Impact of artificial intelligence and industrial automation on territorial development: strategic guidelines

Natalia Polusmakova¹ and Marina Glushchenko¹

¹Volgograd State University, Institute of Management and Regional Economics, pr-t Universitetskij 100, Volgograd, 400062, Russia

E-mail: polusmakova@volsu.ru, malinat57@yandex.ru

Abstract. Automation and artificial intelligence become particularly relevant in the development of modern society that is focused on digitalization. The article considers the impact of automation and artificial intelligence on the sectoral development of the Russian economy and society taking into account their potentials and prospects. Keywords: artificial intelligence, automation, labor market, territorial development.

1. Introduction

The relevance of this topic directly depends on the existence of artificial intelligence and the development degree of production automation technologies in a single state and region.

The article is aimed at identification of strategic guidelines for artificial intelligence and automation development on the sectoral economies of countries as components of their territorial development.

To confirm the main goal, it is necessary to solve the following tasks:
1. Definition of states with the most favorable economic conditions for the creation of artificial intelligence;
2. Identification of professions which are most likely to be finally automated in the near future;
3. Analysis of the disadvantages and advantages of using artificial intelligence in production;
4. Research for the most effective resolution of the conflict between artificial intelligence and human competencies in the workplace.

2. Materials and methods (model)

The following methods were used to analyze the information:
1. Modeling method used to simulate the impact of automation on the labor market;
2. Analytical method compared the results of simulation and determined the optimal solutions to problems.

The innovation consists in the forecast of positive and negative impact of artificial intelligence and automation on industry types in the context of territorial development as factors of strategic stability of spaces. Hence, the need to study the current state of the market for automation and artificial intelligence, identify trends in their development and degree of impact, and determine the optimal strategic directions.

3. Results and discussion

The world community is becoming more high-tech and digital, forming the need for machines with elements of artificial intelligence. One main consequence of this process will be the increasing efficiency of the economy. In the United States production per worker doubled between 1995 and 2015 and
continues to increase. There is a transition from separate “smart machines” to intelligent automation systems, for example, to connect all the equipment of the plant to a network managed by a single center or create a transport network of robotic vehicles transporting goods or people.

**Table 1.** Industrial robots in the USA and Europe (according to the International Federation of Robotics, IFR)

|                      | 1995 | 2000 | 2005 | 2010 | 2015 |
|----------------------|------|------|------|------|------|
| Robots per thousand workers in the United States | 0.5  | 0.7  | 1.1  | 1.3  | 1.8  |
| Robots per thousand workers in the Europe        | 0.4  | 0.5  | 1    | 1.4  | 1.6  |

It is expected that the robot market in the EU will develop and reach $3.7 billion by the end of 2018. According to 2016 statistics provided by World Robot Statistics, IFR, the number of industrial robots will increase by 2.6 million units in 2019. About 70% of industrial robots operate in metalworking, electrical and automotive industries. In 2015, due to the introduction of robotics, production in the EU increased in the electrical industry by 18%, in metallurgy - by 16%, and in the automotive industry - by 10%. The market for industrial robots is growing by 8% annually. The EU holds 32% of the global robotics market. Nevertheless, in the European Union it was decided to invest €700 million in innovation and robotic products by 2020. Statement was made at the World Economic Forum in Davos: “The proliferation of robots and robotics marked the IV industrial revolution” [1].

According to Reuters, in 2017, 9900 units of robotics were installed at enterprises in Central and Eastern Europe, it is by 28% more than in 2016. The International Federation of Robotics estimates that by 2020 robotics shipments to Eastern Europe will increase by 21%.

IFR indicates that Slovakia has the highest robotization rate in Eastern Europe (135 robots per 100,000 workers). In the Czech Republic - 101 robots, in Hungary - 57, in Poland - 32 per 100 thousand workers. Low robotization of Polish industry is due to the influx of cheap labor from Ukraine.

Interestingly, in Eastern Europe, robotization is often forced. The enterprises of these countries are increasing shortage of skilled workers. Skilled human resources go to Western Europe.

According to the IMF "Income Polarization in the United States" in 1970–2014 the share of US households with average incomes (50–150% of the median) decreased by 11% (from 58% to 47%) [2]. Consequently, the middle class is declining, the share of the poor and rich increases. This may be, inter alia, due to an increase in income for specialists working in the field of high technology and software, along with a lag in salaries among workers in the "old" industries.

Throughout the 20th century, automation, and then the introduction of artificial intelligence, helped to reduce the need for human labor. Job cuts in a number of industries, from 1 to 3 professions annually disappear. In catering and trade the automation and artificial intelligence threatens to halve the employment. Pessimistic forecasts indicate an increase in unemployment from 5-6% (natural level) to 15–20% in Russia and up to 30% in Europe.

