A Comparision of Digital Transformation of Industry in the Russian Federation with the European Union

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Abstract The concept of Industry 4.0 is based on a set of digital technologies, forms a new paradigm in the economic and social sphere, and significantly changes production models. The study aims to find out the status and pace of digitalisation of the economy of the Russian Federation, highlighting the industrial sector. The author explores the most relevant digital technologies that enable machine connectedness, adaptability, predictability, and autonomous production. The study hypothesises that the digital transformation of the industry should manifest itself in an increase in the use of digital technology by companies. The author used selected indicators from Russian and European statistical databases, showing enterprises' use of certain types of digital technology. We found that in the Russian Federation, in the last five years, there has been no growth in the use of special software tools for design and production management. The same is observed in enterprise resource management systems (enterprise resource planning and customer relationship management). In the Russian Federation and the European Union, there is an established level of use, which has not changed over the past 5 years. On the other hand, the use of cloud computing technology is growing, including in the manufacturing industry

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of the Russian Federation. The author identified Russia is lagging behind the European Union in using big data technologies, artificial intelligence, the Internet of Things, radio-frequency identification, and cloud technologies. Russia's share of companies using these technologies is usually 2–5 points lower than the average European level. The results obtained can be used in forming the Russian Federation's industrial policy in the digitalisation field. In the future, lengthening the observation history will allow a more detailed evaluation of the dynamics of the digitalisation process. A limitation in the use of the results can be considered differences in the methods for collecting and processing statistical information in the Russian Federation and the European Union.

Keywords Digital transformation · Industry 4.0 · Industrial policy

1 Introduction

The focus on Industry 4.0 and the digitalisation processes is related to the scale of the impact of new technologies on the economic, social, and production spheres. Since 2011, initiatives have been actively developing worldwide to combine industrial production, digital technology, and the Internet, creating a new technological paradigm. Furthermore, digital technology makes it possible in the face of increased competition in the markets and a changing environment to more quickly develop effective solutions in the management of production [13, 28, 30], personnel [17], and interaction with customers [24], partners, and government agencies [8, 31].

Modern digital technology supports the entire life cycle of production, including the development of the product concept, the formation of a system of technical and marketing requirements, detailed specifications, the development of design and technological documentation and digital models, collecting data on customer satisfaction, maintenance, etc. In addition, digital technologies support decision-making in the management of resources, employees, and information links [23].

Traditional business models and production management methods do not always cope with modern challenges, generating risks of reduced efficiency, loss of markets, and loss of enterprises from value chains [22]. Such manifestations can arise in the economy, causing socio-economic problems [2, 10, 20, 26], lack of sustainability [16], long-term lagging [21], and the territory's falling out of the common space [6, 33, 34].

In general, digitalisation, being a new technological paradigm, offers fundamentally new opportunities for the economy and social area [4, 15], especially in the field of industrial production, ensuring its sustainability [9, 29, 32], organising interaction within and between enterprises [14, 27].

A review of the literature shows a lack of publications comparing the level of development and dynamics of digital technologies' penetration into the economy at the company level. Here we wanted to see country comparisons.

The study aims to determine the state and pace of digitalisation of the Russian economy, highlighting the industrial sector and comparing them with similar indicators of the European Union. The article focuses on the most promising and relevant digital technologies applicable to industrial production.

As a hypothesis, it is assumed that the available data will show a digital transformation of the economy, particularly its industrial sector, expressed in an increase in the use of digital technology. Perhaps in an international comparison, the characteristic profile of digitalisation, associated with the priority implementation of certain technologies, will be noticeable.

The study will use selected indicators of Russian (gks.ru) and European (ec.europa.eu/eurostat/en/) statistical databases, taking into account the use of certain types of digital technology by companies as a basis for evaluation.

