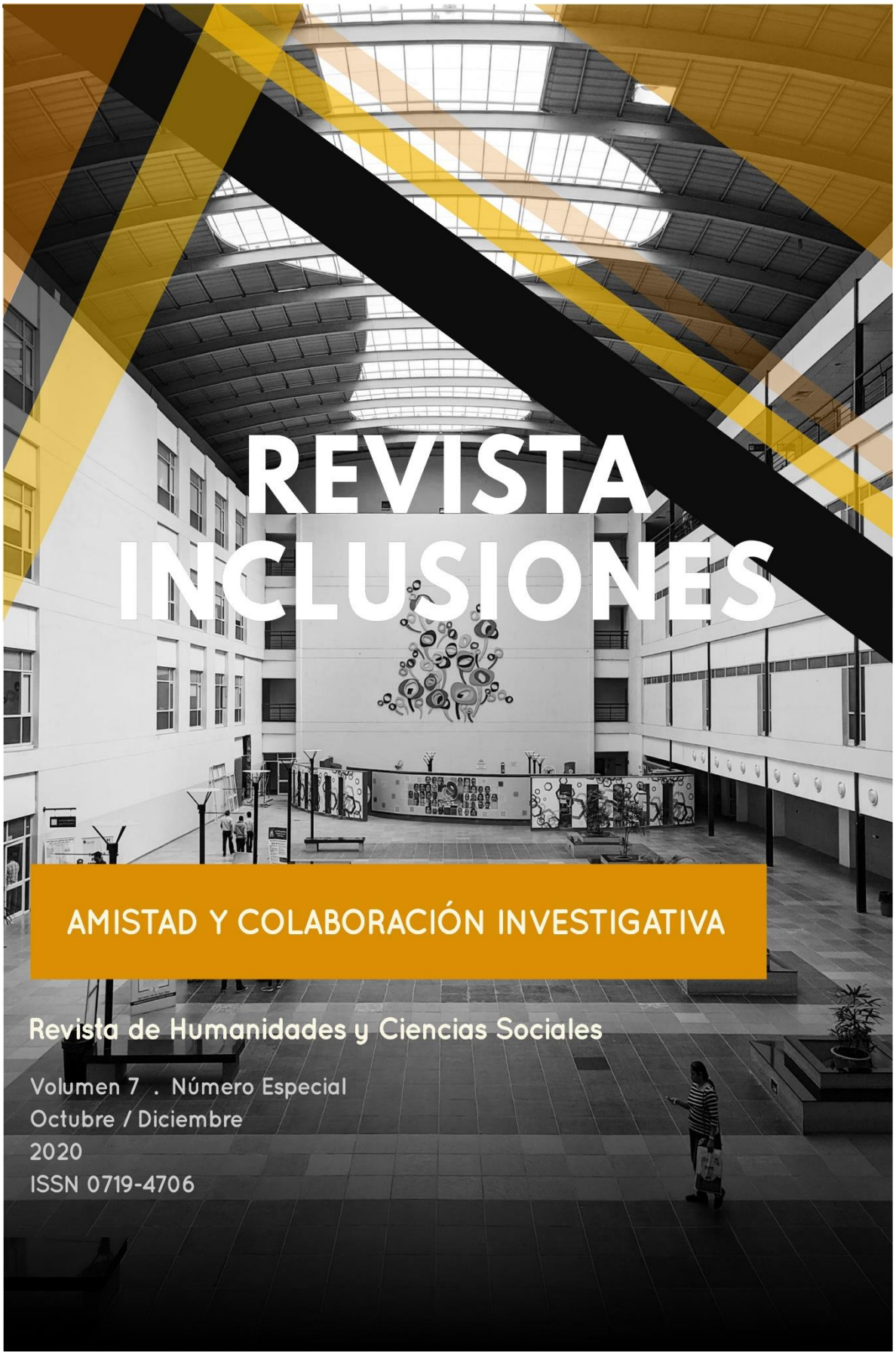

REVISTA INCLUSIONES

AMISTAD Y COLABORACIÓN INVESTIGATIVA

Revista de Humanidades y Ciencias Sociales

Volumen 7 . Número Especial
Octubre / Diciembre
2020
ISSN 0719-4706

REVISTA
INCLUSIONES M.R.
REVISTA DE HUMANIDADES
Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA
EDITORIAL

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CUADERNOS DE SOFÍA EDITORIAL

