CHAPTER 7

Economic Mechanisms of Regulation of Innovative Industrial Technologies in the Post-COVID Age

Tatiana V. Skryl, Marina Gregoric, and Andrey Yu. Markov

Introduction

The development and modernization of the industrial sector of the economy is one of the priorities of the state policy of the Russian Federation. Currently, many industries are dependent on imported components, which refer to high-tech products developed and manufactured abroad. The criterion of successful development of the Russian economy is the

T. V. Skryl (✉)
Plekhanov Russian University of Economics, Moscow, Russia
e-mail: Skryl.TV@rea.ru

M. Gregoric
University North, Varaždin, Croatia

A. Yu. Markov
MGIMO University, Moscow, Russia
e-mail: markov.a.yu@my.mgimo.ru

V. S. Osipov (ed.), *Post-COVID Economic Revival, Volume II*,
https://doi.org/10.1007/978-3-030-83566-8_7

creation of a developed manufacturing and processing industry with strong export potential, consisting of innovative business units which receive the bulk of income from the sale of high-tech products (Braccini & Margherita, 2018; Rojko, 2017).

Being the embodiment of disruptive technologies and taking advantage of innovative industrial technologies, the industrial complex finds itself at the core of the industrial revolution 4.0, offering a wide range of economic opportunities and challenges. It is also a solid growth point for the global economy, especially in the post-industrial era (Konina 2021a, 2021b; Konina et al., 2021). The global economy already relies heavily on the industrial sector. Many solutions enable communication, navigation, mobility, weather forecasting, and have proven indispensable, enabling virtual productivity and understanding and monitoring the effects of disaster during a pandemic. Industrial goods and services are used by users from insurance, energy, agriculture, telecommunications, defense, and security. In addition, the industrial economy contributes to the development of new technological advances: quantum superiority (including quantum communications), autonomous vehicles.

High-tech industry is at the core of a vital part of the economy and is seen by many experts as a vehicle for the economy as a whole, the proper design of economic regulation mechanisms will have a positive effect on economic growth, including productivity growth based on the introduction of innovative industrial technology.

As the economy becomes increasingly digital, the demand for solutions from the industrial sector will steadily increase. The digital economy is estimated to be worth more than $1 trillion by 2040.

The digital economy has a synergistic effect, as investment in innovative industrial technology leads to scientific advances and more data collected, which in turn leads to further scientific advances.

The development of a digital economy based on the introduction of innovative industrial technologies is becoming extremely relevant at the present time, as it has the potential to take a leading role in the recovery of the global economy.

Methodology

The expediency of industrial policy, forms, tools and institutions of its implementation were considered in the works of economists domestic and foreign authors D. Bell, J. Galbraith, G. Murdal, D. North, L. I. Abalkin,

S. Y. Glazyev, D. S. L'vov, V. I. Maevsky, V. M. Polterovich. Modern interpretations of the new industrialization, digital economy, and mechanisms for regulating the spread of innovative industrial technologies can be found in the works of V. V. Akberdina, R. S. Grinberg, S. S. Ivanter, G. B. Kleiner, V. S. Osipov, E. M. Primakov.

The transition to a digital economy is a significant restructuring of the economic system using new digital industrial technologies (Akberdina et al., 2018, 2020). It leads to a fundamental rethinking of the existing structure and changes in all processes, allows the creation of new formats for working with economic actors, such as consortia, and adapting products and services to the needs of a particular economic agent (Maevsky et al., 2016; Polterovich, 2018). The result should be the achievement of key results of economic efficiency, optimization of costs, and improvement of the quality of the provided service or produced product (Allen, 2017; Castells & Himanen, 2002; Krugman, 2003).

But unprecedented measures to curb the spread of COVID-19 have corrected the implementation of the transition to the digital economy and had a negative impact on the Russian economy and industrial production in particular. According to the Ministry of Economic Development, Russia's GDP declined by 3.3% in the first 3 quarters of 2020. And at the end of the year, the decline in industrial production in Russia reached 2.9% (Sarkis et al., 2020).