In the West, the McKinsey Institute is thoroughly engaged in research into the effects of automation on the labor market. In the world, automation could put 1.2 billion people out of work whose total salary is $14.6 trillion. In this case, half of the cuts will fall on the four largest world economies: USA, China, Japan, India [3].

In Europe, the main job cuts will cover 5 countries: France, Germany, Italy, Spain and the UK [4]. In total, automation will replace 62 million people whose salary is $1.9 trillion a year.

**Table 2.** The expected impact of automation on the labor market of foreign countries [5]

| Country | The automation potential (%) | Number of people affected by automation (million) |
|---------|-----------------------------|-----------------------------------------------|
| Japan   | 56                          | 35.6                                          |
| India   | 52                          | 235.1                                         |
China 51 395.3
Russia 50 35.4
France 43 9.7
Germany 48 20.5
Spain 48 8.7
United Kingdom 43 11.9
USA 46 60.6
Italy 50 11.8
Canada 47 7.2

Significant changes in the labor market are expected in Russia

Table 3. Changes in the structure of jobs in the sectors of the Russian economy

| Sector                                      | The automation potential (%) | Number of people affected by automation (million) |
|---------------------------------------------|------------------------------|--------------------------------------------------|
| Production                                  | 54                           | 6.5                                              |
| Retail                                      | 52                           | 5.5                                              |
| Administrative and government agencies      | 47                           | 3.6                                              |
| Education                                   | 20                           | 1.3                                              |
| Transport and logistics                     | 75                           | 4.3                                              |
| Health and social support                   | 41                           | 2.2                                              |
| Agriculture, forestry, hunting and fishing  | 64                           | 3.3                                              |
| Construction                                | 64                           | 3.1                                              |
| Information                                 | 40                           | 0.858                                            |
| Finance and Insurance                       | 43                           | 0.92                                             |
| Science and technology                      | 36                           | 0.673                                            |
| Real estate transactions                    | 37                           | 0.462                                            |
| Art, entertainment and recreation           | 33                           | 0.373                                            |
| Other services                              | 47                           | 0.479                                            |
| Extractive industry                         | 68                           | 0.585                                            |
| Hotel business and catering                 | 67                           | 0.57                                             |
| Wholesale                                   | 54                           | 0.428                                            |
| Housing and Utilities:                      | 52                           | 0.313                                            |
| Top management of organizations             | 65                           | 0.014                                            |

Table 3 shows that the total number of jobs losses in the Russian economy is expected at about 35.5 million.

Using digital technologies in Russia over 6 years, it is possible to reduce the number of officials by one third and reduce government spending by 0.3% of GDP (Deputy Chairman of the Economic Council under the President of the Russian Federation Alexei Kudrin).

“Of today’s seven jobs in the production of motors and other units, only one will remain,” says Michael Brecht, Chairman of the Daimler team.

The report of the World Economic Forum (WEF) for 2016 predicts a reduction of 7.1 jobs by 2020 as a result of the introduction of new technologies. Mostly white-collar workers, office workers, will be fired. In exchange, only 2 million new jobs will appear in the field of information technology, architectural and engineering fields.

According to the UN report, the most significant reduction will affect developing countries - about ⅔ of the population will be unemployed. In developed countries, the first wave of reductions has already passed.
In 2016, Foxconn (an iPhone assembly company in China) installed 40,000 robots and laid off 60,000 people. The number of robots at the company's plants will increase by 20-30% annually, there will leave a minimum of employees responsible for production, logistics, testing and control.

The report of the International Labor Organization noted that in the textile and footwear industry of Southeast Asia more than 6 million workers out of 9.2 million can be fired as a result of automation.

Robots become cheaper than low-cost manual labour [6]. Automation improves speed and productivity. For this reason, Adidas intends to return footwear production to Germany (previously brought to factories in Asia).

In the European economy, automation has been growing for several decades, and yet the unemployment rate has not changed. What factors provide such sustainability?

First, the disappearance of jobs in some areas is offset by new industries and professions.

In the USA in 1900, the population employed in agriculture was 40%, in 2000 it was 2%; in industry in 1950 - 25% of the population, in 2010 - less than 10%. But, unlike the 20th century, when machines replaced the manual labour of low-skilled workers, now the threat of dismissal more affects highly paid specialists with higher education.

Secondly, automation cannot replace simple and important work - communication with clients (specifically with small businesses).

Thirdly, automation allows expanding production volumes and increasing the need for workers whose activities are not reduced as a result of the introduction of new technologies. For example, the appearance of ATMs could lead to the mass dismissal of bank employees. In reality, the ATMs saved money, due to which new bank branches were opened.

