Digital skills supply and demand on the Russia regional labor markets

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Abstract. The digital transformation has a significant impact on labor resources development, leading to a change in the skills types that are in demand and offered in the labor market. Due to the spatial heterogeneity of the Russian economy, the digital skills of the population in different regions have significant differences, which acts as a limitation of labor mobility, reduces the efficiency of using human potential and requires the development of inclusive regulatory measures. The study purpose is to assess the current spatial differentiation of the digital skills of the workforce, the ratio of their market demand and supply, as well as to propose appropriate measures to improve the efficiency of the regional labor market. A quantitative assessment of the demand of employers for workforce digital competencies in the regional labor markets was obtained on the basis of an analysis of the requirements for applicants presented in the unified database of vacancies in Russia, their further automated processing and ranking. The corresponding quantitative assessment of the market supply of digital competencies of the workforce was obtained using the hierarchical data clustering. The scientific novelty of the study lies in the identification the imbalance between the level of workforce digital skills development in Russian regions and the needs of regional labor markets. The practical significance of the study results lies in substantiating the policy of workforce digital skills inclusive development for each region, which should include corporate strategies for the development of digital competencies of both employed workers and potential job seekers.

1 Introduction

The world is on the verge of mass introduction of the Fourth Industrial Revolution technologies (Industry4.0), the objective nature of which has been proven by economic science and is confirmed by reality. According to general estimates, Industry 4.0 will be characterized by widespread digitalization and robotization, the virtuality of fully automated ultra-precise individual production, and the complexity of the intellectual technologies used. Industry 4.0 technologies today have an ambiguous effect on the labor

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market of developed countries, therefore, the possibility of sustainable development of modern society in the context of a radical transformation of the nature and content of labor is the subject of controversy among world scientists and experts. Anyway, the widespread introduction of digital technologies is rapidly changing the forms, methods, objects and processes of human labor, and contributes to the productivity growth and labor efficiency. An analysis of works [2-19] shows that digital skills in the modern economy play a significant and growing role. Thus, in a large-scale industry study based on the EU economy data, it is shown that the lack of ICT skills among workers is one of the main restrictions on the introduction of digital technologies in the industry [10]. In [20-23], it was concluded that the presence of digital skills contributes to higher entrepreneurial activity both in traditional types of business and in the most creative ones. The most recent international studies based on data from a multisectoral economy confirm that countries with a relative surplus of a highly skilled workforce with high digital competencies are growing faster than others [8]. At the same time, it has been proven that the development of digital competencies of the economically active population of developed countries directly depends on the market demand for them from employers [20, 24-28]. The work [11] shows that the increase in the digital component of the quality of life in Russia leads to an increase in the regional gross product.

The significant role of digital skills in ensuring economic growth determines the interest in studying the current situation of digital skills in the regional labor markets of Russia. The regional aspect deserves attention, since spatial inequality has historically been one of the most important constraints on the development of Russian economy, eliminating the digital divide is one of the most important areas of the National Program "Digital Economy of the Russian Federation". As noted in the review of the Analytical Center under the Government of the Russian Federation, the implementation of this direction contributes to the achievement of the global "Reducing inequality" goal of sustainable development [33]. At the same time, the demand for digital skills in regional labor markets and the dynamics of their development in different regions of Russia have not been sufficiently studied, which actualizes the research topic.

The starting points of the study are that 1) the massive replacement of labor by machines or artificial intelligence with the elimination of relevant jobs in the foreseeable future is hardly feasible, but an increase in demand for the labor services of an employee with developed digital skills is highly expected; 2) the processes of labor digitalization and its individual elements do not have a fundamental impact on both the very nature of the relationship between the employee and the employer, and the mechanism for the formation of supply and demand in the labor market; 3) the market mechanism of the external labor market is incomplete in its content, since the act of purchase and sale of labor services does not end there, but there is only an object of supply and demand, which is the labor force; the price of labor services - the salary that the employer previously offers is also not realized on the external labor market, its value will ultimately be determined and paid on the internal labor market, depending on the beneficial effect embodied in the labor service and created by it with the participation of the labor force.

The aim of the paper is to assess the degree of spatial differentiation of the labor force digital skills in the regions of the of Russia (paying special attention to the North Caucasus Federal District of Russia, as the most labor-surplus), to substantiate the hypothesis of a priori development of demand for digital skills of the labor force from regional employers due to the market nature of their supply.

2 Materials and Methods

The study uses the established International Telecommunication Union (ITU) definition of digital skills, which defines digital skills as the knowledge and skills necessary to enable an individual to use information and communication technologies (ICTs) to achieve goals in their personal and professional lives. Digital skills are constantly changing due to the rapid development of ICT and the development of the new economy [15].