2 Methods

2.1 Evaluation of digitalisation

When assessing the level of digitalisation, the question of search, selection, and quality of the data used naturally arises. Often considered indicators of the development of the digital economy are the ICT Development Index, Networked Readiness Index, Inclusive Internet Index, World Digital Competitiveness Index, Global Connectivity Index, International Digital Economy and Society Index, e-Government Development Index, UNCTAD B2C e-Commerce Index, Global Cybersecurity Index, Local Online Service Index, Digital Intelligence Index (Digital Evolution and Digital Trust), and others. The task of these indices is usually to calculate and present a comprehensive indicator consisting of modules to assess the digitalisation of society, public administration, the creation of digital infrastructure, etc. These indicators are not suitable for the objectives of this study, as they include several elements not related to Industry 4.0 and the industrial sector. Therefore, this study focuses on selecting individual indicators that characterise the degree of digitalisation in certain areas and technologies [5]. The level of readiness of the economy for digital technology has already been estimated for European countries [7] but did not include data from the Russian Federation.

In the industrial sphere, it is quite difficult to adequately assess digitalisation processes because digitalisation covers a huge number of technologies and ways of their application [11, 12]. The information technologies used for interaction via global networks, electronic document management, and enterprise resource management are no longer considered digital. As the most advanced, providing new opportunities within Industry 4.0 are called big data, Internet of Things, artificial intelligence (machine learning, deep learning), blockchain, VR and AR, wireless communication technologies (in particular, 5G), cloud computing, additive manufacturing, robotics, and simulation [19]. The more complex the technology, the more important it is to Industry 4.0.

Akberdina proposed [1] a five-level "pyramid of digitalisation", including the stages: computerisation, the use of computer networks; electronic exchange of economic data with partners; means of providing computer support for production; own production of ICT and equipment; production and use of robots, sensors, and other means of industrial digitalisation.

A report from Acatech (https://www.acatech.de) published in 2017 proposed six stages of digitalisation, with only the last four stages attributed to Industry 4.0 technologies. At these stages, information systems and sensors allow recording the performance of production processes, forming a digital model of the company, allows analysing and using the information collected, justifying the decisions made, making reasonable forecasts, reducing the number of unforeseen downtimes, providing a more stable operation of the company.

There are other approaches to the classification of digital technologies, such as four technological layers – Sensor, Integration, Intelligent, and Response [3]. More complex technology development roadmaps and initiatives [18], with allocating the most important technologies for individual areas [27].

When assessing the domestic economy's digitalisation level, the focus should be on the highest stages of digitalisation development and their corresponding technologies [3, 25]. This study will use the Rosstat data for the Russian economy, highlighting the industrial sector. In addition, the averaged data of the Eurostat for the EU countries will be used as a comparative basis. Data for European countries do not include financial sector companies – this is the approach used by Eurostat.

Data to assess the extent of use of the most relevant digital technologies have begun to appear in domestic statistics in recent years. Furthermore, in 2020, Rosstat began adapting statistics collected on digitalisation issues to international standards. The present study considers the widest range of indicators provided by Rosstat, focusing on technologies that can be attributed to Industry 4.0 and which will determine the prospects for industrial development.

Rosstat, like Eurostat, offers indicators of the share of companies using certain types of digital technology for consideration. It should be noted that in 2020, Rosstat changed the data collection and structuring methodology, which manifested itself in a sharp change in values, created a gap in observations, and did not make it possible to assess the changes that occurred in 2019–2020 adequately. The selection of studied technologies allowed for limiting the range of technologies covered by the statistics:

- the use of special software (for design, for automated production control);
- cloud technologies;
- artificial intelligence;
- big data technologies;
- radio frequency identification (RFID) technologies.

3 Results

3.1 Special software tools

In the first stage, let us consider the dynamics of using special software tools in the economy and, separately, in industry. These technologies include a wide range of information tools: for design, automated production management, warehouse, enterprise resource management, information security, procurement management, sales, and financial calculations, as well as for scientific research, electronic document management, etc. The study of the proportion of companies that use any special software tools is declining in the industry with a slight increase in such companies in the economy as a whole. The overall level is 86–87%, with a downward trend (Figure 1).