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Indización, Repositorios y Bases de Datos Académicas

Revista Inclusiones, se encuentra indizada en:

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REVISTA INCLUSIONES M.R.
REVISTA DE HUMANIDADES Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA EDITORIAL

ISSN 0719-4706 - Volumen 7 / Número Especial / Octubre – Diciembre 2020 pp. 460-470

DEVELOPMENT OF HIGH TECHNOLOGIES IN INDUSTRY IN THE CONTEXT OF GLOBALIZATION: DIGITAL TWINS

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Fecha de Recepción: 11 de mayo de 2020 – **Fecha Revisión**: 02 de junio de 2020

Fecha de Aceptación: 05 de septiembre 2020 – **Fecha de Publicación**: 01 de octubre de 2020

Abstract

The aim of this study is a comparative analysis of the development of high-tech industries that are of global importance for the development and implementation of modern technologies. These technologies are a prerequisite for the presence of Russian enterprises in global high-tech markets, characterized by a shift in the center of gravity in the competition for the stage of development of high-tech products, at the stage of their production. In the modern world, due to the high development of IT, it becomes possible to increase the efficiency of traditional production complexes and achieve the best level of product quality. Applying the paradigm of digital production, with the help of modern IT, it is possible to create digital copies (twins) of individual parts of control objects, each of which describes one of the properties (subsystems, representations) of the object, while they give a complete description of the object in the aggregate, where digital twins are complex information technology systems that cover almost all levels of an automated process control system: from the level of terminal equipment to the level of enterprise resource planning.

Keywords

High technologies – Digital twins – Digital technologies – Competitive advantages

Para Citar este Artículo:

Gnezdova, Julia Vladimirovna; Grishina, Vera Tikhonovna; Rebrikoya, Nadezhda Vladimirovna; Kalugina, Svetlana Afanasyevna y Ramazanov, Ibragim Agaevich. Development of high technologies in industry in the context of globalization: digital twins. Revista Inclusiones Vol: 7 num Especial (2020): 460-470.

Introduction

For the first time, the Ministry of Economic Development calculated the share of high technologies and science in the economy in 2011, as the implementation of the May Decree of the President of the Russian Federation on long-term economic policy. This indicator amounted to 19.7%, the contribution of high technologies and science to GDP was consistently growing, but noticeably decreased to 21.3% in 2015. The indicator stopped at around 21.6% in 2016 and 2017. In Russia, the high-tech sector employs 15 million people and is gradually declining. More than 20% of all enterprises are located in Moscow, Moscow region, and Saint Petersburg. Currently, business comfort is one of the most important factors. Creative professionals, or the so-called creative class, choose places where they can realize themselves, where they have high incomes, interesting jobs, and a favorable climate. Russia purchases equipment and machine tools abroad, accounting for about 40% of imports. At the same time, domestic software manufacturers mainly focus on foreign markets, the volume of Russian software exports — $ 8.5 billion in 2017, since the capacity of the domestic market is small. In Russia, there is a development of such industries as robotics, machine tools, and manufacturing[1]. Today, industrial enterprises face the question: what is cheaper or more expensive, robots or people? Robots are cheaper for industrial enterprises than people in Europe and now in China, so they replace detailed routine operations. Moscow concentrates more than 15% of resources for the development of high-tech and about 20% of the contribution to the development and production of high-tech. The Moscow region and Saint Petersburg are also among the largest centers of the country. The centers of the 2nd level are mainly regions with the largest agglomerations. These include Tatarstan, Tyumen region, Krasnoyarsk territory, Perm territory, Bashkortostan, Samara and Novosibirsk regions[2].