As a data source we used Rosstat [21, 30], the Federal database of vacancies and the summary of the digital platform "Work in Russia" (https://trudvsem.ru), WEF research [9, 22], McKinsey [1, 26], NRU Higher School of Economics (HSE) [5,6,7,14], other sources. In particular, we used the results of a study of an online vacancies array presented in the work of S.D Kapelyuk and I.N. Karelin [28, 29]. These authors analyzed 8.8 million vacancies using the automated processing of information about the requirements for applicants indicated in vacancies for 2018–2022. To identify skills, they used methods of symbolic processing of text data, and to identify patterns of the demand dynamics for digital skills, methods of classification and statistical analysis of the data obtained were used [27]. In order to assess the demand for digital skills on the part of regional organizations, fuzzy modeling methods were used, based, as shown in [16], on the following methods: fuzzy specification of labor supply and demand parameters (the functioning of the labor market can be described by an algebraic or differential equation, in where the parameters are fuzzy numbers); fuzzy (linguistic) qualitative variables of the labor market, which is due to inaccurate information about the available and required competencies received from the subjects of labor relations, or qualitative information received from experts; fuzzy description of the system in the form of a set of institutional rules "if-then" - rules that reflect the features of functioning at a qualitative level. Fuzzy rules are fuzzy production rules that describe knowledge about the functioning of the market in the form of relationships of the type: "cause" - "effect", "phenomenon" - "reaction", "sign" - "fact", etc. They are used in the formation of management objectives and description of the management strategy at a qualitative level. The work also used the CURE (Clustering Using REpresentatives) algorithm, which was applied for the purpose of hierarchical clustering using a set of several defining criteria for typifying the digital skills of the workforce from a five-level to a three-level structure. This method is considered the most efficient for low-dimensional data, it "works only on numerical data, performing high-level clustering even in the presence of outliers" [12].

We made a number of assumptions to assess the supply and demand for digital skills in the labor market of the North Caucasus Federal District:

- we proceed from the fact that employed workers always have the opportunity to choose the best place to work and therefore their competencies, with some assumptions, can be considered as the skills of potential job seekers in the labor market;

- a high degree of correspondence between supply and demand will be evidence of a high degree of efficiency of the regional labor market of the North Caucasus Federal District, and a low degree, on the contrary, will show its insufficiency;

- labor market relations are limited only to the territory of the region, which of course does not correspond to reality, because all participants in regional labor markets are de facto present on the national market