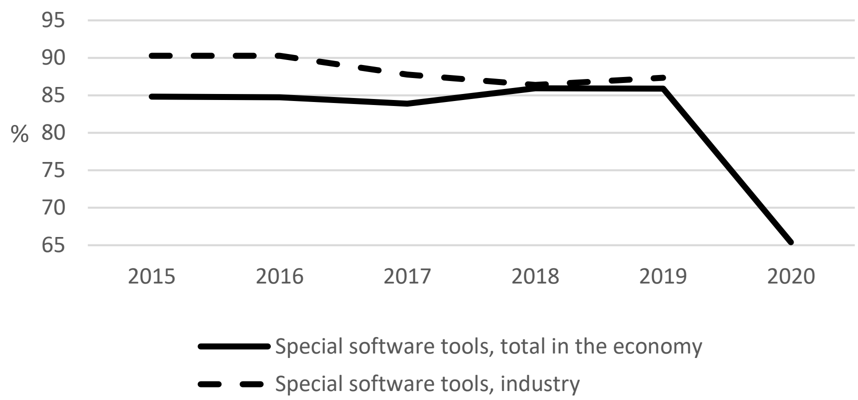

Fig. 1. Share of companies in the Russian Federation that use special software tools, %.

Some special tools can be attributed to the digitalisation characteristic of Industry 4.0. Among these technologies, one can name tools for computer support of design and technological preparation of production, and technical analysis. However, statistics show no growth in the share of companies using this type of funds (Figure 2). For industry, the established level is 30%, and for the economy as a whole – 10–13%.

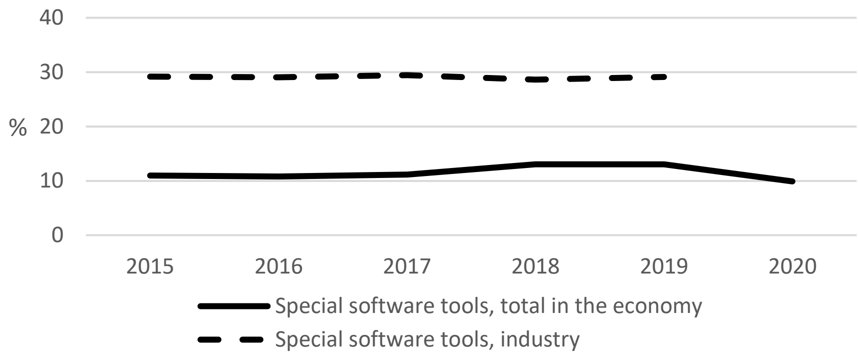

Fig. 2. The share of Russian companies using special software for design (CAD/CAE/CAM/CAO).

One can see roughly the same thing in using software to control individual equipment, technological processes, and industries. The share of companies in Russia that use these funds is about 15%. For industry, it is higher – more than 35% (Figure 3). In the considered five-year period, this indicator remained virtually unchanged. This demonstrates the modest pace of digitalisation processes, or rather the frozen structure of technologies used in this area.

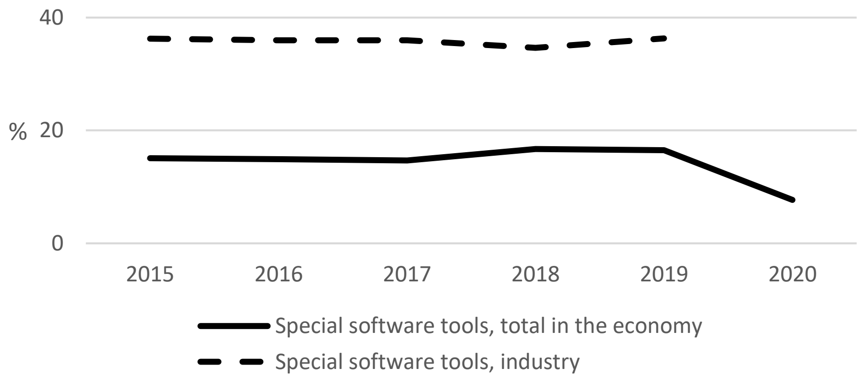

Fig. 3. Share of Russian companies using special software for automated production and process control.

However, the special software tools considered in this section of the statistics, likley to be intended for scientific research, warehouse management, human resources, electronic document management, human resources, procurement, and financial calculations, refer to the initial stages of informatisation of production and cannot be the basis for tracing the processes of industry transformation within Industry 4.0. The dynamics of the indicators of this section of statistics, in general, show that in the Russian Federation economy, and the industry in particular, in the observed five-year period, there were no significant processes of expanding the use of digital technology.