Methods

The study provided a consistent analysis of high-tech industries in the economies of Russia and the world and their impact in the context of globalization. Comparative analysis and synthesis, scientific search, analogies, selection of the most valuable material from the original source were used. We based their conclusions on formal and logical, as well as statistical and experimental estimates. The results of the study revealed that production processes are becoming more and more digital. Creating digital duplicates was expensive and brought limited benefits before the emergence of profitable offers for data storage and processing[3]. When considering the business values that the digital twin potentially offers, companies should focus on issues related to strategic performance and market dynamics, including improved and longer product performance, faster design cycles, and the potential for new revenue streams.

[1] H. Park y S. O. Choi, “Digital innovation adoption and its economic impact focused on path analysis at national level”, Journal of Open Innovation: Technology, Market, and Complexity Vol: 5 num 3 (2019): 56.

[2] N. G. Sidorova; V. S. Osipov y A. G. Zeldner, “Import Substitution in Agriculture: Crises of Overproduction, Choice of Institutional Policy, Application of Behavioral Economics”, In: Solovev D. (eds) Smart Technologies and Innovations in Design for Control of Technological Processes and Objects: Economy and Production. FarEastCon 2018. Smart Innovation, Systems and Technologies Vol: 138. Springer, Cham. 2020

[3] B. I. Volostnov, “Vysokotekhnologichnye otrasli i proizvodstva: kriterii, kharakteristiki i usloviya razvitiya”, Problemy mashinostroeniya i avtomatizatsii num 4 (2017): 4-33.

Literature review

A recent survey by Industrial Analytics[4] among the management of industrial enterprises around the world showed that 45% believe it is important to introduce predictive and prescriptive analytics in production over the next three years and 34% consider such an introduction. Competition for a place in the new type of economy is extremely fierce. Russia does not have much time to successfully enter the international production chains at the stage of a new technological structure and integrate itself not as a raw material appendage of new industrial centers[5].

The main body of work concerns technical re-equipment and digitalization, as well as industry 4.0. These issues were considered in the works of D. Tulpa, N.G. Sidorova, V.S. Osipov, A.G. Zeldner, H. Park, S.O. Choi, C. J. Turner, W. Hutabarat, J. Oyekan, S. Ziyadin, S. Suieubayeva, and A. Utegenova.

The development of new technologies has activated the process of reformatting existing industrial complexes. The processes and systems that are already used in industry are hopelessly outdated. Fei Tao and Qi Qing-Lin explain that virtual models stimulate intelligent production by simulating solutions and optimizing from design to operation[6].

Such authors as A.I. Borovkov, V.M. Maruseva, Yu.A. Ryabov, K. Ponomarev; N. Kudryashov, N. Popelnukha, and A.E. Hassanien considered digital twins as systems.

Results

The share of high technologies in the economy of Russia and the world

It is not profitable for companies to compete with each other using basic technologies now and in the future. If, for example, one car manufacturer has released some unique headlights on the market, they will immediately be copied by a competitor, and the first manufacturer will not get any advantage. It will be possible to lead the markets by implementing some intellectual component in the product in the future. Importantly, the product should become personalized, and as little time as possible should be spent on its development.

Participants in the process, who strive to be competitive in future markets, are forced to react quickly to all changes and challenges. Companies, the reaction speed of which is lower than the rate of change in external conditions are squeezed out of high-tech markets: either the window of opportunity closes or the cost of products turns out to be inadequate to market expectations, as a result of which mass production becomes impractical. Changes in the industrial production index in dynamics are shown in Figure 1.

[4] Industrial Analytics 2016/2017. 2016. Retrieved from: https://iot-analytics.com/wp/wp-content/uploads/2016/10/Industrial-Analytics-Report-2016-2017-vp-singlepage.pdf

[5] J. V. Gnezdova; I. M. Kugelev; I. N. Romanova y J. A. Romanova, “Conceptual model of the territorial manufacturing cooperative system use in Russia”, Journal of Internet Banking and Commerce Vol: 21 num 4 (2016).

