Potential of Digital Solutions in the Manufacturing Sector of the Russian Economy

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Summary

The purpose of the article is to identify priority trends of technological innovations and strategic opportunities for using the smart potential to the benefit of the Russian industrial production development in the context of digital transformation. The article substantiates the demand for technological process automation at industrial enterprises in Russia and considers the possibilities of using artificial intelligence and the implementation of smart manufacturing in the industry. The article reveals the priorities of the leading Russian industrial companies in the field of digitalization, namely, an expansion of the use of cloud technologies, predictive analysis, IaaS services (virtual data storage and processing centers), supervisory control, and data acquisition (SCADA), etc. The authors give the characteristics of the monitoring of the smart manufacturing systems development indicators in the Russian Federation, conducted by Rosstat since 2020; presents projected data on the assessment of the required resources in relation to the instruments of state support for the development of smart manufacturing technologies for the period until 2024. The article determines targets for the development of smart technologies within the framework of the Federal Project "Digital Technologies".

1. Introduction

Global virtualization of production, new challenges, and tasks of informatization of society force contemporary industrial companies to radically change their in-house production processes to maintain a competitive position in the market. Today, standard approaches to production management do not guarantee sustainable profitability of the business.

The concept of smart manufacturing and smart factories is aimed at combining machines, people, information, and value chains into a single network. By giving a new impetus to labor productivity, this concept predetermines new opportunities for improving performance efficiency.

Literature review

In modern literature, scientific interest in new production technologies is vividly manifested. The theoretical framework of the article is based on research in the field of digitalization of industrial production [1-10] and implementation of smart technologies [11-18]. From the perspective of the problem under study, the works of some researchers, in particular [19-23] present a significant interest. Besides, the present research involved materials from Internet sources [24-28]. Despite the variety of directions and approaches to the concerned subject, in our opinion, the existing variety of works do not comprehensively discover the main priorities of modern smart industries, which indicates the need for further scientific research in the subject area under consideration and makes this topic relevant.

The scientific significance of the present research is determined by high-tech innovations, non-standard solutions, and modern tools for managing production systems are systematized; target indicators of the main technological trends in the development of smart industries are specified, and development areas of the smart potential of Russian industry are substantiated.

The practical significance of the research is due to:
- identification of the strategic possibilities of using the smart potential to the benefit of the Russian industrial production development in the context of digital transformation;
- usefulness of scientific conclusions and research outcomes to the management of industrial companies in determining technological trends in the development of smart manufacturing.

2. Methods

The research methods combined comparative and system analysis, as well as qualitative and quantitative approaches. The analysis of priority trends in technological innovations and strategic opportunities for using the smart potential to the benefit of the Russian industrial production development was carried out through general scientific methods of systems theory, abstraction, formalization, as well as special methods of utility theory and decision theory. The level of satisfaction with the software of Russian

industrial companies was determined by a multi-criteria expert assessment, taking into account criteria of functionality, usability, productivity, work stability, and integration with other IT products. The methodologies of system and process approaches were used to solve the tasks set.

3. Results and Discussion

The manufacturing sector is characterized by conservatism. Unlike in the financial sector, the implementation of innovations here is slow. Thus, while new participants and new tools, such as fintech accelerators and their residents appear in the financial sector out of startups that have developments in the areas, such as authentication solutions and technologies, mobile acquiring, e-commerce, virtual banking, Big data, online scoring, p2p lending, contactless technologies for electronic wallets, blockchain technologies, Internet of Things (IoT), smart contracts, crow technologies, risk management technologies, artificial intelligence, etc. [29], in the manufacturing sector, some companies expect the results of using smart technologies from the advanced leaders, while others are limited in finances and do not dare to invest in modernization. The most short-sighted companies simply do not see the point in it [29-31]. One can endlessly deny the need for a digital upgrade, but the fact remains that smart manufacturing has a perspective and a future. The refusal of managers from technological transformations slows down the process of digitalization and is a threat to the loss of the country's competitiveness on the world stage. The pandemic has certainly had an impact on the ongoing changes in the manufacturing sector. On the one hand, strengthening and improving control allowed increasing productivity by reducing human influence, accelerating the restoration of disrupted supply chains, and returning consumer and investment demand to pre-crisis levels. On the other hand, the problems of digital immaturity of most companies have been exposed. The results of the conducted research indicate the high cost of digital transformation projects, insufficient level of digital maturity of employees, and disruption of supply chains. The current circumstances forced companies to accelerate the process of transition from automation to digitalization. Besides, the lack of investment resources and the understanding of the importance of technology modernization led to a revision of the internal digital strategies of companies.