3 Results and Discussion

3.1 Implementation of key technologies of the digital economy

The analysis of statistical indicators of the digital economy development in the Russian Federation [5-7] made it possible to assess the degree and depth of digital economy key technologies implementation in their modern dimension in Russian regions, namely the prevalence of digital platforms, ERP systems, the Internet of things, geographic information systems and artificial intelligence technologies. As can be seen from Figure 1, the share of organizations using key digital technologies in Russia is as follows: digital platforms are used by 14.7% of organizations (organizations of the Ural Federal District (UFD) are in the lead - 16.3%, and organizations of the Southern Federal District (SFD) are the last) - 14%); ERP-systems are used on average in 13.8% of Russian organizations (organizations of the Central Federal District (CFD) are in the lead - 15.5%, and organizations of the Southern Federal District are the last - 11.6%); the Internet of things is used on average in 13.7% of organizations (organizations of the North Caucasus Federal District (NCFD) are in the lead - 17.2%, and organizations of the Siberian Federal District (SFD) are the last - 12.1%); geoinformation systems are used on average in the country by 12.6% of organizations (most of all in the Ural Federal District - 14.7%, and least of all in the Central Federal District - 11.2%). Artificial intelligence technologies have the lowest level of application in Russia - only 5.7% of Russian organizations use them, and they are most common in the Central Federal District - 6.6%, and least of all in the Siberian Federal District - 4.7%.
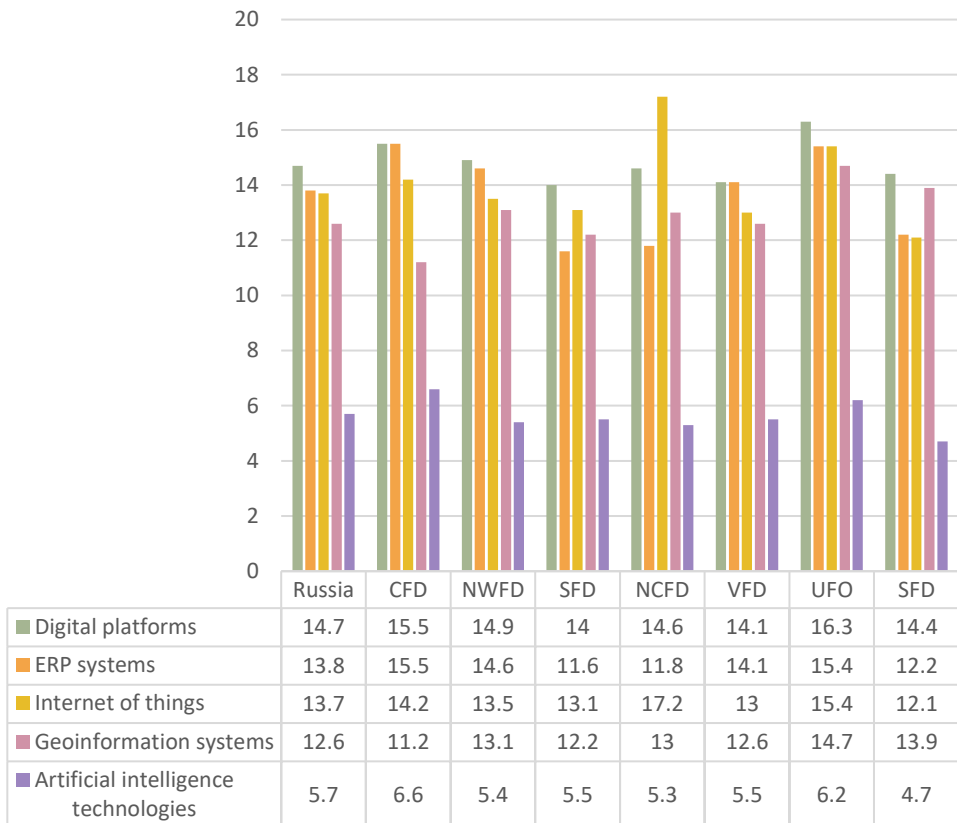
Comparative analysis shows that, in general, the organizations of the Ural Federal District are leading in terms of the prevalence of digital technologies, while the organizations of the Southern Federal District generally lag behind. The absolute leaders at the same time were the organizations of the North Caucasus Federal District in terms of the level of the Internet of things implementation - 17.2% and the organizations of the Ural Federal District in terms of the level of implementation of digital platforms - 16.3%. The leadership of organizations in the regions of the North Caucasus Federal District in terms of the prevalence of the Internet of Things as a key digital technology is, of course, quite unexpected, since the economy of the vast majority regions has been seriously underfunded over the past three decades, showed the lowest rates of technological development and has been highly subsidized for many years. Since digital technologies a priori presuppose the presence of a skilled workforce in the field of ICT, and Internet of Things technologies require the presence of highly qualified digital skills of workers, we conducted a comparative analysis of the level of development of digital skills of the employed population in the context of Russian regions.

3.2 Supply of digital skills in the regional labor markets of Russia

Figure 2 shows a comparative structure of the digital skills of the employed population in the regions of the North Caucasus Federal District and the five most advanced regions of Russia in terms of this indicator, compiled on the basis of a study by the National Research University Higher School of Economics [6]. It should be noted that these skills in the HSE study are hierarchically graded, as in international comparisons of the UN, WEF, World Bank and other organizations, into four levels: above the basic level, basic level, low level and zero level, when digital skills are absent. To them, in the source [6], one more was added - they did not use the Internet for the last three months.

As can be seen from Figure 2, on average, these skills (above the basic level, basic level, low level and zero level, have not used the Internet for the last three months) are assessed by HSE experts in the following structural ratio: 13%, 25%, 44 %, 1% and 17% respectively. To the greatest extent, only one region of the North Caucasus Federal District, the Stavropol Territory, approaches the all-Russian structure, the rest of the regions are

significantly behind in terms of the degree of mastery of digital skills at the level of basic and above basic competencies. The only exception is the Republic of Ingushetia, where, according to a study by the Higher School of Economics, more than 51% of the employed population has basic and above basic levels of digital competencies (37% and 14%, respectively). Let us consider them in comparison with the skills of those employed in neighboring regions: in Karachay-Cherkessia this level is more than 2 times lower (17% of the employed have a basic level of digital competencies and only 3% have them at a level above the basic level), in Chechnya the level digital competencies is twice as low as in Ingushetia (23% baseline and 2% above baseline), in Kabardino-Balkaria 30% (25% baseline and 5% above baseline), in North Ossetia - 29% (20 % basic level and 9% - above the basic level), in Dagestan only 17% of employees have a basic level of digital competencies and 5% - above the basic level. The level of proficiency in digital skills in the five leading regions is much higher: in the Murmansk region, proficiency in digital skills of basic and above the basic level is 34% and 28%, in Moscow - 32% and 27%, in St. Petersburg - 33% and 19%, in the Yamalo-Nenets Autonomous Okrug - 37% and 20%) and in the Republic of Altai 19% and 18%, respectively.

