

The Influence of Digital Technologies on Regional labour Market Structure (The Case of St Petersburg)

Natalya Aleksandrovna Zhuravleva

Doctor of Economic Sciences, Head of the Department of
Transport Economics,
Petersburg State University of Railways of the Emperor
Alexander I
Saint-Petersburg, Russia
zhuravleva_na@mail.ru

Martin Grantovich Grigoryan

Doctor of Economic Sciences, Professor of the Department
of Transport Economics,
Petersburg State University of Railways of the Emperor
Alexander I
Saint-Petersburg, Russia
deptrans@mail.ru

Karine Georgievna Riet

Candidate of Economic Sciences
of the Department of Transport Economics
Petersburg State University of Railways of the Emperor Alexander I
Saint-Petersburg, Russia
deptrans@mail.ru

Abstract — The article presents the results of a study of changes in the regional labour market, resulting from the introduction of digital technologies, which are not only able to replace human labour, but also turn the means of access to information into the means of controlling physical processes. It is demonstrated, what social and economic risks in the structure of demand and supply are relevant to the transition to a new technological order in a region with high scientific and technical potential. The object of the research is the labour market of the St Petersburg agglomeration, numbering more than four million people, with a high proportion of intellectual migration. The purpose of the research is a qualitative and quantitative assessment of the structure of supply and demand in the regional labour market, as well as the formalization of changes occurring under the influence of digital technologies. In addition to traditional methods of statistical analysis and observation, in particular, the analysis of time series characterizing the dynamics of demand and supply of employees, asymmetric analytics of sectoral labour market transformations is used. The results of the study of the modification of the regional labour demand model are given, associated with the disaggregation of the organizational structures of companies, the emergence of part-time workers, the desire of high-tech businesses to reduce transaction costs, primarily labour costs. The directions of transformation of the professional activities of employees in a number of professions, that are actively changing under the influence of digital technologies towards intellectualization of activity, have been determined. A three-component model of demand in the regional labour market is justified, combining the parameters of digital competencies, target parameters of regional development and a matrix for generating competency data.

Keywords – *digital competences, regional labour market, demand model, digitalization risks*

I. INTRODUCTION

In an era of active change, information technologies are transformed from a means of access to information to a means of controlling physical processes. It is assumed that cyber-physical systems will be widely introduced into all fields of human activity. For example, in St. Petersburg, the projects are already being implemented to create such systems: "Smart St Petersburg" – an innovative program aimed at the formation of a city management system "smart city" [1]; "Factory of the Future" – a program implemented within the National Technology Initiative and aimed at integrating advanced production technologies and business models in the industry in order to create competitive products [2].

These transformations change not only the former structure of the production processes, but also the nature of the labour activity of the employees involved therein. This issue is widely covered in research and practical discussions. In particular, in a comprehensive study of the Organization of European Economic Cooperation (OEEC) on the impact of digitalization on the economy, a significant place is given to the problems of transforming labour markets and risks associated with new innovative technologies [3].

An active discussion is under way on the transformation of labour markets under the influence of new knowledge, in particular, National Research Council (2012), and the impact of this transformation on the efficiency of the economy [4], [5]. However, research on changes in the structure of demand

in regional labour markets is not enough for a reliable understanding of the emerging trends in the impact of digitalization on them.

II. MATERIALS AND METHODS (MODEL)

In accordance with the premise stated above, the goal and research methods used in the preparation of the present article were determined.

The purpose of the research is to identify and disclose the impact of digital technologies over the structure of demand in the regional labour market.

To achieve this purpose, the following tasks were resolved:

- assessment of quantitative and qualitative changes in the structure of demand and supply in the regional labour market in connection with the use of new digital technologies;
- identification of the direction of transformation of the employees' professional activities in a number of professions in course of the implementation of digital technologies.

The study was based on the data of the Federal State Statistics Service and the results of scientific-research work, carried out as part of the implementation of a separate activity "Providing of the monitoring the labour market and developing a forecast of the balance of labour resources in St Petersburg" of the State program of St Petersburg "Promotion of population employment in St Petersburg", approved by the decree of the Government of St Petersburg of 2014/6/17 No. 490 (hereinafter – R&D NRU HSE).

During the work on the article, the authors used such research methods as comparative analysis, structuring processes, analysis of time series, time series characterizing the dynamics of demand and supply of workers, logical analysis of cause-effect relationships. Particular attention was paid to content analysis of materials on the problems of measuring the needs in labour resources.

III. RESULTS AND DISCUSSION

Evaluation of quantitative and qualitative changes in the structure of demand and supply in the regional labour market associated with the use of new digital technologies.

