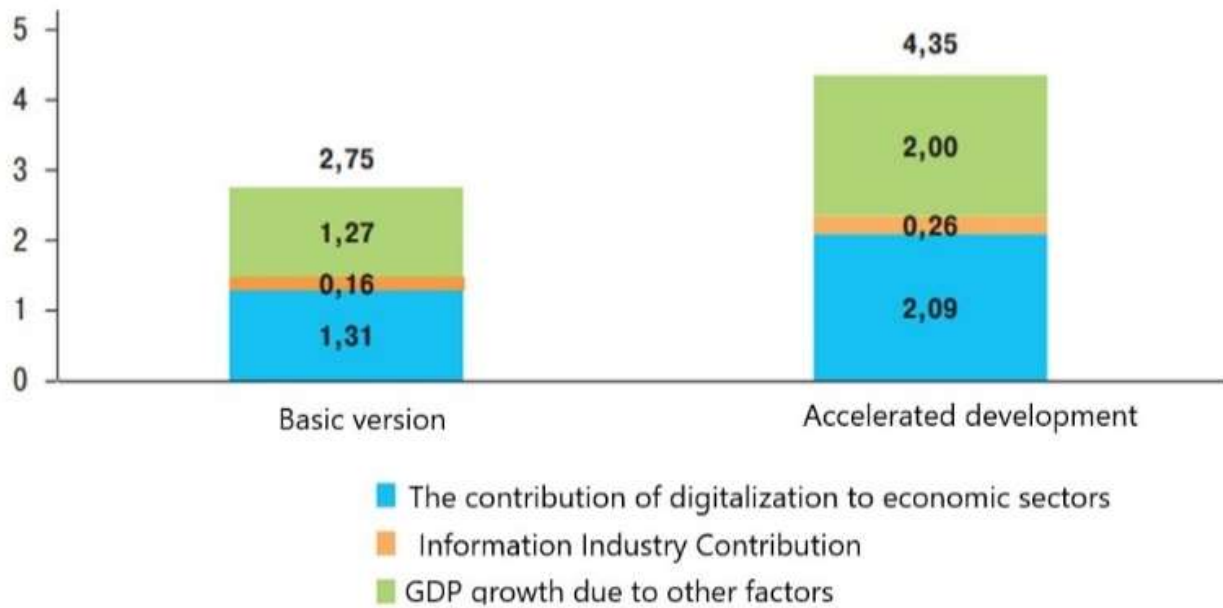


Fig. 3. Estimates of digitalization contribution to GDP growth (average annual growth rate for the period from 2019 to 2030 at two variants of economic development) (%)

VII. CONCLUSION

As a result of the study we have made the following conclusions:

1. The main directions of development of human capital in the era of globalization, the digital economy is the collection, storage and analysis of data on the necessary training and qualifications of university students. In addition, it becomes evident the need to create a system based on the use of artificial intelligence, the aim of which is the study and analysis of open unemployment statistics, the number of vacancies, the most sought-after specialties and building a model of the future graduates with a forecast for 10–15 years forward. This approach will allow changing the number of budget places for different specialties, thus stimulating the correction of the number of graduates in a given industry.

2. Human capital development is a complex system of interrelations of different technological areas. For example, the forecast for the development and stimulation of experts necessary to carry out analysis using data-processing techniques. Subsequently, future professionals will need highly qualified teaching staff who must meet modern requirements and actively use information technology. Universal digitalization has led to the spread of information technology in all spheres of human life, which is a natural development in the era of digital economy.

3. The effect of digitization on the economy can not be overestimated, since it is increasingly under the influence of positive changes observed GDP growth. This indicates the need for additional investment in the digital sphere of production. Despite current concerns about reducing the demand for human capital as a factor of economic development, it is necessary to take into account what is happening at the present time replacement specialists some

other professions. So without the development of professionals in the field of information technology is impossible to further the development of the digital economy.

4. Human capital development is impossible without the qualitative upgrading of the educational process, as well as the application of innovative technologies of training of students. The lack of an adequate level of training is replaced by the pace of development of human capital. In the era of digitalization economy requires constant change and improvement of educational programs. Traced urgent need for implementation case model of education. In this case is unacceptable use of existing educational models. Only the modernization of the educational sphere will form a quality human capital capable to meet the needs and requirements of the digital economy.

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