	Russia	CFD	NWFD	SFD	NCFD	VFD	UFO	SFD
Digital platforms	14.7	15.5	14.9	14	14.6	14.1	16.3	14.4
ERP systems	13.8	15.5	14.6	11.6	11.8	14.1	15.4	12.2
Internet of things	13.7	14.2	13.5	13.1	17.2	13	15.4	12.1
Geoinformation systems	12.6	11.2	13.1	12.2	13	12.6	14.7	13.9
Artificial intelligence technologies	5.7	6.6	5.4	5.5	5.3	5.5	6.2	4.7

Fig. 1 The share of organizations using five key digital technologies in the macro-regions of Russia, %. Source [5,7]

Conclusion about the backlog of the North Caucasus regions in terms of the digital competencies level generally coincide with the Russian population digital literacy index provided by the center of the Scientific and Analytical Financial Institute under the Ministry of Finance of Russia (NAFI), which includes five calculation components:

information literacy, digital content creation, digital security, digital problem-solving skills and communicative literacy [25].

As can be seen from Figure 3, the digital literacy index in North Caucasus region is equal to 56%, that is 10% lower than the national level (56% versus 63.6%), 18.8% lower than the index of the leading regions and 17.6% lower than in the Central regions. Taking into account that the regions of the North Caucasus over the past three decades have been donors for the Russian labor market, especially the Central Federal District and the Northwestern Federal District, a more thorough analysis of the digital competencies of the North Caucasian Federal District workforce is required in order to further propose measures to level the digital inequality of the North Caucasian labor migrants in the labor markets of other regions.

3.3 Demand for digital skills in the regional labor markets of Russia

The most objective assessment of the demand for digital competencies in the regional labor markets of Russia is possible on the basis of the employers needs analysis, reflected in the information bases of the largest national Internet resources for employment – "HeadHunter" and "Trud Vsem". In recent years, studies have been published containing an assessment of the needs of employers for specific jobs [24, 32], among them the most large-scale results are contained in the works of S.D. Kapelyuk & I.N. Karelin [28, 29]. The processing of five-year arrays (2018-2022) of vacancies of the unified digital platform "Trud Vsem" allowed S.D. Kapelyuk & I.N. Karelin to reveal that the requirements for digital skills are found in a relatively small number of vacancies, which is explained by "a rather primitive structure of employment in Russia, the predominance of vacancies for working professions, as well as positions requiring low-skilled or low-skilled labor" [29].
However, S.D. Kapelyuk & I.N. Karelin record a decrease in the differentiation of Russian regions in terms of the demand for digital skills for 2018-2022, although it still remains very significant. In their research, the authors use a 3-level hierarchical classification of digital competencies, highlighting basic, advanced and professional skills.
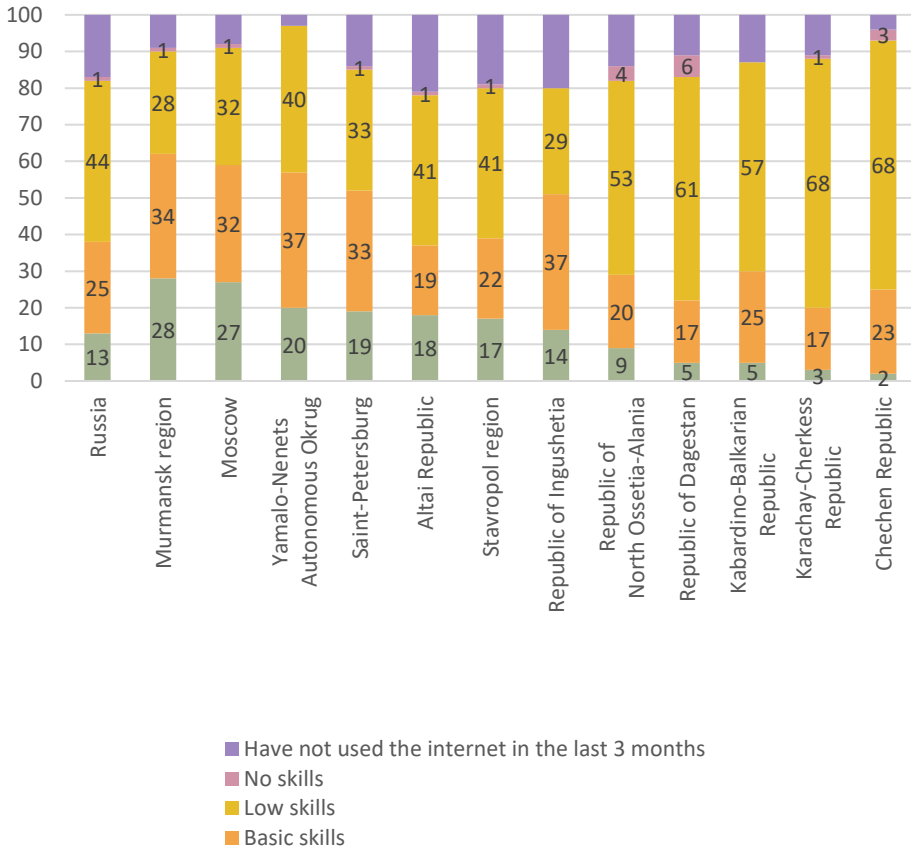
Fig. 2 The structure of digital skills of the employed population of the regions of the North Caucasus District and the most advanced regions of Russia by this indicator, %Source [5,6]
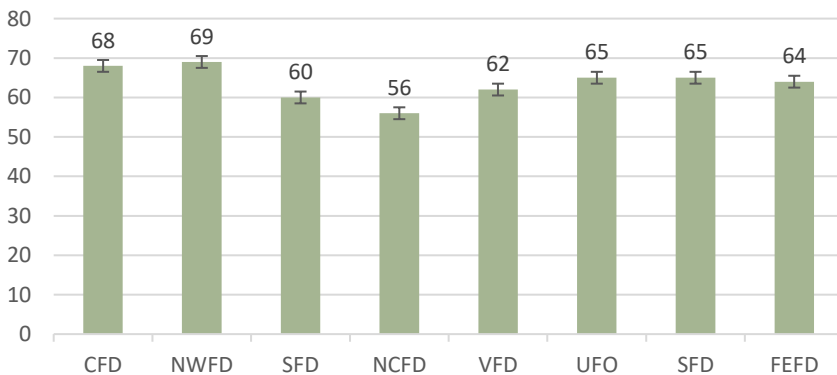
Fig. 3. Russian population digital literacy index provided by the NAFI, % Source [25]

