

Transformation of the World Steel Market Under the Influence of General Industrialization and Digitalization of Industry



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Abstract: *The current global transition to a new phase of development under the influence of the Fourth industrial revolution is characterized by the emergence of end-to-end technologies, increasing the speed of introduction of new developments, reducing the life cycle of products, the emergence of new players, strengthening trends in digital transformation. Against the background of the formation of the digital economy, a limited group of leading countries focused on the use of renewable resources and possessing advanced production technologies is emerging.*

Keywords: *industrialization, digitalization, industry, steel market, transformation.*

I. INTRODUCTION

In recent years, Russia has made significant progress in the transition to a digital economy based on the development and use of digital technologies and data. The tasks of digitalization have firmly entered the national agenda of Russia and have acquired additional relevance in connection with the launch of three national programs that determine the vector of long-term scientific, technological and economic development: the national program "Digital economy of the Russian Federation", the National technological initiative (NTI) and the national project "Science" (on the implementation Of the strategy of scientific and technological development of the Russian Federation). A wide range of tools have been created that have shaped the ecosystem of sustainable development. Nevertheless, considerable efforts will be required for Russia to make a technological breakthrough and become a world leader in the field of digital economy [22]. The acceleration of the global technological race and intense competition create an environment in which urgent action is critical to implement breakthrough development in order to overcome the backlog of world leaders, the creation of globally demanded technologies, products and services of the new generation. One of the leading roles in solving this problem belongs to industrial complexes and their constituent industrial enterprises, whose total contribution to the GDP of the Russian Federation in 2017 amounted to 26.4 %.

Reindustrialization is a new industrial policy, which assumes the growth of the role of qualitative changes in the development of production and society, the active development of new economic sectors and the re - equipment of basic industries on a new technological platform.

One of the main drivers of economic growth in the conditions of reindustrialization is the development of industrial complexes mainly in the steel industries. The reason for this is that the manufacturing industry is changing the structure of the economy, providing a transition from labor-intensive economic activities to more capital-intensive and technologically capacious.

Object: the object of research are industrial complexes and their constituent enterprises. The subject of research is management and organizational-economic relations arising in the process of development of industrial complexes in the conditions of reindustrialization.

Methods: theoretical and methodological basis of research was a dialectical approach to the study of regularities of formation and development of systems, basic tenets of scientific methodology to study phenomena and processes, scientific empirical-theoretical methods of system analysis, abstraction, analysis and synthesis, induction and deduction, analogy, modeling, specification, historical and logical methods of research. As specific scientific methods, continuous and selective observation, methods of expert assessments, content analysis, cluster analysis, methods of detail, comparative, factor and correlation-regression analysis, the method of optimal solutions, the method of predictive extrapolation, the mathematical apparatus of genetic algorithms were used. The reliability of the obtained results is confirmed by the analysis of a significant number of empirical and theoretical works on the studied and interdisciplinary problems, the use of General scientific and special research methods, the approbation of the results of the study at industrial enterprises, the analysis of a representative sample of data.

Literature Review. The problems of reindustrialization of the economy are devoted to the works Fedonin O. V., Unru S. Ya., Nemkin M. V., Danilenko D. N., Kandaurov E. L.[3], Golubchik E. M [5,6], Kharitonov V. A., Stolyarov A. Yu [7], Lyapunov A. I., Aparova A. I. [8], Voronkin B. C.[9] and reports of production in 2014 [1], 2018 [2], global economic report 2019 [4] and global foundry report [10] etc.

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II. RESULT AND DISCUSSION

1. The main direction of the development of industrial complexes in the conditions of reindustrialization and digital transformation is the creation of integral ecosystems that comprehensively develop all actors of industry on the basis of cross-border interaction of business, the scientific community, the state and citizens.

In Russia, the recession of 2014-2015 was overcome and since 2016 there has been a positive dynamics of GDP, a small economic growth began. The index of industrial production of the Russian Federation, showing a decrease in dynamics in 2010-2014 and a negative value of the rate in 2015, in 2016-2017 shows a weak increase due to the raw materials sector and improvements in the global energy market. The gap between the raw materials and manufacturing industries in these conditions indicates the instability of the emerging recovery trend.

The driver of growth in the manufacturing industry is an increase in the state defense order, but not the overall recovery in the economy. The policy of import substitution has not yet led to medium-term growth in the manufacturing industries, and reindustrialization projects are implemented point-by-point, only in certain areas [20].