[6] F. Tao; M. Zhang y A. Y. C. Nee, Tsifrovoe intellektualoe proizvodstvo s dvoinym privodom (New York: Academic Press, 2019)

Information technologies today bring much less benefit to the Russian economy than agriculture. According to the conclusions of economists, 1.2 million people work in the IT sector, or 1.7% of the total employed population of the country. As a share of GDP (2.7%), the industry is significantly inferior to agriculture (4.4%), the financial industry (4.2%), and construction (6.4%), while the mining industry is lagging behind by as much as four times and is comparable only to energy supply (2.9%). According to these indicators, Russia lags behind the OECD countries by an average in 1.6 times and almost two or three times from the leading countries — South Korea, Sweden, and Finland[7].

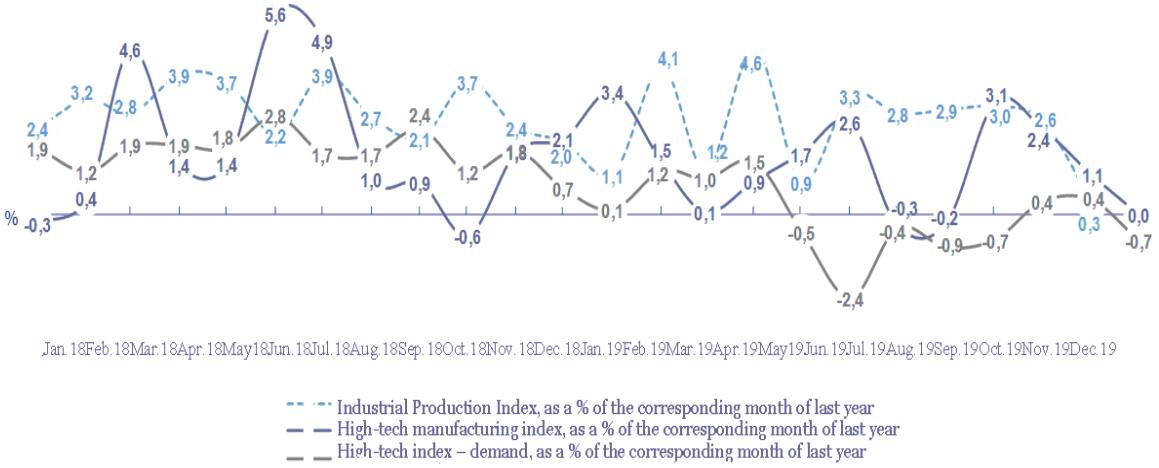

Figure 1[8]
Dynamics of industrial development indices

However, there are only three industrial robots per 10,000 workers in the Russian Federation, with an average of 69 robots worldwide and more than 100 robots in the leading countries in terms of digitalization. Similarly, the share of numerical control machines is more than 90% in Japan, more than 70% in Germany and the United States, about 30% in China, and only 10% in Russia in 2016, with forecast growth of up to 33% in 2020. Currently, South Korea is the leader – there are 631 robots per 10,000 people working there. Most of the machines are used in the automotive and electrical industries.

The cost of developing and implementing technological innovations in industrial production in 2018 amounted to 886.8 billion rubles, a decrease of 5.2% in constant prices from the previous year.

The total cost of innovation in 2018 changed slightly in organizations engaged in activities in the field of telecommunications and information technology. The intensity of expenditures on technological innovations (their share in the total volume of manufactured products) in industrial production in 2018 turned out to be 1.4%, there was a decrease in comparison with 2017 by 0.3 percentage points. Since 2014 – by 0.7 percentage points. The downward trend is typical for mining, production of petroleum products, tobacco products, and woodworking.

[7] T. G. Stroiteleva; E. Y. Kalinicheva; G. G. Vukovich y V. S. Osipov, “Peculiarities and problems of formation of industry 4.0 in modern Russia”, Studies in Systems, Decision and Control Vol: 169 (2019): 145-153.

[8] Federal State Statistics Service. Retrieved from: http://old.gks.ru/

The corresponding indicator is kept at 5% in high-tech industries (in the production of computers – 5.5%). The growth in the intensity of innovation expenditures is observed in paper production (in 2018 – 4.2%), chemical production (2.6%), beverage production (2.4%), and pharmacy (2.1%). The trend of increasing the indicator is similarly shown by organizations in the field of telecommunications and information technology (2.5% in 2018 against 2.3% in 2016-2017), agriculture (1.2% against 1% in 2017)[9].