Table 1 presents a rating assessment of employers needs in the 10 leading regions, in which the highest proportion of vacancies with required digital skills is recorded, correlated with the economically active population of the region. Analysis of the data in Table 1 allows us to draw a number of significant conclusions:

- the most demanded among Russian employers are basic (from 4.65 in the Yamalo-Nenets Autonomous Okrug to 2.97 in the Oryol region) and professional (2.34 in the Leningrad region to 0.67 in the Stavropol Territory) skills, while advanced skills are least in demand; such results, in our opinion, indicate either the error of the algorithms used by the authors for machine processing of the text of employers' vacancies, or the very high polarization of Russian organizations in terms of their digital transformation;

– the cities of Moscow and St. Petersburg, having the highest absolute volume of vacancies with digital skills, in the presented ranking of regions are not included in the top ten regions in any of the types of digital skills, which indicates that the business and cultural capitals of Russia are noticeably lagging behind in digital transformation calculated for 1,000 people (in terms of vacancies with basic digital skills, Moscow lags behind the leading Yamalo-Nenets Autonomous District by 1.8 times, and St. Petersburg by 6.6 times; in terms of vacancies with advanced skills, Moscow lags behind the leading in the ranking Chukotka Autonomous District by 1.7 times, and St. Petersburg by 3 times; in terms of vacancies with professional skills, Moscow lags behind the leading Leningrad region in the ranking by 4.3 times, and St. Petersburg by 9.4 times);

- not a single region of the North Caucasus Federal District was among the leaders in the demand for digital skills, with the exception of the Stavropol Territory, which took the last position in the ranking of regions with advanced digital skills vacancies, which indicates a critically insufficient digitalization of the NCFD regions for the purpose of sustainable economic and human development.

Table 1. Regions with the highest ratio between the number of vacant jobs with digital skills requirements and the labor force in beginning 2022, per 1000 people

Rank	Basic		Advanced		Professional	
	region	ratio	region	ratio	region	ratio
1	Yamalo-Nenets Autonomous District	4,65	Chukotka	1,18	Leningrad Region	2,34
2	Leningrad Region	4,17	Oryol region	1,16	Murmansk region	1,57
3	Nizhny Novgorod region	3,79	Yamalo-Nenets Autonomous District	1,16	Yamalo-Nenets Autonomous District	1,05
4	Primorsky Krai	3,76	Karelia	1,14	Primorsky Krai	1,03
5	Novosibirsk region	3,37	Murmansk region	1,14	Amur region	0,84
6	Karelia	3,28	Nizhny Novgorod region	1,05	Krasnodarskiy kray	0,78
7	Chukotka	3,22	Primorsky Krai	0,98	Novosibirsk region	0,77
8	Kalmykia	3,16	Kamchatka Region	0,91	Karelia	0,68
9	Murmansk region	3,00	Tomsk region	0,82	Chukotka	0,67
10	Oryol region	2,97	Novosibirsk region	0,73	Ставропольский край	0,67
	…		…		…	

| Moscow | 2,62 | Moscow | 0,69 | Moscow | 0,54 |
| Saint-Petersburg | 0,70 | Saint-Petersburg | 0,40 | Saint-Petersburg | 0,25 |