The introduction of new technologies does not always propose job cuts for all enterprises. A survey conducted in 2016 by ManpowerGroup agency revealed that only 12% of executives plan to reduce staff over the next 2 years due to the introduction of automation. The high cost of introducing new technologies, the lack of experience in working on new equipment stop many managers.

As a result, in 2011, McKinsey research showed that over 15 years the Internet has deprived 500,000 people of work, but created 1.2 million new jobs.

Often automation of production requires the creation of jobs. Amazon's online store plans to create 100,000 new jobs in the US over the next 18 months. The company requires both software developers and warehouse employees because new technologies increase turnover.

Statistics in Germany shows that automation and robotics in industry and transport, which have been accelerating sharply in recent years, does not lead to a decrease in the overall level of employment in the country. It is more likely opposite. Germany ranks third in the world in terms of robotization after South Korea and Japan, but employment in the industry is at a record high.

Already 40 percent of German enterprises complain about the shortage of qualified personnel. The problem of the lack of qualified personnel is especially acute in companies that provide IT services to industrial customers, as well as in machine-tool plants.

Over 350 thousand new jobs have been created in the German manufacturing industry over the past five years.

So, automation, robotization and digitalization, the introduction of digital technologies, on the one hand, lead to the destruction of certain jobs. However, they, on the other hand, invariably contributed to the creation of new jobs, and often - the emergence of new professions. Unmanned vehicles will leave many drivers and taxi drivers without earnings, but will overwhelm the work of the creators of software for self-driving vehicles. In factories, robots will replace classic conveyor workers, but someone will have to design, program and repair these mechanisms.

There was a polarization in the labor market: Automation affects the middle class, low-paying jobs are more profitable for people to do, and high-paying jobs cannot be done by robots yet. A new people activity type is machine learning. According to research by the McKinsey Institute, the global market for artificial intelligence services is growing at 25% annually, and by 2025 it will reach 125 billion euro. The number of employees in the information technology (IT) industry is constantly growing, in the West this is one of the few areas of activity where there are always vacancies.
According to The New York Times, in 2016, OpenAI, an artificial intelligence research organization founded in 2015 by Elon Musk and other investors, spent $7 million on wages for its 52 employees.

According to the report of Tencent Holdings, in the world there are from 200,000 to 300,000 specialists involved in the development or direct creation of artificial intelligence. But it is believed that only 22 thousand programmers can develop artificial intelligence systems.

The British laboratory DeepMind, owned by Google, spent $138 million on 400 employees, that is, an average of $345 thousand.

Google, Facebook, Apple, Amazon, Uber require specialists to work on face recognition programs, automatic natural language processing, digital assistants and autopilot cars.

The training of bachelors and masters in the field of artificial intelligence development is increasing and it is expected that in 3–4 years the shortage of specialists will be eliminated. In addition, Intel, Facebook and Google are introducing their internal training programs for AI professionals. The global spread of the Internet has made it possible to work remotely, as well as offshore outsourcing of software production when information technologies commissioned by companies are created by employees from another country.

There is a struggle between AI for specialists in AI, and the automotive industry, which creates drones, is competing with Silicon Valley. Companies also hire top academics, even professors from Stanford University.

Human activities will undergo change. Workers will often have to adapt to the machine, and not vice versa. Of course, there will be less routine monotonous work. But simultaneously, employees will need to switch to new tasks, learn flexible working methods. Thorough knowledge of AI machines operations will become a necessary requirement for specialists and management personnel. Understanding safety in working with “thinking machines” will become increasingly important.

4. Conclusion

New technologies have global importance, but the pace of their development and implementation varies significantly in different countries. In the field of artificial intelligence, the vast majority of innovations are created in the United States, Japan is the leader in robotics. Among European countries, Germany leads in new technologies, followed by France and the United Kingdom. In 2005, an average of 1 robot was involved in European factories per thousand workers, currently 1.6 robots. The market for industrial robots is growing by 8% annually. The EU holds 32% of the global robotics market.

Artificial intelligence and automation can reduce errors, improve quality and speed. As a result, in developed countries, labor productivity rises annually by 0.8-1.4%. If 1975 is taken as the starting point, then the total volume of production in developed countries has doubled.

At the current pace of development, by 2055, half of all work performed by people will be fully automated. In the 20th century mainly a simple routine work performed by unskilled workers has undergone automation. In the 21st century, new technologies allow the replacement of highly qualified specialists, such as engineers or office workers.