The structure of the cyber-physical system in production involves the design, analysis of big data for online decision making, augmented reality technology, 3D printing to create prototypes of small batches of products, application of the industrial robots united by this system, after-sales service and customer relationships [6]. Such an improvement in the functioning of business processes is necessary to maintain the competitiveness of organizations, because it increases the speed and scalability of production, sales of goods or services, reducing costs and, at the same time, prevents the possible negative influence of the human factor.

In the St. Petersburg labour market, the trend of reduction of the negative impact of the human factor is primarily observed in decision-making processes. This is reflected in the reduction of the offer of administrative and managerial

workers in organizations of various sectors of economy. According to a study [7] conducted in 2018, over the past 10 years, the rate of decline in the number of open CVs for leading managerial positions has amounted to 5–10% annually. Table 1 presents the rating of reducing groups of employees belonging to the management category.

TABLE I. TOP 20 REDUCING GROUPS OF EMPLOYEES (annual 5–10% decline over 10 years)

Place	Code according to All-Russian Classification of Occupations (ACO)	Name
1	1120	Heads of institutions, organizations and enterprises
2	1211	Financial Managers
3	1113	Heads of local authorities
4	1114	Senior officials of political and community organizations
5	1323	Heads of departments (managers) in construction
6	1325	Heads of departments (managers) in transport
7	3153	Aircraft pilots and related professionals
8	3355	Police inspectors and investigators
9	1322	Heads of divisions (managers) in the extractive industry
10	1342	Healthcare service managers
11	1222	Advertising and Public Relations Managers
12	1330	Heads of services and departments in field of information and communication technologies
13	1212	Human Resources Managers
14	1223	Heads of research and development departments
15	1432	Heads of organizations of physical culture and sports
16	1346	Heads of services and departments in the field of financial activity and insurance
17	1221	Sales and Marketing Managers
18	1324	Heads of services for the supply and distribution of goods
19	1213	Heads in the field of policy and planning activities
20	1219	Managers of financial, economic and administrative activities

Source: R&D NRU HSE

The introduction of digital technologies that facilitate the adoption of rational decisions transforms the management process and makes new demands on the management of organizations that require openness to the introduction of new technologies, use of a systematic approach to management and introducing digital technologies, commitment to learn new knowledge, etc. The modern education market forms the necessary competencies for such workers: educational projects are being created, the purpose of which is the formation of knowledge about digital technologies and digital

transformation of business processes of organizations. An example is the program of additional professional education for managers at all levels of production organizations “Enterprise Management in the Conditions of Digital Transformation”, implemented by St Petersburg Polytechnic University [8].

According to Table 1, a reduction in labour supply is also observed for aircraft pilots, as well as related professionals. This trend is caused by the development of outstaffing in civil aviation, and the proliferation of the practice of using complexes with unmanned aerial vehicles in the Armed Forces of the Russian Federation, the FSB, the Emergencies Ministry, the Ministry of Internal Affairs, the Federal National Guard Troops Service, etc.

The order of the Ministry of Labour and Social Protection of the Russian Federation approved the professional standard “Specialist for the operation of unmanned aircraft systems including one or more unmanned aircraft with a maximum take-off weight of 30 kg or less,” according to which these specialists are assigned to the “Mechanics and repairmen of aircraft, ships and railway rolling stock” according to the all-Russian classifier of occupations [9]. Figure 1 presents the forecast of staffing requirements for this group, according to which by 2021 the number of such specialists is expected to increase by 2 times compared to 2016.

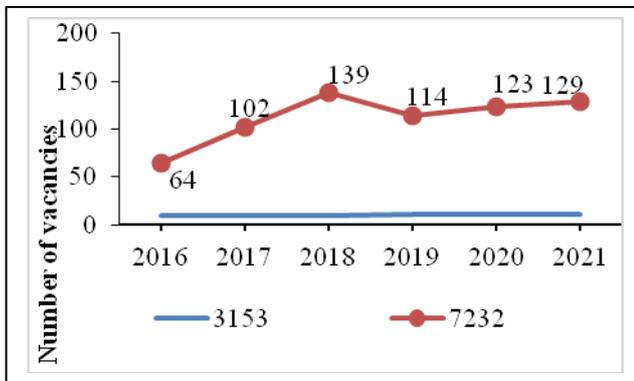


Fig. 1 The need of organizations in employees to fill vacancies for certain groups, persons. Source: R&D NRU HSE

With the introduction of unmanned aerial vehicles, the profession of mechanics in the technical operation of unmanned aircraft systems, an external pilot of an unmanned aircraft (unmanned aircraft systems operator), have emerged [9]. In accordance with the Recommendations [10] on the method of training of employees-operators of unmanned aerial vehicles in the state security bodies, the latter should have knowledge of the basics of professional flight education, the use of modern computer facilities and have special technical training. Currently, these specialists are trained in training centres of the Ministry of Defence equipped with automated training systems [11]. In addition, the operation of unmanned aircraft systems requires the development of additional competencies among the lawyers in the field of air law.