Source [29]

Table 2 presents a rating assessment of employers needs for digital skills in 10 outsider regions, also calculated per 1000 people of the region's population. Data analysis shows that digital skills are least in demand by employers in the regions of the North Caucasus Federal District, where the lowest demand for digital skills of applicants is recorded in 2022, and, accordingly, these regions have the highest share of demand for manual low-tech labor, mainly in such areas as construction, trade, public catering, consumer services sector and delivery. The extremely low demand for advanced and professional digital skills in the North Caucasus is noteworthy: it is incomparably lower than the group of leading regions and noticeably lower than the average for the group of lagging regions. In Ingushetia, at the beginning of 2022, there were no vacancies with advanced and professional skills.

Table 2. Regions with the lowest ratio between the number of vacant jobs with digital skills requirements and the labor force in in beginning 2022, per 1000 people

Rank	Basic		Advanced		Professional	
	region	ratio	region	ratio	region	ratio
85	Dagestan	0,03	Ingushetia	0	Ingushetia	0
84	Ingushetia	0,05	Dagestan	0,01	Dagestan	0,01
83	North Ossetia – Alania	0,15	North Ossetia – Alania	0,03	Chechen Republic	0,02
82	Kabardino-Balkarian Republic	0,16	Kabardino-Balkarian Republic	0,06	North Ossetia – Alania	0,03
81	Karachay-Cherkess Republic	0,29	Karachay-Cherkess Republic	0,09	Karachay-Cherkess Republic	0,03
80	Khakassia	0,42	Zabaikalsky Krai	0,19	Kabardino-Balkarian Republic	0,05
79	Chechen Republic	0,50	Khakassia	0,19	Mordovia	0,11
78	Saint-Petersburg	0,70	Belgorod region	0,24	Khakassia	0,13
77	Tyva	0,84	Chechen Republic	0,24	Tyva	0,13
76	Nenets Autonomous Okrug	0,85	Astrakhan region	0,26	Bryansk region	0,15

Source [29]

3.4 Imbalance of demand and supply of digital skills in the labor market: the case of the regions of the North Caucasus Federal District

To assess the demand and supply balance for digital skills in the North Caucasus labor market, it is necessary to synchronize the structures of employers' vacancies (Table 1 and Table 2) and the digital skills of the employed population (Fig. 3). Using the CURE hierarchical clustering algorithm, we have transformed the 5-level structure of digital skills of the workforce of the North Caucasus regions (Fig. 3) into the corresponding 3-level structure (Fig. 4).
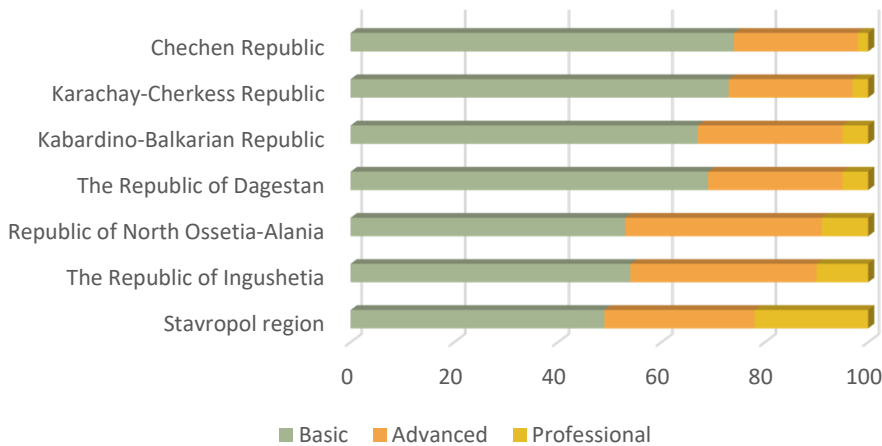
Fig. 4 The structure of the employed digital skills in the North Caucasus regions, % Source: [5,6, 32]