The problem of economic growth, especially in industry, remains urgent for the Russian economy. Its actually achieved pace at the present time can not provide breakthrough scientific and technological and socio-economic development of the country, the need for which is emphasized in the Decree of the President of the Russian Federation from 07.05.2018 "on national goals and strategic objectives of the development of the Russian Federation for the period up to 2024". From the point of view of the implementation of sound industrial policy, in the opinion of the author, it is necessary to build a structure based on the PC in the field of manufacturing [21].

Industrial complexes are represented as integral economic entities that combine a variety of socio-economic, scientific and technological, innovative, production processes and economic institutions in order to integrate and obtain synergistic effects. Industrial complexes are considered at five levels of management (table. 1).

Table 1 - forms of coexistence of industrial complexes at different levels of management

Mega	The meso-level 1 (mega-macro)	The makro-level	The meso-level 2
Global metasystem of world industrial production	Transnational industrial companies Global industrial clusters complexes of unions, communities or groups of countries Eurasian technology-platforms, etc.	Branch industrial complexes: military-industrial, agro-industrial, fuel and energy, machine-building, metallurgical, nuclear power industrial complexes, etc.	Territorial production complexes: special territories of economic development, clusters, technoparks, technopolises, industrial parks, etc. United corporations and other integrated structures Consortiums

At present, the ecosystem approach to management of development and transformation processes, which leads to the creation of transboundary economic systems of a new quality by analogy with natural processes and phenomena, is widely used. Within the framework of sustainable development, ecosystems are formed, which are complex mechanisms that interact closely with other elements of the environment.

The ecosystem of industrial complexes development is a set of economic development institutions, tangible and intangible assets (human capital and competencies, values, physical and service infrastructure, platforms and technologies, financial resources) in interaction with a variety of actors operating in markets and industries, providing effective interaction between organizations and people. The ecosystem of development of industrial complexes can be represented by three projections [23].

The interaction of actors (actors) takes place in the markets and industries; platforms and technologies form competencies for the development of PCs in the conditions of reindustrialization; the environment creates conditions for the development and effective interaction of actors.

The paper highlights the main conceptual provisions of the ecosystem approach to managing the development of industrial complexes [24]:

§ due to the analogy to natural systems, the development of industrial complexes in the conditions of reindustrialization can be viewed through the prism of ecosystems, the distinctive feature of which is the ability to internal dynamics and development under the influence of both endogenous and exogenous factors;

§ one of the main functions of the ecosystem of development of industrial complexes is the financing of research activities, technological re-equipment and other areas that affect the efficiency of development processes, as well as the qualitative improvement of the level of infrastructure development [25];

§ the main objective of the ecosystem should be to achieve a stable state with a stable homeostasis, that is, the desire and ability to maintain balance in the process of development of industrial complexes;

§ the ecosystem forms and carries out the changes necessary for the output of industrial complexes to a new stability as a whole with the preservation, accumulation and transformation of the necessary qualities;

§ the ecosystem allows to form positive feedback, provides interaction between all actors involved directly or indirectly in the process of development of industrial complexes. Positive feedback occurs when the exchange of ideas, people, information, cooperation and symbiosis become more important than the traditional logic of economic competition;

§ the ecosystem of development of industrial complexes implies the presence of several ecosystems (academic, educational, technological, economic, innovative, expert and others) and their synergistic interaction [19].

2. The methodology of management of PC development in the conditions of reindustrialization allows to obtain theoretical knowledge for the developed scientific and practical tools, including a methodological approach to the assessment of technological development and scenarios of scientific and technological development of PCs in the long term [18]. Development management of industrial complexes is based on the laws of dialectics and development of economic systems, as well as selected principles that can be classified in six groups (tab. 2).

Along with the classical laws and the selected principles, the methodology for managing the development of industrial complexes in the conditions of reindustrialization, which is a unity of theoretical positions, mechanisms, estimates of the effectiveness and efficiency of management.

To improve the manufacturability of production contributes to the re-industrialization in the age of digital economy. Countries that have successfully carried out rapid reindustrialization and achieved sustainable economic growth have managed to create a developed technologically capacious manufacturing industry. Under these conditions, the author developed a methodological approach to assessing the level of technological development of industrial complexes, including the following stages [17]:

Stage 1. Standardization of indicators. The basic principles for the construction of the integral index are the principles of measurability and accessibility of information, pragmatics of calculations and analyticity.

Stage 2. Differentiation of indicators. The system of indicators for assessing the level of technological development of PCs and their constituent enterprises consists of five domains (groups of indicators) and thirty-three indicators.