3.2 Cloud technologies

Since 2020, detailed information on the use of big data, artificial intelligence, the Internet of Things, RFID, and remote data centres by companies has become available in Russian statistics. Unfortunately, not all indicators in this section have a history of observation, and one can only assess the level of digital development achieved using them. The growth in the use of cloud technology in the economy is noticeable and, according to available data, has reached a level of 26–27% in the Russian economy as a whole and the manufacturing industry (Figure 4).

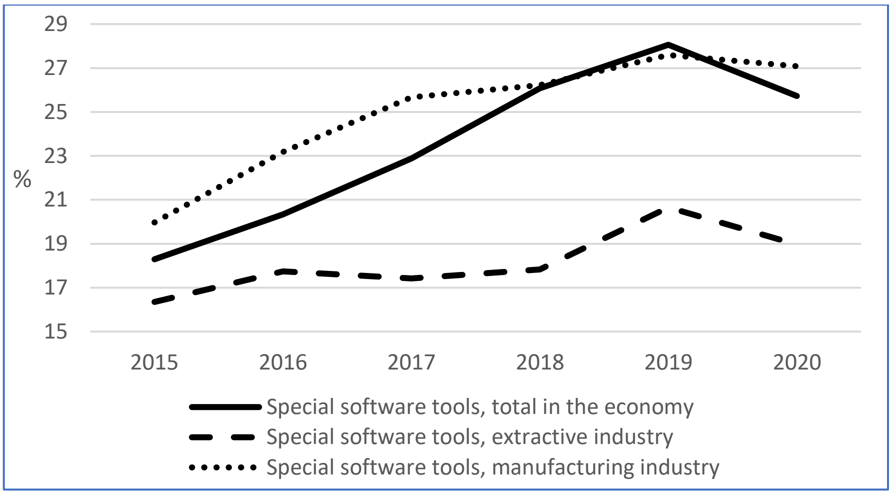

Fig. 4. Share of Russian companies using cloud technologies, %.

In the Eurostat database, there is an indicator of the proportion of companies that have purchased cloud services. The average for the 27 EU countries rose from 19% in 2016 to 36% in 2020 and 41% in 2021. Despite the noticeable growth, one can talk about the lag of domestic companies from the average European level.

3.3 Big Data

Enterprises most actively use big data generated from their own websites, social networks, mobile operators, and enterprise accounting systems (Figure 4). In the economy as a whole, 22.4% of companies use any technology to collect and process big data, whereas in manufacturing – 26.5%, and in extractive industries – 21.8% (Figure 4).

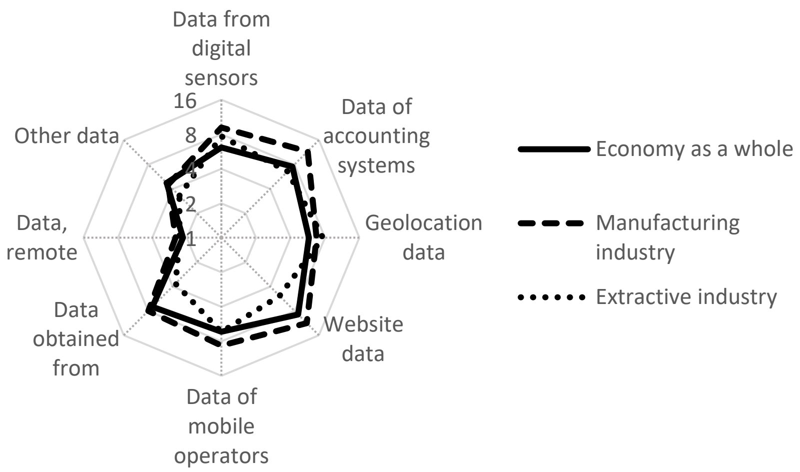

Fig. 4. Share of Russian enterprises using Big Data by type of data, 2020, %.

As of 2020, in the EU, 13% of companies used big data analytics technology from at least one source. That said, big data on geolocation and big data from social media is handled by about 7% of companies, and data from smart sensors and devices within companies by about 4%.

Domestic companies are already at the average European level in this technological area, especially manufacturing ones. If one considers big data use, the main two reasons are for sales (marketing) and the production process and, to a lesser extent – for security.