The real volume of innovative products produced by industrial enterprises remained unchanged: in 2018 – 3.7 trillion rubles, which is 98.4% compared to last year (in constant prices). The change in the indicator is unstable: output declined in the period 2014-2015, it increased to the maximum value in 2016, and recently there has been a reduction in production, which is explained by a reduction in consumer and investment demand.

Russia can become one of the leaders in the use of artificial intelligence in-process production, which is traditionally the most developed in Russia: metallurgy, oil and gas, and chemistry. The development of an integrated end-to-end planning optimization system at oil refineries made it possible to increase the planned gross revenue by 2.4-4.7% – 35 million rubles of savings per year for one enterprise. Germany, being the world's industrial and technological center, has a robotics density of 309 units and ranks 3rd in the world. It takes over 36% of the annual robot deliveries from the total sales of EU countries. The German government plans to increase the volume of deliveries by 5% annually in 2018-2020 due to the growth of demand in the automotive sector. China remains the Asian dragon, leading in the number of not only people but also robots. The automation boom occurred between 2013 and 2016, which led to an increase in density from 25 to 68 industrial robots. Although some countries are still ahead of it: in terms of the density of robotization, China remains in the 23rd place. However, the government aims to move forward progressively and enter the top 10 most robotic states in 2020. Innovative Singapore, a city-country, remains in 2nd place: the density of robotization in 2016 was 488 units. Moreover, 9 out of 10 robots are used in the production of electronic devices. In Japan, the automation density is 303 units. It accounts for 52% of the world's supply as a leading manufacturer of robots. In 2016, Japan managed to produce 153 thousand units – a level that no other country could achieve[10]. The digital model of development involves the total digitalization of the economy and industry: the use of "smart models" and digital twins (smart digital twins) products, equipment, and production.

The concept of digital twins

Production processes are becoming increasingly digital. Many solutions could not be implemented before the advent of connected smart technologies. One of these solutions is the digital twins, a digital model of a physical object that works in real-time, which helps to increase business efficiency[11].

[9] C. J. Turner; W. Hutabarat; J. Oyekan y A. Tiwari, “Discrete Event Simulation and Virtual Reality Use in Industry: New Opportunities and Future Trends”, IEEE Transactions on Human-Machine Systems Vol: 46 num 6 (2016)

[10] S. Ziyadin; S. Suieubayeva y A. Utegenova, “Digital Transformation in Business”, Lecture Notes in Networks and Systems (2020).

[11] S. Bakardzhieva, “Gibridnyi tsifrovoi dvoinik: dva v odnom”, Umnoe proizvodstvo Vol: 4 num 48 (2018): 39-44. Retrieved from: https://digitaltwin.ru/media/resources/DTwins_Umnoe_Proizvodstvo.pdf

Today, when mass digitalization occurs, the term "digital twin" is increasingly used. Indeed, it is with the help of pre-designed digital counterparts that the leaders of the world's high-tech markets generate guaranteed development. The concept of a virtual representation of a physical object has been used for more than a decade. However, the development of information technologies has changed dramatically in recent years[12].

Digital twins are designed to simulate complex processes or products that interact in different ways with an environment for which it is difficult to predict outcomes throughout the product lifecycle[13]. Digital twins can be created in a variety of contexts for different purposes. For example, digital twins are sometimes used to model complex products, such as jet engines and large mining trucks, to monitor and evaluate wear and specific types of stress when using the product in the field. Such digital twins can provide important information that could influence the design of future products. The digital twin serves as a virtual copy of what is actually happening in production in real-time. Thousands of sensors distributed throughout the physical manufacturing process jointly collect data on a wide range of measurements: from the behavioral characteristics of production equipment and design (thickness, color quality, hardness, torque, speed, etc.) to the environmental conditions within the plant itself. This data is constantly transmitted and combined by the digital twin software[14].

In addition to the business value areas mentioned above, a digital twin can help achieve many other key performance indicators for a manufacturing company. In general, a digital twin can offer a variety of applications to increase costs and dramatically change the way a company works.