A comparative analysis of the employed digital skills structure in North Caucasus regions with their market demand reveals their systemic contradiction: the structure of digital skills (Fig. 2 and Fig. 4) is generally more primitive than in the advanced regions of Russia, but not to the same extent as reflected in Table 2. This conclusion is also confirmed by data on the use of Industry 4.0 key technologies in the North Caucasus: as mentioned above, the North Caucasus Federal District is quite comparable with the average Russian level of implementation of digital platforms and artificial intelligence technologies, and surpasses the all-Russian level in the field of implementation of geographic information systems and the Internet of Things (Figure 1). We believe that the current contradiction is explained by the presence of a limited number of points of digital growth in the regions of the North Caucasus Federal District and the extremely low overall level of the economy digitalization, which so far does not act as an incentive for the development of digital skills among the economically active population. At the same time, according to the WEF, due to the digital transformation 85 million jobs in the world may be transformed over the next few years [22]. The digital transformation will have a profound impact on the global workforce, but in terms of the total number of new jobs, the outlook is positive, as it is expected to create twice as many new jobs as those that are displaced. These conclusions of the WEF were obtained, among other things, on the basis of longitudinal studies of the features of the business digital transformation in different countries and regions. For example, the WEF 2023 study attempts to assess the potential of new technologies to create new jobs, develop recommendations for improving the quality and productivity of people's work, and preventively prepare people for future challenges. Based on a survey of HR directors and senior executives in 12 industries and 20 developed and developing countries (which together account for 70% of global GDP), the report concludes that 54% of

employees in large companies are in need of significant retraining and skills development to take full advantage of the growth opportunities offered by the Fourth Industrial Revolution. At the same time, just over half of the CEOs surveyed said they plan to retrain only those employees who hold key positions, and only one-third of directors plan to retrain employees at risk. It is noteworthy that almost 50% of all CEOs surveyed expect their workforce to be reduced as a result of digital transformation and automation, almost 40% expect to retain their staff as a whole, and more than a quarter expect automation to create new digital employment in their enterprise [9].

WEF experts believe that the prospects for creating technology jobs today are much more positive, as people in the post-Covid-19 world have a much better understanding of the opportunities provided by technology. At the same time, the huge changes that automation will bring to the global workforce will almost certainly lead to significant shifts in the quality and structure of labor demand, and this will require close attention from business and government. Among the set of professional competencies that will experience growing demand in all industries, the WEF report names data analytics, software and application development, e-commerce and social media skills, and a number of others; they are all heavily digital based. The employment of the workforce based on "non-linear competencies" – sales and marketing, innovation, customer support and creative activities – will also experience a growing demand for digital skills. Positions that are expected to become redundant include the so-called white-collar jobs of data entry specialists, accountants, payroll specialists, legal consultants, etc.

WEF experts have proposed change management strategies. All industries are expected to have significant skill gaps, with an average skills volatility of 42%, highlighting the scale of the challenge in preparing today's workers for changes in their current and new jobs in the future. Technological skills, such as digital design and programming, and purely human skills, such as creativity and critical thinking are among the competencies that will grow in importance rapidly [9].

3.5 Modernization of institutions and instruments of labor market regulation

The described global processes generate the need to develop new approaches to the modernization of institutions and instruments for regulating social and labor relations based on a strategic partnership of stakeholders in order to increase the effectiveness of labor market regulation and ensure decent employment of the North Caucasus population. This is especially true of the situation in the labor market of educated youth, which, due to the mismatch of existing digital skills with the dynamic requirements of employers, may increase their transition to low-tech employment sectors, which will most likely mean a transition to shadow employment. Taking into account the deterioration of the demographic structure of the Russian population, namely the fact that the age cohort of 20-30 years old decreased by 0.5 million people in 2022, the lack of ICT competence of the North Caucasus youth may lead to a noticeable lack of digital competencies in the Russian labor market in the near future. Since the market itself cannot cope with such a situation, state participation is required at the federal and regional levels, as well as the interaction of the state, business and educational institutions in order to neutralize the revealed discrepancy between the market demand of employers and the supply of digital skills of applicants.

Given that more and more professional knowledge and skills acquired in the learning process become obsolete before graduation, the constant improvement of digital skills is becoming one of the key factors in adapting to the growing technological needs of the labor market. An important area for the development of digital skills in this regard is online education. The digital learning model is Massive Open Online Courses (MOOCs), which first appeared in Canada in 2009. By the start

of the COVID-19 pandemic, dozens of e-learning educational platforms had been created, reaching more than 50 million people worldwide. The number of Russians participating in online educational courses on domestic and foreign platforms is growing every year and during the pandemic it exceeded 1 million people. After the pandemic, digital learning has become the main technological trend of modern Russian and global education. This has led to a significant increase in the need for access to ICT, as well as to an accelerated transition of the educational model to the new 4th generation. The Education 4.0 model includes smart technologies, artificial intelligence and robotics, so learning on platforms gives good results in the development of digital skills. However, digital education must meet the needs of the economy and be tied to the needs of employers, therefore, in the field of corporate training, the use of phygital technologies (physical + digital) is more preferable so that employers have the opportunity to choose the best students for employment in their companies. With regard to education in the North Caucasus regions, national corporate programs should be actively promoted and the widest range of students of educational organizations, as well as recent graduates, should be involved in it.