It should be noted that the Russian economy and industrial sector had problems with growth even before the epidemic. This was due to both structural problems and the energy crisis. Today, the situation is exacerbated by a drop in demand for energy resources (which make up a significant part of the export earnings of the Russian economy) and gaps in the supply chain (Skryl & Osipov, 2021). In the first two quarters of 2020, energy prices fell by 18%. Now the situation has begun to improve, as production is gradually resuming its work, the lifting of the quarantine has dramatically increased transport activity, as air transportation accounts for about 7% of the total consumption of petroleum products (Oztemel & Gursev, 2020).

A crisis of any nature shows how important and valuable reliable and readily available data is to assess impacts, develop responses, monitor and support their implementation to mitigate negative impacts and accelerate recovery. Satellite imagery, navigation, and communications supported decision-making and increased the transparency of the impact of government responses during the pandemic (Casalino et al., 2020).

The COVID-19 crisis and the measures taken by governments to control the spread of the disease had a major impact on most sectors of the economy, including industry. The main problems for the industrial sector are the introduction of telework, shutdowns of industrial plants and start-ups, outages, loss of activity in connected sectors, supply chain disruptions, payment delays, increased costs and reduced demand, resulting in lower income and productivity levels and increased costs. Long-term threats to the sector could be low demand, changes in government policy, and reduced budgets.

According to ESPI, 40–50% of workers in the European industrial sector were working remotely in the second quarter of 2020. Some satellite operators switched almost entirely to telecommuting. Employees had to adjust to the new work environment, while employers were quick to develop IT infrastructure and other necessary facilities to enable telecommuting. Still, 44% of employees showed some degree of productivity loss (Degli Esposti et al., 2021).

The UK reports that 47% of companies have experienced a drop in international demand and 44% of companies are operating below full capacity, while 52% of companies have postponed or abandoned plans to expand internationally or to attract foreign investment (PwC, 2020).

Public-private partnerships, widely used in industrial infrastructure, have been threatened by a weak private sector. Industry did its best to mitigate the negative effects of the pandemic and ensure business and plan continuity. Government customers met payment schedules and ensured stable and predictable demand, which had a positive impact on the upstream segment, while the commercial (about 33% of EU revenues) and export segments were subject to higher levels of uncertainty (ESPI, 2020). Commercial actors expected revenue losses ranging from 15 to 30% (Ivanov et al. 2020).

The industry has been particularly vulnerable to the current crisis due to the fact that most workers in the sector are employed directly in production, and the work is often difficult or impossible to do remotely (Hess, 2013). In addition, given the specifics of the industry, it is not always possible in principle to ensure social distance at workplaces in manufacturing plants, warehouses, logistics, etc. (Guo et al., 2018). The negative consequences of the crisis were especially pronounced in the energy, automotive, and aviation industries (Galushkin et al., 2019). Due

to the spread of the COVID-19 epidemic around the world, manufacturers of cars, electronics, and aircraft are facing problems related to the availability of raw materials and components.

The OECD estimates that each month of forced prolongation of restrictive measures will result in an additional decline in industrial production equal to a 2-percentage point reduction in annual GDP growth (UNCTAD, 2020).

If at the macro-level we will see a decrease in GDP due to the prolonged introduction of restrictive measures limiting economic activity, then at the micro-level the accumulated losses of companies will only increase in the context of a slowdown in trade growth due to growing trade contradictions and border closures in the near future.