The digital twin is a leading industry trend and finds application in everyday life. Some experts distinguish three types of twins: Digital Twin Prototype (DTP), Digital Twin Instance (DTI), and aggregated twins (Digital Twin Aggregate, DTA).

"Digital twins have become a really powerful catalyst for the development of modern companies. Thanks to them, technical support of the system is significantly simplified, resources are saved, and the risks of errors and failures are minimized, which extends the stable operation of the product. All this allows the business to get the maximum possible return on investment, increase competitiveness, and intensify customer loyalty"[15]. The use of digital twins helps companies save up to 20% on capital costs. The technology is also in demand in the engine industry, transport industry, and mechanical engineering.

[12] A. I. Borovkov; V. M. Maruseva y Yu. A. Ryabov, "Umnye" tsifrovye dvoiniki — osnova novoi paradigmy tsifrovogo proektirovaniya i modelirovaniya globalno konkurentosposobnoi produktsii novogo pokoleniya. Tramplin k uspekhu num 13 (2018): 12–16. Retrieved from: http://assets.fea.ru/uploads/fea/news/2018/04_april/12/tramplin-uspeha_13-16.pdf

[13] A. M. Dumitru; V. Merticariu y P. Baumann, Array Database Scalability: Intercontinental Queries on Petabyte Datasets. In: Proceedings of the 28th International Conference on Scientific and Statistical Database Management. ACM, 2016.

[14] K. Ponomarev; N. Kudryashov y N. Popelnukha, Main Principals and Issues of Digital Twin Development for Complex Technological Processes. In: Proceedings of the 28th DAAAM International Symposium. 2017.

[15] L. E. Varshavsky, “Issledovanie dinamiki pokazatelei rynkov vysokotekhnologichnykh proizvodstv s ispolzovaniem metodov teorii upravleniya i dinamicheskikh igr”, Vestnik TsEMI num 1 (2018): 15.

The level of readiness of this sub-technology in Russia is estimated at "6-9" with the maximum possible value of "9". The level of readiness in the world is "7-9". The traditional PLM (Product Lifestyle Management) market is estimated at $ 7.7 billion in the US, $ 3.82 billion in Japan, $ 3.75 billion in Germany, and the market will grow by 6% annually until 2022. A list of end-to-end companies and organizations within certain end-to-end digital technology markets is shown in Table 1.

Market	Type of production	Leading companies	Revenue, billion rubles
Manufacturing activity	Manufacturing activities	State Corporation "Rostech"	1,589
	Manufacturing activities	State Corporation "Rosatom"	821
	Metallurgical production	PJSC "Severstal"	458
	Manufacture of helicopters, airplanes and other aircraft	PJSC "UAC"	452
	Construction of ships, vessels, and boats	JSC "USC"	326
	Manufacture of helicopters, airplanes and other aircraft	JSC "Helicopters of Russia"	244
	Manufacture of motor vehicles, trailers, and semi-trailers (including the manufacture of engines for motor vehicles)	PJSC "AVTOVAZ"	226
	Metallurgical production	JSC "West Siberian Metatlurgical Plant"	181
	Manufacture of aircraft, including spacecraft, and related equipment	State Corporation for Space Activities "Roscosmos"	27
Extraction of minerals	Crude oil production	PJSC NK "Rosneft"	4879
	Wholesale trade of solid, liquid and gaseous fuels and similar products	PJSC "Gazprom Neft"	1347
Transportation and storage	Railway transport activities intercity and international passenger transportation	JSC "Russian Railways"	2252
	Transportation of oil and oil products through pipelines	PJSC "Transneft"	854

Table 1[16]

List of end-to-end companies and organizations within specific end-to-end digital technology markets

The introduction of digital twins in engine building is of great importance. Modern products of design bureaus of enterprises have already been fully digitized. Digital twins are used in the design, production, operation of engines, as well as a promising high-thrust engine, marine gas turbine engines.