In the near future, robotization will affect the following activities:
- banking (computers independently assess the situation in the financial markets or the creditworthiness of the borrower);
- industry (many manufacturers of high-tech products plan to automate most of the technological processes);
- medicine (computerized systems for diagnosing diseases, robots for patient care, and even robotic surgeons have been introduced);
- transport (the transition from individual computerized functions, such as cruise control, to a car without a driver, such as a Daimler drone truck);
- trade and catering (in Europe there are fully automated stores without sellers and security, automated snack bars are being introduced);
- construction (projects have been developed for the automated construction of houses using a 3D printer).
Artificial intelligence continues to evolve. Voice and face recognition technologies, self-learning neural networks are introduced. These technologies will reduce a significant number of office workers.

There are areas of activity where artificial intelligence cannot replace humans. This is a job requiring complex decisions (for example, a politician or a judge), creative activity (architect, inventor, artist), work involving communication (teacher, doctor). The most advanced computer lags far behind a human in terms of flexibility of thinking, ability to solve non-standard issues.

Automation and implementation of artificial intelligence elements have a significant impact on the labour market of regions and countries. According to the forecast of the McKinsey Institute the world automation could lose 1.2 billion workers whose total salary is $14.6 trillion. In Europe, 62 million people may lose their jobs, mainly in France, Germany, Italy, Spain and the UK.

The above graph shows that the growth rate of median income, this level of income, that is shared by 50% of low-paid and 50% of high-paid workers, lags behind the growth rate of the gross domestic product in developed countries. Labour productivity is growing, but income is falling, and the number of jobs is declining.

Economic statistics shows that new technologies do not always increase wealth. In developed countries, the middle class is "eroded", the proportion of the poor and rich is increasing. The income of IT development specialists is growing significantly, while in developed countries the salary of skilled workers remained at the level of the 70s, taking into account inflation. Average income growth rates lag production growth rates. The unemployment rate is higher than in the 90s, while social programs mitigate the negative consequences.

In the coming years, it is expected further development of artificial intelligence and automation. Their impact on the labour market will increase. Regarding its nature, there are opposing points of view. Proponents of accelerated technological progress argue that new technologies will create more jobs than they eliminate. As an example, they point to the German industry experiencing a shortage of qualified personnel. Robotization reduced the number of workers at the assembly line but required a significant increase in software developers or robot maintenance specialists. Within a wide time frame, they consider the reduction in employment in agriculture from 50% at the beginning of the 20th century to 2% now. These workers have found a place in industry and services.

A more critical approach indicates that in recent decades, jobs for low-skilled workers who could undergo retraining and find a new job have been reduced. Now automation is becoming global. Jobs will be absent in catering, in offices. Job cuts will increase, and humanity will not have time to adapt to the new reality.

Even the owners of large companies are aware of the threat of uncontrolled development of automation because the unemployed will not be able to buy their products and make a profit.

To mitigate the effects of automation and robotization, a number of strategic solutions are proposed:
- development of social programs;
- unconditional basic income (any citizen of the country will receive it);
- partial nationalization of the economy (the economy will be controlled by artificial intelligence in the interests of the general population).

The analysis of the automation and implementation of the elements of artificial intelligence showed their high importance in terms of territorial development, the impact on the labor market and industry activities, taking into account potential opportunities. When developing a strategy and implementing relevant measures it is necessary to consider the prospects and trends of automation and robotization, the need for the use of artificial intelligence and digital technologies for the effective development of countries and regions.

References
[1] Watry G 2016 The fourth industrial revolution and robot journalism. Available at: http://www.rdmag.com/news/2016/01/fourth-industrial-revolution-and-robot-journalism (Date of reference 18.09.2018)
[2] Urunov A A and Rodina I B 2018 Fundamental'nye issledovaniya 1 138-142. Available at:
[3] McKinsey Global Institute. Technology, jobs, and the future of work. briefing note prepared for the fortune vatican forum. December 2016. Updated april 2017. Available at: https://www.mckinsey.com/~media/mckinsey/featured-insights/DigitalDisruption/HarnessingAutomationForAFutureThatWorks/MGI-A-future-that-works-Executive-summary.ashx (Date of reference 18.09.2018)

[4] Lizunkov V, Politsinskaya E, Malushko E, Kindaev A and Minin M 2018 International journal of energy economics and policy 8 (3) 250-257.

[5] Harnessing automation for a future that works, ed James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott and Martin Dewhurst. Available at: https://www.mckinsey.com/featured-insights/digital-disruption/harnessing-automation-for-a-future-that-works

[6] Ergunova O T, Lizunkov V G, Malushko E Yu, Marchuk V I and Ignatenko A Yu 2017 IOP Conference Series: Materials Science and Engineering 177 012046. DOI:10.1088/1757-899X/177/1/012046