In the context of the pandemic, the Government of the Russian Federation has developed a number of economic mechanisms to support the private sector, namely the introduction of tax vacations, preferential loans for the payment of wages, etc. All these measures theoretically should lead to an increase in business activity and the growth of real incomes of the population. In fact, only those enterprises on the list of industries that are particularly affected by the introduction of quarantine measures receive these measures. These are mainly the trade and services sectors. Not a single enterprise, which is part of the real sector of the economy received these preferences (Resolution No. 434 of the Government of the Russian Federation of April 3, 2020). This half measure will not bring much efficiency, because it is the stable operation of enterprises in the real sector that ensures the course of recovery of the economy as a whole, since industry and manufacturing occupy the second place in terms of the number of people employed in the economy. The short-sightedness of the exclusion of industry from the list of affected industries is especially evident when considering the indicator of industrial production growth in the "Forecast of socio-economic development" presented for 2021 and planned for 2022, 2023. Note that in 2020 industrial growth was—2.9%, against the stated 3.3% by the end of 2021. It turns out that in a year, the real sector of the economy should not only recover its values compared to 2019 (in 2019 growth was 2.3%), but also further increase the growth rate in subsequent years (AIAA, 2020).

The crisis caused by the spread of the coronavirus infection has worsened the prospects of the Russian economy in 2020–2021 (Table 7.1). Official statements by officials and the imminent end of the epidemic (thanks to universal vaccination) make optimistic forecasts for the near

Table 7.1 Main macroeconomic indicators of the Russian economy

Index	*2020*	*2021*[a]
GDP, billion rubles	106,6	115,0
Industry Production, %	−2,9	3,3
Retail Trade, %	−4,1	3,0
Gross Investments, %	−8,4	3,8
Real Disposal Income, %	−4,5	2,6
Federal Budget Balance, % of GDP	−3,8	−1,5
Money Supply (M2), %	13,5	9,0

[a]Forecasted values
Source Authors' processing

future, but qualitative economic recovery growth will be very difficult. Every crisis leaves its mark and requires an adequate response and support from the state (Baldwin, 2016). The affected sectors of the economy will not be able to recover on their own due to the fall in wages and employment during the crisis, especially in small and medium-sized enterprises. The global economy is also in a critical condition. According to IMF experts, by the end of 2020 the world economy will have shrunk by 3%. This figure is much higher than during the global financial crisis of 2007–2008. Therefore, one should not expect a rapid recovery of the world economy and pull the Russian economy with it (Yankovskaya et al., 2020).

Results

The raw materials sector of the Russian economy is still the leader in terms of revenues. In the current crisis, these revenues are distributed throughout the economy through the budget mechanism, which serves as a kind of basis for recovery growth (Shumacher et al., 2016). In addition, it is necessary to launch new economic mechanisms in the field of regulation of innovative industrial technologies. Otherwise, we will continue to observe a fading economic dynamic. If short-term industrial policy measures are now identified, new sources of industrial production growth must be found in order to continue economic growth. Among them we can highlight the following (Elder-Vass, 2016; Osipov, 2016; Shwab, 2017).

- Automation of production. The introduction of robots, artificial intelligence, mechanisms of the Internet of Things, etc., into the production process.
- Reprofiling of production. Due to the aftermath of the COVID-19 crisis, some non-medical companies have begun to produce medical products such as masks, ventilators and their components, and disinfectants. It is worth noting, however, that this is not a long-term survival strategy.
- Creation and development of industrial centers and clusters operating on a fundamentally new technological basis and modern organizational management principles.
- Training and retraining of personnel.
- Close coordination with the public sector, which will regulate the production of critical products and ensure the interests of citizens.

On the other hand, new sources of growth can carry certain risks for the country's entire economy. In particular, I would like to analyze how the introduction of innovative industrial technologies can transform the structure of the economic system.

Undoubtedly, the application of innovative technologies has many advantages. When we talk about innovative digital technologies (Osipov & Roncevic, 2021), at the household level we mean electronic goods and services, the transition of people and businesses to online interaction and online services. The introduction of innovative industrial technologies is the future, and most importantly, digital technologies should solve the problem of overcoming the dependence of the Russian economy on raw material resources. Indeed, the digital economy can significantly reduce costs by replacing live labor with robotic labor, improve information support for decision-making, and reduce the role of office, production, and sales areas. The digital economy is characterized by the appearance on the market of fundamentally new products (unmanned cars, artificial intelligence), electronic money, renewable energy sources, the development of energy-saving technologies, etc. Digitalization is the result of the industrial revolution, and by no means can the fact of technological progress be denied, because in the end it will contribute to the victory or defeat of this or that particular game. When digital optimism begins to transform from theory to practice, then

the country, the company, and even the average consumer face challenges that many are not prepared for.