3.4 Artificial intelligence

Artificial intelligence as a set of technologies belongs to the most important areas of Industry 4.0. The share of companies using individual artificial intelligence technologies does not exceed 5.4% (3.65% in manufacturing, 2.5% in mining), with machine learning, computer vision, and language processing being the most important technology areas (Figure 5). It should be noted that in the financial and insurance services and trade, the share of companies using these technologies for certain types of services reaches 20%. Trade and financial services in the Russian Federation, as the easiest areas for digitalisation, are much more developed in this direction.

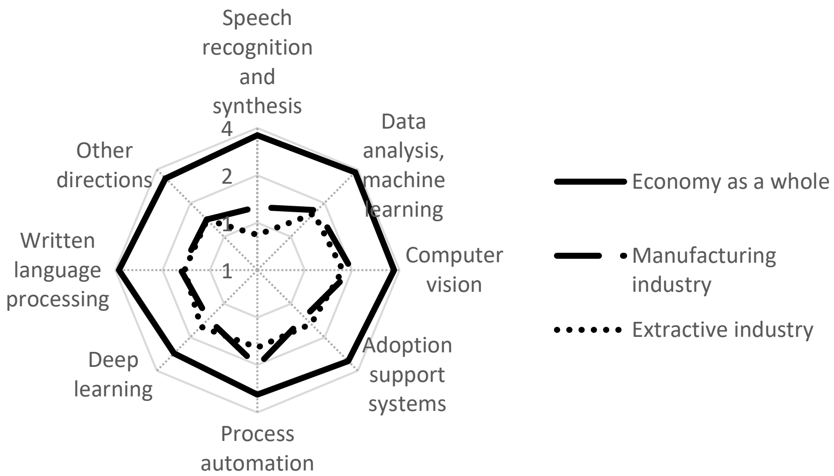

Fig. 5. Share of Russian sorganisations that used artificial intelligence technology in the areas.

Artificial intelligence is used primarily for production and marketing and less so for security. About 8% of companies in the EU use artificial intelligence for certain functions. At the same time, the share of companies using artificial intelligence for the implementation in individual areas: speech recognition, machine learning, computer vision, decision support systems, automation, robotics, and written language processing is in the range of 2–3%. One can observe that domestic companies have reached the average European level.

3.5 Internet of Things

Only 4% of Russian companies use the Internet of Things technologies. Among the main uses are optimising electricity and heat consumption, monitoring customer activity, tracking the movement of vehicles and products, automating the production process, and managing logistics and product movement (Figure 6). In some areas, manufacturing enterprises are more actively using this technology. In the wholesale and retail trade, the use of Internet of Things technology reaches 25%.

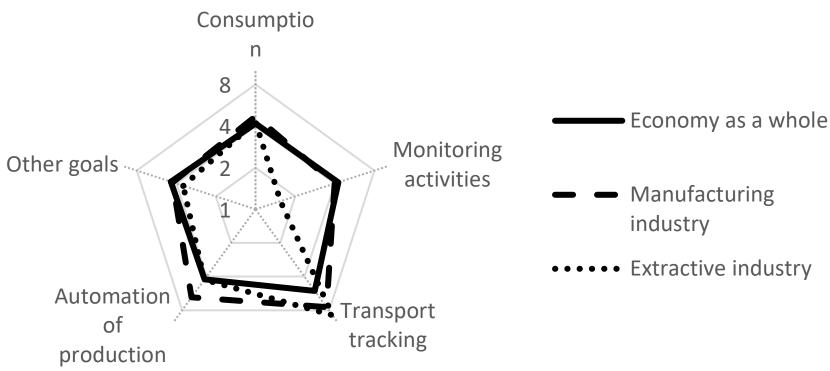

Fig. 6. The share of Russian enterprises that use IoT technologies by directions in 2020.

At the same time, about 30% of companies in the EU use the Internet of Things, including 9% – to control energy consumption, 5% – to control sensors and cameras, 7% – to control the movement of objects, 5% – to control production processes, 6% – for logistics. In addition, this type of technology provides the connectivity of equipment, collecting the data needed for predictive analytics, a key element of Industry 4.0. However, a significant observation is that the domestic industry lags far behind the European average in using this technology.