Modern smart manufacturings automate technological processes as much as possible, thereby infinitely expanding the possibilities for improving the activities of manufacturers.

The manufacturing industry in Russia is increasingly moving away from Soviet stereotypes, characterized by noisy production, a large production team, and outdated equipment. Enterprises increasingly rely on innovations aimed at optimizing costs and accelerating business processes, increasing productivity and production efficiency, improving product quality, etc. [4,32,33].

Digitalization of production projects is actively promoted in the Russian Federation. This concerns new factories being built within the framework of the Industry 4.0 concept, machine learning, and artificial intelligence being introduced. Cost-effective projects become of particular interest.

The implementation of machine vision technology for sorting manufactured products in Sibur company has increased the level of production automation and eliminated the risk of product mixing.

The analytical logistics management system based on artificial intelligence minimized the timing of planning and coordination of oil shipment operations and optimized transportation costs in Gazprom Neft company.

The constant increase in the cost of production, the presence of a mature market, the retention of competitive positions in the long term, the desire of enterprises to increase the marginality of business – all this encourages enterprises to implement smart technologies. Enterprises, interested in digital technologies, prefer the following types of solutions: accurate digital modeling of all elements of the production process; analytics and Big Data; as well as orchestration of all production systems (both production and non-production). Besides, the stability of the systems against external impacts and cybersecurity are highly demanded. Additive technologies for growing products augmented and virtual reality, manufacturing execution systems (MES), machine vision systems, operating digital twins, predictive analytics systems, etc. are also popular.

Today, the Russian manufacturing sector is focused on the use of virtual data storage and processing center (basic IaaS services). This is due to a large number of existing "patchwork automation" (legacy IT systems), operating according to various standards and protocols. It is either difficult or simply impossible to operate with the data of such systems.

However, the IT structure of large production facilities is saturated with a huge amount of data that requires both storage and processing. There are often problems of territorial fragmentation of production sites, full provision of IT facilities, and, accordingly, proper qualifications of IT specialists. In this regard, cloud technologies are in demand in the industry, where critical data is processed on-site, and the rest of the data are used by IaaS solutions of cloud providers.

The mass implementation of enterprise resource planning (ERP) systems, centralized supervisory control and data acquisition (SCADA), and manufacturing execution system (MES) increases the range of IaaS services and PaaS solutions on the market.

So far, only large Russian enterprises have access to digital twin technologies, predictive analytics, the Industrial IoT, and data science-based solutions [7,34].

A multi-criteria expert assessment of the level of satisfaction with the software of Russian industrial companies gives the following results (Fig. 1).

Russian analogs								Foreign analogs							
Assessment criteria	ERP	PDM	PLM	MDM	MES	SCADA	WMS	Assessment criteria	ERP	PDM	PLM	MDM	MES	SCADA	WMS
Functionality	4	4	4	4	4	4	4	Functionality	5	4	5	5	5	5	4
Ease of use	4	4	4	4	4	4	4	Ease of use	4	4	4	5	4	5	4
Productiveness	4	4	4	4	4	4	4	Productiveness	4	4	4	5	4	5	4
Stability of operation	4	4	4	4	4	4	4	Stability of operation	5	4	4	5	4	5	4
Possibilities of integration with other IT products	4	3	4	3	4	3	3	Possibilities of integration with other IT products	3	4	4	4	4	3	4
Final assessment	20	19	20	19	20	19	19	Final assessment	21	20	21	23	21	23	20

Fig. 1. Multi-criteria expert assessment of the level of satisfaction with the software of Russian industrial companies

Russian ERP, MDM, and MES systems are the most competitive among the analyzed software products. Unlike them, Russian PDM, PLM, and SCADA class systems are less in demand on the market, which is primarily due to the importance for consumers of having end-to-end solutions that are less developed in Russian software.

For the digitalization of the manufacturing sector in 2021, it is important to switch from a variety of local IT solutions to unified platforms and standards and, accordingly, to transfer infrastructure to the cloud. The pandemic period has proved the relevance and importance of ensuring the operability of production systems in crisis conditions. Many manufacturers will think about increasing the automation of production processes and ensuring comprehensive personnel safety. Justifiably, contactless technologies, intelligent cloud video surveillance systems, and AI analytics of production processes will become more popular. Such solutions will not only establish a system of rapid response to crisis developments, but also help to correctly predict them, which, ultimately, will reduce financial losses and, without a doubt, will ensure the growth of business efficiency and competitiveness.