Many risks can be predicted and forecasted, and with a good combination of circumstances, they can also be insured. But in order to do so, it is important to get the regulatory mechanisms for innovative technologies right (Curran, 2018; Kagermann, 2015).

One consequence of digitalization is the risk of preserving databases and protecting personal data from abuse. The right to protect the personalized sphere from digital fraud and piracy must be understood and protected. Today, interacting in a multipolar world, many companies are faced with escalating and increasing information aggression. Therefore, it is important that the transition to a digital economy is accompanied by strict rules and regulations and supported by a stable institutional environment. Effective institutions will also help reduce the risk of monopolization of digital ownership. Today's economy shows that ownership is not always based on an ownership relationship. In most cases the owner can be separated from the digital resource, and a third party can regulate access to or even dispose of the resource. Here we are talking about various electronic services, social networks, and messengers.

Discussions

The innovative industrial technology sector is currently the fastest-growing job-creating industry. It is erroneous to assume that automation and robotics carry the risk of losing most jobs, thereby creating an additional risk of declining incomes. In reality, an innovative industrial sector will create more jobs than will be cut as a result of digitalization. This fact is confirmed by the work of many economists, including experts from the World Economic Forum. But the risk will still manifest itself in the fact that new jobs will not be distributed evenly throughout the country but will be concentrated in the so-called high-tech centers. There will be a high percentage of unemployment in areas where manufacturing and mining are located, as well as a large share of agriculture.

There is another risk of digitalization—the digital divide. As a rule, a high level of communication quality (which is a mandatory element of the transition to digital development) is observed near large cities and centers (Osipov et al., 2018). In hard-to-reach places, there is still not even access to broadband Internet. Nor can we deny the existence of

stagnant industrial centers that are not ready for the transition to new technologies.

The digital economy requires flexible, highly skilled IT personnel. Today the share of IT-cadres is negligibly small and amounts to just over 1.5% of the able-bodied population, even though IT-specialty is considered one of the most popular among job seekers. Every year about 22–24 thousand young IT specialists enter the labor market, but the market capacity does not meet the requirements of the digital economy. In fact, it turns out that the labor market is not yet restructured and cannot provide jobs for IT specialists. The pace of digitalization of the economy does not match the pace of labor market transformation. (Hendrickson et al., 2020).

Barriers to personnel training represent the most significant obstacle to the development of innovative industrial complex in Russia. This issue was especially relevant after the crisis caused by COVID-19. In the study the set of barriers can be divided into five main groups of problems.

Lack of qualified personnel is a barrier to development of innovative industrial complex in 27 out of 85 Russian regions. First, the problem arises due to the insufficient number of graduates in the field of digital economy and digital transformation. It should be noted that in this case the issue of managerial and analytical competencies is crucial.

The implementation of projects for the digitalization of industries requires a large number of industry analysts, who must form the requirements for the digital transformation of the industry through the implementation of digital technologies. Due to the fact that educational institutions are not focused on training chief digital transformation specialist and data analysts, specialists are severely lacking. In order to achieve the indicators of training specialists in the field of information security it was necessary to organize in 2015–2016 an increased enrollment of students in relevant educational programs. The recommended sets of specialties and areas of training in key competencies are limited to information technology specialties, and not all areas of training exist in the regions. Insufficient admission of applicants to universities in the field of digital economy and the lack of budgetary places in the specialties related to information technology and information security are noted in many regions.

Second, not all existing employees have sufficient skills to support the digitalization of the economy, and there is also an outflow of specialists. In the industrial sector, there is a shortage of state and municipal

employees with digital competencies at the required level. There is a shortage of highly qualified specialists in many areas of implementation of the measures of the national program "Digital Economy of the Russian Federation" in public authorities at all levels, as well as in high-tech industries.