[16] Dva v odnom: dlya chego zavodu nuzhen tsifrovoi bliznets. RBK Tsifrovaya Rossiya. Retrieved from: http://digital-russia.rbc.ru/article-page_11.html

Digital twins are a useful tool for industrial enterprises. Half of all large industrial companies will use digital twins by 2021; the global market for digital twins will reach $ 16 billion by 2023[17].

Digital twins can significantly enhance the ability of enterprises to make proactive decisions based on data, increase their efficiency, and eliminate potential problems. They can also provide an opportunity to work out what-if scenarios in a safe and cost-effective manner — essentially experimenting with the future. In Europe, in particular, in Germany, the volume of full-scale tests has been reduced by more than 50 times in 5-7 years as a result of the introduction of digital twins, and the volume of virtual tests had to be increased by 100-200 times. At the same time, the number of teams that can do this has decreased 10-fold[18].

One of the illustrative examples of the introduction of the "digital twins" technology is the project of one of the world's largest oil refining complexes, Reliance Jamangar in India. A comprehensive approach to digital transformation, which included the creation of the "twin", allowed the company to become the most efficient oil refining and petrochemical complex in the world according to the Shell benchmarking. As a result, Reliance Jamangar now has the lowest maintenance costs, an index of energy consumption and product losses, and the highest operational efficiency, labor productivity, and return on investment[19].

Panorama project for the implementation of digital twin technology at ADNOC (Abu Dhabi National Oil Company) enterprises. The Twin brings together a complex of assets of the key operator of the oil and gas industry in the region, scattered throughout the Middle East, collecting data from more than 20 enterprises into a single dispatch center. "The solution based on our platform included predictive analytics, real-time visualization, a system for modeling energy consumption, incidents, and various scenarios of the enterprise"[20].

Conclusion

The creation and use of models are carried out under special control in critical applications such as weapons or the nuclear industry. At the same time, this problem becomes particularly relevant due to the fact that digital twins in the near future will be used not only for modeling or prototyping complex objects during their development but also to increase the efficiency parameters during operation in other areas of application. The introduction of digital twins also affects the activities of specialists, radically changing the ratio of designers and calculators.

[17] D. Tulpa, “Primenenie iskusstvennogo intellekta v promyshlennosti: Predposylki i vozmozhnosti”, Instrumenty konstruktora-tekhnologa num 1 (2020): 26-30. Retrieved from: https://digitaltwin.ru/media/resources/Dtwins.pdf

[18] C. Petty, Prepare for the Impact of Digital Twins. Smarter With Gartner. 2017. Retrieved from: https://go.nature.com/2krzbjd.

[19] S. Kher, “Chislennoe modelirovanie – osnova tekhnologii tsifrovykh dvoinikov”, Cadfem Review num 4 (2017): 8-11. Retrieved from: https://digitaltwin.ru/media/resources/cadfem_review_dt.pdf

[20] A. E. Hassanien; A. T. Azar; V. Snasel; J. Kacprzyk y J. H. Abawajy, Big data in complex systems: challenges and opportunities (Springer, 2015)

The advantages of new technical capabilities are obvious to all market participants. The manufacturers and governments of virtually all countries claiming to be industrialized understand this. In particular, China counts on the development of the artificial intelligence industry, perceiving it as an engine of economic growth and a factor of competitiveness of Chinese industry instead of cheap labor.

References

Bakardzhieva, S. “Gibridnyi tsifrovoi dvoinik: dva v odnom”. Umnoe proizvodstvo Vol: 4 num 48 (2018): 39-44. Retrieved from: https://digitaltwin.ru/media/resources/DTwins_Umnoe_Proizvodstvo.pdf

Borovkov, A. I.; Maruseva, V. M. y Ryabov, Yu. A. "Umnye" tsifrovye dvoiniki — osnova novoi paradigmy tsifrovogo proektirovaniya i modelirovaniya globalno konkurentosposobnoi produktsii novogo pokoleniya”. Tramplin k uspekhu num 13 (2018): 12–16. Retrieved from: http://assets.fea.ru/uploads/fea/news/2018/04_april/12/tramplin-uspeha_13-16.pdf

Dumitru, A. M.; Merticariu, V. y Baumann, P. Array Database Scalability: Intercontinental Queries on Petabyte Datasets. In: Proceedings of the 28th International Conference on Scientific and Statistical Database Management. ACM. 2016.