Table 2 presents the rating of groups of employees for which an increase in demand (the rate of vacancies opening) has been observed over the past 10 years. The largest number of demanded positions refers to groups of information technology employees.

TABLE II. TOP 20 IN TERMS OF ADDITIONAL NEED IN LABOUR RESOURCES

Place	Code according to All-Russian Classification of Occupations (ACO)	Name
1	2353	Foreign Language Teachers
2	4313	Employees on the accounting of working hours and salary
3	2513	Web and Multimedia Application Developers
4	2514	Application programmers
5	7223	Machine operators and machine tool adjusters
6	2431	Advertising and Marketing Specialists
7	7311	Precision Instrument Repair Workers
8	2424	Personnel Training Specialists
9	2511	System analysts
10	7512	Bakers, confectioners and candy makers
11	2523	Computer Network Specialists
12	2161	Architects of buildings and structures
13	3313	Accounting Assistants
14	2512	Software developers
15	2521	Database Designers and Administrators
16	3323	Corporate buyers
17	2141	Industrial Engineers
18	2423	Recruitment Specialists
19	3512	ICT Customer Support Specialists
20	2631	Economists

Source: R&D NRU HSE

Determining the direction of transformation of the professional activities of employees in a number of professions in course of implementation of digital technologies

The available statistics do not reflect changes in the nature of employees’ work in many fields where cyber-physical systems are used (or are planned to be used). Thus, in the structure of employment by types of economic activity of St. Petersburg, an increase in the number of people employed in industries where a large proportion of workers, from whom high qualification is not required, are traditionally attracted – wholesale and retail trade (18.7%–21.6%), hotel and restaurant business, transport and communications, real estate transactions, rent and provision of services (13.3%–14.4%) [12]. At the same time, the introduction of separate digital technologies in the economy and the construction of cyber-physical systems will lead to significant transformations of labour activity in these sectors. We illustrate such a thesis on the example of the transport system of the Russian Federation, which is part of the global transport system. It is possible to remain competitive in it, seriously changing under the influence of digital technology.

In the new technological structure, time and speed are monetized, and the transport industry generates a demand for specialists knowing how to create, implement and operate high-speed technologies, which allow to reduce the time and material costs for consumers of transport services (passenger and shipper), and at the same time, maintain the services associated with these new technologies.

The economist in such context becomes a specialist at the intersection of two professions – an engineer-economist with the knowledge and ability to manage industrial and end-to-end digital technologies, the number of which will grow, and an understanding of how the benefits are derived from their use in terms of cost reduction.

The transition of car-repair factories to robotized depots, and modern technical capabilities allow this to be done, will lead to a decrease in the number of people employed in these organizations. When this happens, the demand for employees in creating and maintenance of robotics will occur. The introduction of robotics and sensor components in order to remotely monitor the condition of railways and transport, allowing to carry out round-the-clock operational control of their operability, predict accidents and carry out scheduled preventive maintenance, eliminates the need for a huge number of workers involved in operation, minor repairs and track patrolling. In this case, the need in operators of remote diagnostic systems occurs.

Physical objects with embedded sensors are components of the Internet of Things technology that unites the company's infrastructure into a single network, increasing the risk of cyber-attacks, which creates a growing demand for professionals with cybersecurity skills. The Internet of Things is also a source of information on consumer preferences, allowing to get more expanded and reliable data array than with traditional marketing research methods. This poses new demands to the marketer's competencies – the ability to analyse data of the Internet of things, possessing knowledge in the big data analysis technology.

Another technology, the introduction of which will fundamentally change the nature of work in the transport sector, is Blockchain. The introduction of this technology into the business process of a transport company helps to reduce the costs of preparing tens and hundreds of documents required for the transported goods, by reducing those forms to zero. This means that the demand in employees (accountants, lawyers, customs services, etc.) involved currently in the preparation of documents for transported goods will decrease in future, and they will have to modify their competencies. For example, a company accountant needs to master the functionality of work on the Blockchain platform. At present, in some universities, appropriate curricula for accountants and economists are already being created.

In the transport industry there is a demand for designers of new transport systems specializing in virtual and augmented reality technologies. The possibilities of virtual visualization allow to understand and present to the investor images, digital layouts, duplicates which enable to correctly assess the future benefits from innovative, not yet existing projects of high-speed highways.