The general low level of competence of citizens in the field of information technology makes it difficult to digitize various processes and apply innovative technologies. Many citizens, including members of the older generation, do not have computer skills, which leads to difficulties in obtaining various services electronically. Unequal access to technology among the population in the context of an acute shortage of professional development courses and training programs does not allow the necessary level of digital literacy of citizens. There is a problem of a shortage of people who want to acquire skills in the digital economy.

The lack of educational programs and professional development courses in the digital economy is a problem in 17 regions. Additional educational courses and programs in educational institutions are needed to develop digital literacy for various categories of the population. There are no programs for the mandatory specialized training of regional executives in the digital economy. The federal executive authorities are responsible for comprehensive training in the digital economy. It should be noted that there are no criteria required to assess the level of training, as well as a methodology for their application. The absence of a list of educational programs aimed at developing competencies in the digital economy does not allow for an objective assessment of the level of training for the digital economy.

Another barrier is the absence of a fixed list of competencies as part of the implementation of innovative programs. The absence of certain criteria for the concept of "digital competencies" does not allow economic agents to implement measures to achieve the indicators of the national project "Personnel for the Digital Economy". There is a difficulty in the qualitative preparation of training programs for competencies in the digital economy, in the management of recruitment plans for specialties in this area, in the preparation of professional development and retraining programs. Until tools for independent assessment of competencies in the digital economy are developed, it is currently impossible to assess the competencies of specialists.

In addition, it is necessary to outline the problem of employment in the context of the recommended number of information security specialists, as regional organizations do not need such a number of specialists. This barrier is observed in many regions of Russia, which also lack the necessary jobs for specialists in this area.

Despite all the difficulties, the industrial sector survived the COVID-19 crisis quite well. The decline in production was less than expected in spring-summer of 2020. But investments in industry have not yet reached the desired level and at the end of the year amounted to more than half of the total volume of investments in fixed assets. It is planned to further increase investment activity in the industrial sector. The market growth of innovative industrial technologies is expected to be 15% (CNES, 2020).

The impact of COVID-19 was mainly focused on manufacturing and operating activities during the period of restrictions, resulting in financial pressure on small and medium-sized businesses and program delays. With a high reliance on government spending, the future of the industrial sector will depend on changes in regulatory mechanisms for the introduction and diffusion of innovative industrial technologies. There may also be ripples from other industrial clusters.

It is worth noting that in integrating industrial technology, space exploration is the most vulnerable subsector of industry. Navigation, Earth observation, and satellite production show moderate impact on industrial development in general, while telecommunications and launch systems are highly resilient. The space sector is influenced by both macro-level trends and market forces. It has a significant dependence on the industrial sector, which is subject to macro-trends. Supply chains in the space sector are evolving as top-down factors drive the development of new systems and the creation of new innovative industrial technologies on the downstream stages. Space exploration is likely to expand through lower launch costs and technological advances. Mass production of satellites and reusable vehicles will reduce costs. Potentially the cost reduction could be from $200 million over the last decade to $5 million (currently $60 million) (ILO, 2020). Green initiatives and the SDGs will create significant demand for space products.

Conclusion

The industrial sector will continue to be a sector where positive externalities are centralized, offsetting the effects of the interaction of the world's

economies. Successful regulation of industrial technology can propel the industrial sector to the forefront, thereby returning the economy to prosperous recovery growth.

The proposed industrial technology regulation mechanisms would allow high-tech companies to dominate the industrial sector by offering more scalable and innovative solutions with a personalized approach. This will result in limited entry into the sector and oligopolistic competitive relationships may develop.

To take full advantage of the fourth industrial revolution, a sustainable industrial complex must be built in the economy. State regulation of industry must be expressed in competent industrial policy, which plays an important role in the recovery of this sector. Industrial policy is aimed at economic growth and achieving the sustainability of the digital economy, including the development of public-private partnerships. A review of government programs to develop a green economy will create additional market opportunities in the industrial sector.