3.6 Radio Frequency Identification (RFID) technology

Companies in the Russian Federation use RFID technology to identify individuals, control access to hotel rooms, and monitor and control production and logistics processes. At the same time, the share of companies using these technologies does not exceed 8% (Figure 7). In retail and wholesale trade, the use of Internet of Things technology reaches 22.3% in the direction of personal identification and access control to hotel facilities. Limited Eurostat data shows that the percentage of EU companies using RFID tags rose from 11% in 2014 to 13% in 2017. On the other hand, the share of domestic companies using RFID in the most important area – directly in the production process does not exceed 3% for the industry.

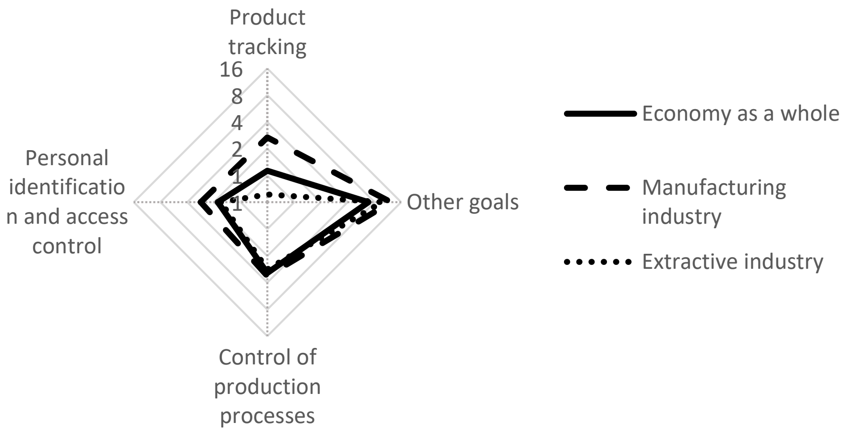

Fig. 7. Share of enterprises using radio frequency identification (RFID) technology, by areas, 2020.

One can consider the level of companies' use of integrated resource utilisation systems as an additional element for comparison. The use of enterprise resource planning (ERP) systems in European countries is at 36–38% and has not grown in the past five years. In Russia, ERP systems are used by 13% of companies in the economy, 12.3% – in extractive industries, and 18.6% – in manufacturing. There is also a noticeable lag in the systems interaction with customers and partners. In European countries, the established level of use of customer relationship management (CRM) systems is 35–37%, and in Russia – 12.1% (5.2% – in the extractive industries, 10.5% – in manufacturing).

4 Conclusions

This study assesses the status and pace of digitalisation of the Russian economy and, separately, the extractive and manufacturing sectors of the Russian Federation. The study focused on current and promising digital technologies applicable to industrial production. These technologies ensure the accumulation and processing of big data and provide connectivity, predictability, and autonomy of production management within Industry 4.0. In addition, based on data from the statistical authorities of the Russian Federation and the European Union, a comparative analysis of the level of use of digital technology by organisations was conducted.

The study showed that there had been no growth in the use of special software tools in the Russian Federation over the past five years. This applies to software tools for design and production management. Furthermore, the study shows that companies have already provided the necessary level of use of special software tools in this area, demonstrating a saturation effect. On the other hand, cloud computing technology is growing, including in the manufacturing industry. This is probably due to the development of cloud technology capabilities applicable to the industry. A comparison of the level of digital technology use by Russian companies with EU data reveals a lag in cloud technology, big data processing, artificial intelligence, the Internet of Things, and radio-frequency identification technologies. At the same time, the lag, as a rule, does not exceed 2–5 points. In addition, a lower level of use is noticeable in traditional enterprise resource management systems – ERP and CRM. In this area, both in the European Union and in the Russian Federation, there is an established level of use, which has not changed over the past five years.

The results expand the understanding of the state and dynamics of digitalisation processes in the Russian Federation and can be used in managing the digital transformation of industry in the Russian Federation. Furthermore, results underscore the need for government measures to increase digital technologies used by Russian companies to improve their performance of industries and reduce the gap with European companies.

Short observation periods and international differences in static techniques can be considered limitations in using the results obtained. We see prospects for further research of the problem in the application of econometric and other methods to assess the processes of industry digitalization. This will become possible after expanding the number of monitored indicators and increasing the time period of statistical observation. We consider it promising to build agent-oriented models describing the process of digital technologies adoption by industrial enterprises.

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