To monitor the development of smart manufacturing systems in the Russian Federation, Rosstat defined the form "Information on the development and (or) use of advanced production technologies" (Order 424 dated 30.07.2020), required to be filled in by enterprises developing and using advanced production technologies. The scope of activity of these industries is very wide, it covers manufacturing, mining, provision of energy resources, information sector, architecture, communications, engineering, technical design, etc. According to this form, enterprises need to provide the information concerning:
- the development of advanced production technologies in the reporting year (section 1);
- use of advanced manufacturing technologies (section 2);
- effects of the implementation of advanced manufacturing technologies (section 3);
- implementation of the technological strategy of the organization (section 4);
- factors, hindering the implementation of advanced production technologies (section 5).

Fig. 2 shows the projected data on the assessment of the required state support resources for the development of smart manufacturing technologies for the next three years, while the total amount of funding is 18,910.00 mln rubles [6].
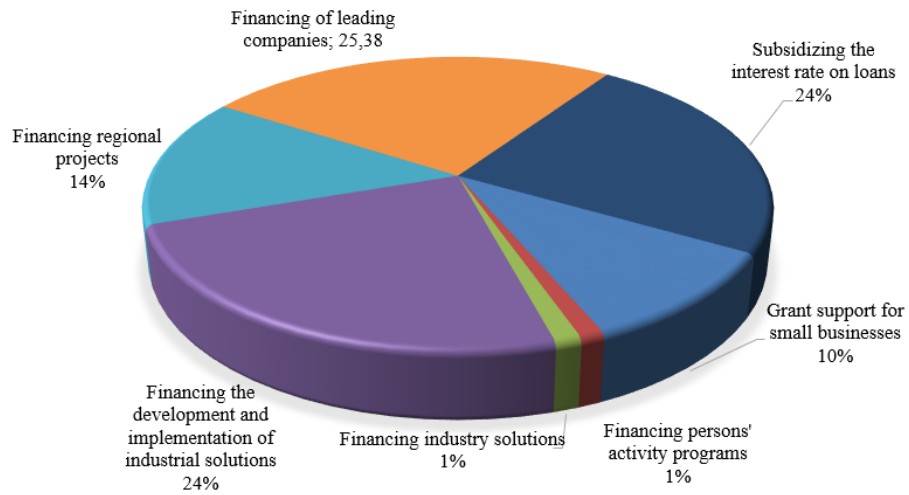
Fig. 2. The projected assessment of the required resources in relation to the instruments of state support for the development of smart manufacturing technologies, %

Most of the resources are provided for financing industrial solutions (4,520 mln rubles), support for leading companies (4,800 mln rubles), and using subsidizing the interest rate on the loan (4,510 mln rubles).

The state demonstrates its interest in promoting the digitalization of the manufacturing sector. For example, the Ministry of Industry and Trade of the Russian Federation is currently working on creating a marketplace for industrial software. The project was named "Modular Multiservice Industrial Platform".

The complex of software and hardware that provides a single development environment, use and distribute business applications and systems employing modern digital technology, includes common data exchange formats and protocols, regulations and requirements of the industries, a platform for developers, and a distribution model (Fig. 3).

A functional diagram of the interaction of a large number of concerned participants through the use of consolidated solutions unified development environment, use and distribution of business applications and systems are presented in Fig. 4.

The Modular Multiservice Industrial Platform site will present software for production process management, product design, dispatch control, data collection, etc. Interested companies will be able to receive software on the platform by subscription, compensating part of the costs through subsidies.

Common data exchange formats and protocols	Developer platform, environment, and repository
Forming requirements by enterprises	Forming a distribution model (IaaS, PaaS, SaaS, transition from a license to a subscription model)