Recovery from the crisis is central to regulatory policies worldwide. The symbiosis of entrepreneurship and technological progress is essential for industry. As the industrial sector begins to successfully commercialize the introduction of innovative industrial technologies, the concentration of production in special zones remains a matter of paramount importance, since the development of an innovation market must be supported not only by market forces but also by qualified human resources. The role of education is to move towards creating a favorable environment for the growth of human resources potential, building the required competencies, and orienting and adjusting the market architecture so that domestic companies are globally competitive.

References

AIAA. (2020). *Addressing COVID-19 challenges to the U.S. aerospace and defense industry is mandatory for economic recovery, continued national defense, and future growth.*

Akberdina, V., Kalinina, A., & Vlasov, A. (2018). Transformation stages of the Russian industrial complex in the context of economy digitization. *Problems and Perspectives in Management, 16*(4), 201–211. https://doi.org/10.21511/ppm.16(4).2018.17

Akberdina, V. V., Korovin, G. B., & Dzyuba, E. I. (2020). State management mechanisms of the scientific and technological development. *Public Administration Issues, 4*, 111–140.

Allen, R. (2017). *The industrial revolution: A very short introduction*. Oxford University Press.

Baldwin, R. (2016). *The great convergence: Information technology and the new globalization*. Harvard University Press.

Braccini, A., & Margherita, E. (2018). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability, 11*(1), 36. https://doi.org/10.3390/su11010036

Casalino, N., Zuchowski, I., Labrinos, N., Nieto, Á. L. M., & Martín-Jiménez, J. A. (2020). Digital strategies and organizational performances of SMEs in the age of coronavirus: Balancing digital transformation with an effective business resilience. *Law and Economics Yearly Review, 8*, 347–380.

Castells, M., & Himanen, P. (2002). *The information society and the welfare state: The Finnish model* (1st ed.). Oxford University Press.

CNES. (2020). *Observatoire d'économie spatiale—Impacts COVID-19*.

Curran, D. (2018). Risk, innovation, and democracy in the digital economy. *European Journal of Social Theory, 21*(2), 207–226. https://doi.org/10.1177/1368431017710907

Degli Esposti, P., Mortara, A., & Roberti, G. (2021). Sharing and sustainable consumption in the era of COVID-19. *Sustainability, 13*(4), 1–15. https://doi.org/10.3390/su13041903

Elder-Vass, D. (2016). *Profit and gift in the digital economy*. Cambridge University Press. https://doi.org/10.1017/CBO9781316536421

ESPI. (2020). *Special Report—COVID-19 and the European space sector*.

Galushkin, A. A., Nazarov, A. G., Sabyna, E. N., & Skryl T. V. (2019). The Institutional model of formation and development of industry 4.0 in the conditions of knowledge economy's formation. In E. Popkova, Y. Ragulina, & A. Bogoviz (Eds.), *Industry 4.0: Industrial revolution of the 21st century*. Studies in Systems, Decision and Control (Vol. 169). Cham. https://doi.org/10.1007/978-3-319-94310-7_22

Guo, Y., Xin, F., Barnes, S., & Li, X. (2018). Opportunities or threats: The rise of Online Collaborative Consumption (OCC) and its impact on new car sales. *Electronic Commerce Research and Applications, 29*, 133–141. https://doi.org/10.1016/j.elerap.2018.04.005

Hendrickson, C., & Rilett, L. (2020). The COVID-19 pandemic and transportation engineering. *Journal of Transportation Engineering, Part A: Systems, 146*(7). https://doi.org/10.1061/jtepbs.0000418

Hess, D. (2013). Industrial fields and countervailing power: The transformation of distributed solar energy in the United States. *Global Environmental Change, 23*(5), 847–855. https://doi.org/10.1016/j.gloenvcha.2013.01.002

ILO. (2020). *COVID-19 and the world of work: Impacts and policy.*

Ivanov, O. V., & Inshakova, A. O. (2020). *Public-private partnerships in Russia*. Springer.