Table 2 Principles of management of development of industrial complexes

I Principles of system-strategic approach	II Principles of strategic forecasting and planning	III Principles of strategic management	IV Principles of sustainable development of industrial complexes
1.1 the unity and integrity 1.2 multifunctionality 1.3 hierarchy 1.4 multiplicity of solutions and complexity of development 1.5 self-organization 1.6 nonadditivity	2.1 continuity and 2.2 balance 2.3 effectiveness and efficiency 2.4 transparency (openness) 2.5 realistic 2.6 resource security 2.7 measurability of goals 2.8 compliance	3.1 openness 3.2 integrated approach 3.3 future orientation 3.4 creative, creative approach 3.5 results orientation 3.6 collaboration and joint activities	4.1 inclusivity (involvement) 4.2 adherence to ethical standards 4.3 responsible management 4.4 transparency 4.5 continuity 4.6 flexibility 4.7 compliance with

	of indicators with objectives		sustainable development goals
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Stage 3. Calculation of complex integral estimates (sub-indices K_j) for each of the j -th group of indicators ($j=1...5$), characterizing technological development.

Stage 4. Calculate the final composite index by weighing and finding the average of the sub-indices.

The value of the index of technological development of industrial complexes is interpreted as follows: the more the integral indicator tends to one, the higher the level of technological development of a particular industrial complexes. The index in the range (0; 0,3) is considered extremely low, in the range [0,3; 0,4) - low, in the range [0,4; 0,6) - average, in the range [0,6; 0,7) - high, in the range [0,7; 1] - extremely high.

The level of technological development of industrial complexes is on the average and below the average level depending on the domain and decreases in the period 2012-2016 annually (from 0.353 to 0.326). In 2017, there is a small increase in the index of technological development.

In the framework of forecasting the development of industrial complexes in justified the following scenarios of scientific and technological development of the PC of the Russian Federation and their conditions [16]:

§ target forced scenario of breakthrough scientific, technological and socio-economic development (scenario 1). Implementation of the National technology initiative until 2035, introduction of end-to-end technologies. The formation of the digital economy on the way to the knowledge economy is a development priority for the state and business. Stimulating the development of small and medium-sized businesses on the basis of large high-tech companies. Scenario of technological breakthrough, reindustrialization, lagging behind the leaders of less than 5 years. The share of the digital economy is 5.6 % of GDP. Added value for the economy - 5-7 trillion rubles per year [15];

§ innovative (scenario 2) - a variant of catch-up development and local technological competitiveness. The growth of digitalization in the public and social sectors. Scenario of technological adaptation, lagging behind the leaders 8-10 years. The share of the digital economy is 3.0% of GDP. Added value for the economy - 0.8-1.2 trillion rubles per year;

§ conservative (scenario 3) - inertial scientific and technological development, stagnation of the economy, the growth of the digital divide with the leaders. Scenario of technological degradation, deindustrialization, lagging behind the leaders of 15-20 years. The share of the digital economy is 2.2 % of GDP. The added value for the economy is 0.1-0.2 trillion rubles per year [26].

The developed reference points of scenario conditions are presented in table. 3. Forecasting was carried out by extrapolation of statistical data, expert analysis of strategic goals of socio-economic and scientific and technological development.

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Table 3 Reference points of scenario conditions for forecasting scientific and technological development of industrial complexes of Russia

Indicator	Period	Scenario		
		3	2	1
Gross domestic product, annualized growth rate, %	2016 - 2020	3,6	4,4	6,8
	2021 - 2025	4,2	6	8,9
	2026 - 2030	4,8	7	10,0
Industry, average annual growth rate, %	2016 - 2020	2,0	3,4	5,3
	2021 - 2025	2,3	4	6,1
	2026 - 2030	2,3	4,9	7
Investments in fixed assets, average annual growth rate, %	2016 - 2020	5,1	6,6	12,6
	2021 - 2025	4,3	5,5	7,1
	2026 - 2030	3,6	4,8	4
Investments in transport infrastructure, technology and science, total, in percentage points, on average per year	2021 - 2025	0,6	1,4	1,8
	2026 - 2030	0,4	1,1	1,4
Investments in the development of technological industries, in percentage points, on average per year	2021 - 2025	0,3	0,5	0,7
	2026 - 2030	0,2	0,3	0,4
Investment in research and development, in percentage points, on average per year	2021 - 2025	0,1	0,4	0,5
	2026 - 2030	0,1	0,5	0,7
Investments in the development of technological industries from the budget system, in percentage points, on average per year	2021 - 2025	0,1	0,2	0,3
	2026 - 2030	0,1	0,3	0,4
High-tech and knowledge-intensive sector, % of GDP	2018	-	-	29
	2020	-	-	35
Labor productivity, % growth relative to 2015	2018	131	136	150
	2020	141	149	170
Domestic research and development expenditure, % of GDP	2025	1 - 1,1	3	7
	2030	1,3	3,5	10
The share of private expenditure as % of domestic expenditure on research and development	2025	>30	>30	-
	2030	<40	>35	50
The share of expenses for wages, % of spending on science	2030	36 - 34	<30	<30