Fig. 3. Software and hardware complex of a modular multiservice industrial platform
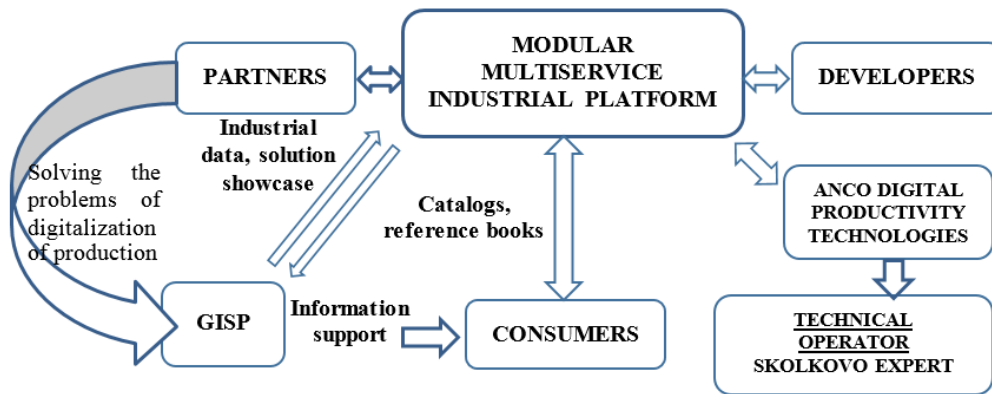
Fig. 4. Functional scheme of interaction of a large number of concerned participants through the use of consolidated solutions of a single environment

The idea of creating a Modular Multiservice Industrial Platform will help to solve the problem of technical dependence on foreign engineering and industrial software. Besides, Russia was the first in the world to approve standards in the field of digital twins, namely, GOST R 57700.37-2021 "Computer models and modeling. Digital twins of products. General provisions", PNST "smart manufacturing. Catalogs of hardware behavior for a virtual production system. Part 1. General provisions", PNST "Production automation systems and their integration. Assessment of convergence of informatization and industrialization for industrial enterprises. Part 1. Structure and typical model". Developing standards will allow forming common technical requirements in the field of smart manufacturing for all high-tech companies that ultimately aim at forming the technological superiority of the Russian industry.

The Ministry of Industry and Trade of the Russian Federation initiated the following projects of digital transformation of manufacturing industries in Russia: smart manufacturing, Digital Engineering, Products of the Future, New Employment Model, and the departmental digital transformation program Transition to Digital Public Administration.

It is predicted that by 2024, about 30% of industry workers will actively use digital platforms; maintenance costs for high-tech products will be reduced (by about 25%) due to the use of predictive analytics technology and the transition from "repair according to regulations" to "repair according to condition"; the return on funds will be increased by half due to the use of cooperative chains; forced downtime of production capacities will be reduced by 45%; the timing of the launch of high-tech products to the market will be narrowed (up to 1.5 times) due to the recognition of the results of virtual tests, and the payback period for investments in Russian production will decrease by 30%.

The target indicators reflecting the development of smart technologies within the framework of the Digital Technologies federal project predict significant growth (Table 1).

Table 1. Target indicators reflecting the development of smart technologies within the framework of the Digital Technologies federal project

Title	2021	2024
Human participation in the preparation and commissioning of production, % of all operations	85.0	65.0
Implementation of the MES system, not less than, units	-	1,000
The number of industry standards, units	2	4
Equipping with MDC systems*, %	50.0	70.0
The number of enterprises with digital certification, connected to State Industry Information System (SIIS) services, thousand units	5.8	14.4

*The MDC system provides real-time data acquisition from the equipment

According to data, presented in Table 1, it can be argued that it is planned to significantly reduce human involvement in the preparation and commissioning of production (from 85 to 65% of all operations). The number of enterprises with digital certifications, connected to SIIS services will increase almost 2.5 times (from 5.8 to 14.4 thousand units) [12].

4. Conclusion

Thus, summarizing the above the following can be noted.

Prerequisites for transiting enterprises to smart technologies include a constant increase in the cost of production, the presence of a mature market, the retention of competitive positions in the long term, the desire of enterprises to increase the marginality of business, testing of smart technologies by competitors, recognizing the return on investment and its transparency.

Digital modeling, analytics, and Big Data, cybersecurity, additive technologies, machine vision systems, digital twins, predictive analytics systems, etc. are highly demanded by contemporary production.

Since 2020, the development of smart production systems has been monitored in the Russian Federation, which provides for reporting on the development and use of advanced production technologies. Substantial state support for 18,910 mln rubles is provided for developing smart manufacturing technologies for the period up to 2024. Today, the Russian state actively supports and promotes the digitalization of the manufacturing sector. It is planned to launch a marketplace for industrial software, which will be able to solve the problem of technical dependence on foreign software. The first adopted standards in the field of digital twins will allow systematizing the general technical requirements in the field of smart manufacturing, which, ultimately, will allow laying the foundation for the technological superiority of Russian industry. Currently, the state is actively promoting digital transformation projects in the manufacturing sector of the Russian Federation.

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