In order to achieve the expected effects of digitalization, Russian companies need to more actively develop their human resources, since the low digital literacy of ordinary employees and top management of organizations is, according to World Bank research in 2018, one of the main problems hindering the digital transformation of Russian business [4]. These conclusions are consistent with the estimates of the NAFI, according to which the digital financial literacy index of Russian residents in 2022 was 5.63 points on a 10-point system, and the share of Russians with a sufficient level of digital literacy was only 30% [25]. One of the most effective ways to develop the digital skills of the workforce is through internal corporate development programs not only for qualifications, but also for creativity: by improving digital skills and increasing the overall intellectual level of their staff, companies can reliably count on increased productivity and labor efficiency. This is convincingly evidenced by both international [8] and domestic [11] studies.

In addition, strategies for creating and maintaining a positive work environment, as well as creating an open creative space for companies [3, 17], play an increasingly important role in the development of the workforce, which reduces staff turnover, improves employee morale and motivates interest in working in these companies. And the longer and more consciously an employee works, the more necessary skills and experience he acquires, the higher the market value of the company due to the growth of its human capital [2, 19].

Studies show that focusing on the human resources capitalization is the financially most effective, and market most adaptive development strategy in the era of digital transformation [13, 18]. According to the conclusions of the International Telecommunication Union, digital skills are constantly changing due to the rapid development of ICT and the development of the new economy, they include not only activities using ICT, but also a combination of "behavior, experience, knowledge, work habits, character traits, aptitudes and the ability to think critically" [15], that is, employees of modern companies should be ready to adaptively use new knowledge, make efforts for self-education and self-improvement, and this is possible only in an open intellectual and creative environment [2]. In this regard, human capital development strategies aimed at creating a culture of continuous learning and improvement of employees seem to be critical. Thus, by investing in the quality of life of employees, companies can create a skilled and motivated workforce that can adapt to constantly evolving technologies, unpredictable market challenges, and even stay ahead of them.

One of the areas for modernizing vocational training in the coming years should also be the development of an apprenticeship system by companies (and the subsequent employment of young people) according to programs that have been coordinated by

educational organizations and employment services. The formation of high-quality apprenticeship programs for acquiring digital skills at different levels - coupled with bringing information about new opportunities to the widest possible range of potential participants, including students in rural areas of the North Caucasus Federal District - is considered by us as another key factor in effective employment regulation, which significantly reduces the risks of young people leaving from the legal labor market.

4 Conclusion

The working hypothesis of the study that the market demand for high-tech labor has a dominant influence on the digital skills development of the region's workforce has been proven. At the same time, there was revealed a contradiction between the highest level of implementation of IoT technologies in the North Caucasus Federal District and the lowest market demand for digital competencies of the workforce, as well as the growing discrepancy between the digital competence levels of employed in North Caucasus regions and in Russian regions leading by this indicator. The conclusion is substantiated that without proactive approaches, the regions of the North Caucasus Federal District can quickly lose their existing digital potential and not use the opportunities for developing a new economy based on the technologies of the Fourth Industrial Revolution.

Measures to bridge the gap between the growing demand for digital skills from the leading Russian companies and the structurally unbalanced supply from the labor force of the North Caucasus Federal District are recommended. These measures include the digitalization of core educational programs, the development of digital competencies in corporate training systems and apprenticeships. At the same time, it is critical to stimulate the creation of high-tech jobs in each region: the growth in demand for digital skills will immanently stimulate the economically active population, especially young people, to acquire them. The regions are recommended to develop inclusive strategies for developing the digital skills of the workforce, since in the near future it is the effective use of new digital technologies that will determine the competitiveness of both individual companies and entire regions of the country. To do this, in Russian regions Russia there are organizational, legal and motivational prerequisites: using the resource support of the National Program "Digital Economy of the Russian Federation", which contains 9 federal projects, the regions can already today, on the principles of public-private partnership of business elites, governments and educational organizations implement unique digital development projects for local labor markets. At the same time, large-scale state support aimed at developing the digital skills of employees is extremely beneficial for organizations, since competition for qualified personnel in the Russian labor market will only intensify in the foreseeable future.

The study allows us to conclude that in order to remain competitive in a technologically modernizing economy and use new opportunities to create jobs, companies will need a highly skilled local workforce, the formation of which in the foreseeable future will largely depend on the efficiency of the regional labor markets functioning.

5 Acknowledgments

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