We list only those competencies generated by the transport industry, but quantitative changes in the structure of demand for workers are not yet reflected in the available statistical studies. According to the forecast of the balance of labour resources for the period of 2017–2024, a 14% increase in the number of employees is expected for such type of economic activity as “transportation and storage” [7]. At the same time, there are professions that were predicted to be replaced by robots, while the practice of introducing new technologies showed that there is no viable substitute for people in the processes where these technologies are embedded. An example is the recruitment specialist. The implementation of screening techniques using robots and chat bots for mass selection of personnel has given rise to assumptions about the disappearance of this profession. However, the recruitment specialist has entered in the rating of the most demanded professions over the past 10 years (Table 2). The mentioned technologies implement a superficial approach to personnel selection and contain a number of shortcomings that need to be addressed with the participation of recruiters, the demand for whom will continue to grow [13].

IV. CONCLUSION

Thus, the article examined the visible and expected changes in the nature of the work activity of employees in the regional labour market under the influence of digital transformation. The main results of the research are the following:

Digitalization in the new technological structure creates prerequisites for disaggregating the organizational structures of companies that do not meet the standard full-time model, and for reduction of transaction costs, primarily related to the labour process;

The introduction of digital technologies contributes to the formation of a class of workers with temporary or part-time employment (precariat), and turns the work process itself into a set of smaller operations that make up the competencies of new professions, which ultimately modifies the relationship between the precariat and the employer.

The demand model in a regional labour market should contain at least three main components: parameters of compliance of required competences with digital technologies introduced in the region; built-in mechanism for intersectional analysis of indicators of territory development and personnel compliance; a temporary matrix of new competencies generation taking into account all education systems.

References

- [1] Smart St Petersburg. The concept of introducing technologies of a smart city. Available at: <https://www.petersburgsmartcity.ru/>
- [2] National Technology Initiative "Factory of the Future". Available at: <http://www.nti2035.ru/technology/technet>
- [3] DSTI/ICCP/IIS (2015)10/Final directorate for science, technology and innovation committee on digital economy policy 25-May-2016 <http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS%282015%2910/FINAL&docLanguage=En>

- [4] Education for life and work: developing transferable knowledge and skills in the 21st century. (D. of B. and S. S. and E. Board on Testing and Assessment and Board on Science Education, Ed.) National Academies Press. Washington, DC: The National Academies Press.
- [5] McGowan, M., and Andrews, D. (2015), Labour Market Mismatch and Labour Productivity: Evidence from PIAAC Data, Available at: <https://www.oecd.org/eco/growth/Labour-Market-Mismatch-and-Labour-Productivity-Evidence-from-PIAAC-Data.pdf>
- [6] Schwab, K. The Fourth Industrial Revolution / Moscow: Eksmo, 2019. – p. 209 (Top Business Awards).
- [7] Research work of R&D NRU HSE “Ensuring monitoring of the labour market and developing a forecast of the balance of labour resources in St Petersburg”, prepared in 2018 by order of the State Autonomous Institution “Employment Centre of St. Petersburg” (Agreement of 6/27/2018. No. 0749/2018) within the framework of implementation of the State program of St. Petersburg “Promotion of employment in St. Petersburg”, approved by the decree of the Government of St. Petersburg of 6/17/2014 No. 490
- [8] Centre for Scientific and Technical Studies of St Petersburg State Polytechnic University conducted training on the professional advancement program for managers and specialists of industrial enterprises in St Petersburg. Available at: <https://nticenter.spbstu.ru/news/6837>.
- [9] Order of the Ministry of Labour of Russia of 7/5/2018 N 447H On the approval of a professional standard of the Specialist for the operation of unmanned aircraft systems, including one or more unmanned aircraft with a maximum take-off weight of 30 kg or less (Registered in the Ministry of Justice of Russia on 2018/7/23 No. 51669).
- [10] Anisimov, A.A. Recommendations on the method of training employees-operators of unmanned aerial vehicles in state security bodies / Prospects for the development and use of complexes with unmanned aerial vehicles. Collection of reports and articles based on the materials of the II-nd scientific-practical conference / edited by the candidate of technical science. Bodrov, A.S., Bezdenezhnykh, S.I. / Kolomna: 924 HZ UmAV Ministry of Defence of the Russian Federation: Home page, 2017, p. 181–196.
- [11] Zlotnikov, K.A., Kudryavtsev, A.N. Relevant issues of creating automated systems for training specialists in controlling complexes with unmanned aerial vehicles / Prospects for the development and use of complexes with unmanned aerial vehicles. Collection of reports and articles based on the materials of the II-nd scientific-practical conference / edited by the candidate of technical science. Bodrov, A.S., Bezdenezhnykh, S.I. / Kolomna: 924 HZ UmAV Ministry of Defence of the Russian Federation: Home page, 2017, p. 91–97.
- [12] Decree of the Government of St Petersburg of May 13, 2014 No. 355 “On the strategy of the economic and social development of St. Petersburg for the period up to 2030”.
- [13] Ryabtsova, D.Yu. Problems of mass recruitment at the present stage / Journal of Economy and Business, vol. 6, 2018, p. 128–132.