Kagermann, H. (2015). Change through digitization—Value creation in the age of industry 4.0. *Management of Permanent Change*, 23–45. https://doi.org/10.1007/978-3-658-05014-6_2

Konina N. (2021a). Introduction: At the dawn of the fourth industrial revolution—Problems and prospects. In N. Konina (Ed.), *Digital strategies in a global market*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-58267-8_1

Konina N. (2021b). Conclusion: The fourth industrial revolution—Further research agenda. In N. Konina (Ed.), *Digital strategies in a global market*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-58267-8_19

Konina, N., Vladimirova, I., & Stonehouse, G. (2021). The evolution of conglomerates in the digital era: Adapting strategies to the requirements of the fourth industrial revolution. In N. Konina (Ed.), *Digital strategies in a global market*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-58267-8_11

Krugman, P. (2003). *The great unraveling*. W. W. Norton.

Maevsky, V., Malkov, S., & Rubinstein, A. (2016). A theory of overlapping generations of fixed capital. *Herald of the Russian Academy of Sciences, 86*(1), 39–47. https://doi.org/10.1134/s1019331616010019

Osipov, V., & Roncevic, A. (2021). Institutionalization of the fourth industrial revolution in national economics and on global market: Different paths to success. In N. Konina (Ed.), *Digital strategies in a global market navigating the fourth industrial revolution*. Palgrave Macmillan.

Osipov, V. S. (2016). Project-functional structure of management for public administration. *Public Administration Issues, 3*, 219–230.

Osipov, V., Zeldner, A., & Skryl, T. (2018). *Making the smart city: Technologies, experiences, and future perspectives*. MATEC Web of Conferences/Volume 212, ICRE.

Oztemel, E., & Gursev, S. (2020). Literature review of Industry 4.0 and related technologies. *Journal of Intelligent Manufacturing, 31*(1), 127–182. https://doi.org/10.1007/s10845-018-1433-8

Polterovich, V. (2018). Towards a general theory of socio-economic development. Part 2. Evolution of coordination mechanisms. *Voprosy Ekonomiki* (12), 77–102. https://doi.org/10.32609/0042-8736-2018-12-77-102

PwC. (2020). *Main trends & challenges in the space sector 2nd edition.*

Rojko, A. (2017). Industry 4.0 concept: Background and overview. *International Journal of Interactive Mobile Technologies (Ijim), 11*(5), 77–90. https://doi.org/10.3991/ijim.v11i5.7072

Sarkis, J., Cohen, M., Dewick, P., & Schröder, P. (2020). A brave new world: Lessons from the COVID-19 pandemic for transitioning to sustainable supply and production. *Resources, Conservation and Recycling, 159*, 104894. https://doi.org/10.1016/j.resconrec.2020.104894

Schumacher, A., Erol, S., & Sihn, W. (2016). A Maturity model for assessing industry 4.0 readiness and maturity of manufacturing enterprises. *Procedia CIRP, 52*, 161–166. https://doi.org/10.1016/j.procir.2016.07.040

Schwab, K. (2017). *The fourth industrial revolution*. Crown Business.

Skryl, T., & Osipov, V. (2021). Transforming enterprise networks: Building a wellness human being ecosystem. *IOP Conference Series: Earth And Environmental Science, 650*(1), 012019. https://doi.org/10.1088/1755-1315/650/1/012019

UNCTAD. (2020). *Global trade impact of the Coronavirus (COVID-19)*.

Yankovskaya, V., Osipov, V., Zeldner, A., Panova, T., & Mishchenko, V. (2020). Institutional matrix of social management in region's economy: Stability and sustainability vs innovations and digitalization. *International Journal of Sociology and Social Policy, 41*(1/2), 178–191. https://doi.org/10.1108/ijssp-03-2020-0088