Dva v odnom: dlya chego zavodu nuzhen tsifrovoi bliznets. RBK Tsifrovaya Rossiya. Retrieved from: http://digital-russia.rbc.ru/article-page_11.html
Federal State Statistics Service. Retrieved from: http://old.gks.ru/

Gnezdova, J. V.; Kugelev, I. M.; Romanova, I. N. y Romanova, J. A. “Conceptual model of the territorial manufacturing cooperative system use in Russia”. Journal of Internet Banking and Commerce Vol: 21 num 4 (2016).

Hassanien, A. E.; Azar, A. T.; Snasel, V.; Kacprzyk, J. y Abawajy, J. H. Big data in complex systems: challenges and opportunities. Springer. 2015.

Industrial Analytics 2016/2017. 2016. Retrieved from: https://iot-analytics.com/wp/wp-content/uploads/2016/10/Industrial-Analytics-Report-2016-2017-vp-singlepage.pdf

Kher, S. “Chislennoe modelirovanie – osnova tekhnologii tsifrovykh dvoinikov”. Cadfem Review num 4 (2017): 8-11. Retrieved from: https://digitaltwin.ru/media/resources/cadfem_review_dt.pdf

Park, H. y Choi, S. O. “Digital innovation adoption and its economic impact focused on path analysis at national level”. Journal of Open Innovation: Technology, Market, and Complexity Vol: 5 num 3 (2019): 56.

Petty, C. Prepare for the Impact of Digital Twins. Smarter With Gartner. 2017. Retrieved from: https://go.nature.com/2krzbjd.

Ponomarev, K.; Kudryashov, N. y Popelnukha, N. Main Principals and Issues of Digital Twin Development for Complex Technological Processes. In: Proceedings of the 28th DAAAM International Symposium. 2017.

Sidorova, N. G.; Osipov, V. S. y Zeldner, A. G. Import Substitution in Agriculture: Crises of Overproduction, Choice of Institutional Policy, Application of Behavioral Economics. In: Solovev D. (eds) Smart Technologies and Innovations in Design for Control of Technological Processes and Objects: Economy and Production. FarEastCon 2018. Smart Innovation, Systems and Technologies Vol: 138. Springer, Cham. 2020.

Stroiteleva, T. G.; Kalinicheva, E. Y.; Vukovich, G. G. y Osipov, V. S. "Peculiarities and problems of formation of industry 4.0 in modern Russia". Studies in Systems, Decision and Control Vol: 169 (2019): 145-153.

Tao, F.; Zhang, M. y Nee, A. Y. C. Tsifrovoe intellektualoe proizvodstvo s dvoinym privodom. New York: Academic Press. 2019.

Tulpa, D. "Primenenie iskusstvennogo intellekta v promyshlennosti: Predposylki i vozmozhnosti". Instrumenty konstruktora-tekhnologa num 1 (2020): 26-30. Retrieved from: https://digitaltwin.ru/media/resources/Dtwins.pdf

Turner, C. J.; Hutabarat, W.; Oyekan, J. y Tiwari, A. "Discrete Event Simulation and Virtual Reality Use in Industry: New Opportunities and Future Trends". IEEE Transactions on Human-Machine Systems Vol: 46 num 6 (2016).

Varshavsky, L. E. "Issledovanie dinamiki pokazatelei rynkov vysokotekhnologichnykh proizvodstv s ispolzovaniem metodov teorii upravleniya i dinamicheskikh igr". Vestnik TsEMI num 1 (2018): 15.

Volostnov, B. I. "Vysokotekhnologichnye otrasli i proizvodstva: kriterii, kharakteristiki i usloviya razvitiya". Problemy mashinostroeniya i avtomatizatsii num 4 (2017): 4-33.

Ziyadin, S.; Suieubayeva, S. y Utegenova, A. Digital Transformation in Business. Lecture Notes in Networks and Systems. 2020.

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