In the process of development of industrial complexes, the emergence of bifurcation points (inflections of trends in scientific and technological development) and attractors as stable States that attract many trajectories of scientific and technological development after passing the bifurcation points is possible. The bifurcation point of making a breakthrough can be the optimal and effective integration of various of the world's best technologies with the addition of original cross-industry intellectual know-how, formed in the process of working with various industrial companies-world leaders in the framework of the international system of division of labor, participation in global technological chains.

3. A fundamental element of the methodology is the system of management of development of industrial complexes in the conditions of re-industrialization, providing an effective combination of management actions of the subject of management on object using the functions of the office, its content, methods and tools to correlate resource constraints and the results of management of development of industrial complexes [14]. We have developed a conceptual model underlying the formation of a management system for the development of industrial complexes in the conditions of reindustrialization and represented by three blocks [13].1.

The first block includes definition and statement of the purposes of process of management of development of industrial complexes and the enterprises entering into their structure. Such objectives include the following: maximizing the level of global leadership (competitiveness) in high-tech markets $GC \rightarrow max$; increase of level and life quality $LQ \rightarrow max$; the growth of labor productivity in the manufacturing industry $LC \rightarrow max$, employment growth in non-oil sectors $NoE \rightarrow max$. Improving the quality of life is achieved, inter alia, by reducing harmful emissions and improving the environmental friendliness of industrial production. The growth of employment in the manufacturing industry requires the correlation of technologies chosen for implementation with the availability of resources and the level of qualification of the workforce. In addition, a necessary condition for development is the presence of a favorable environment (ENV) and a formed ecosystem (SES) as a set of actors of industrial complexes, agents and services.

2. The second block is a continuous integrated process of managing the development of PCs and their constituent enterprises. Mega, mega-macro, macro, macro-micro, micro-levels of management (L), objects in accordance with the faces of the pyramid of the development environment (O), management functions (F), NTI markets (M), SCBIN (socio-cognito-bioinfo-nano) technologies (T), directions of digitalization in accordance with the program "Digital economy of the Russian Federation" (D), the stages of innovative (I) and production (P) processes along the value chain. The process of managing the development of industrial complexes ensures the principle of continuous development through the management of development at all levels: $L = L1 \cup L2 \cup L3 \cup L4 \cup L5$; the principle of integration through mutual penetration of elements of the development environment, i.e. $O = O5 \cup O6 \cup O7 \cup O8 \cup O9 \cup O$; the principle of complexity by combining nine functions: $F = F5 \cup F6 \cup F7 \cup F8 \cup F9 \cup F$; $U F < U F = U F >$



3. The last, third block of the conceptual model is associated with the reflection of the results and effects of development management and fixation of the resulting state of industrial complexes after the implementation of management processes. The achievement of the goals set in the first block in the third block ensures purposeful management of the development of industrial complexes and their constituent enterprises. The processes of development of industrial complexes both at the level of individual economic entities and at the level of industries, national and world economy determine the need for the formation of a special management system that ensures the consistent implementation of decisions aimed at ensuring global, innovative, inclusive, proactive and sustainable development of industrial complexes using intensifying factors.

The introduction of digital platforms in industrial manufacturing corporations guarantees an annual acceleration of GDP growth by at least 1 %. Other industries can additionally produce GDP growth of 0.1 % to 2 % per year each.

The introduction of digital platforms in industrial complexes will entail a digital transformation: the transition to a new paradigm of business and production, a change in thinking, business processes, competencies and the entire system of economic relationships. Under these conditions, digitalization covers a narrower range of tasks and means transformations initiated by the introduction of technologies of digital design and modeling, computer and supercomputer engineering, "smart" and additive manufacturing, together with methods of various optimization, bionic design, robotics, etc.

The key technology of digital transformation of industrial enterprises is the creation of digital doubles. Hence the need to institutionalize this new type of asset. The program of digital transformation should be carried out by the top management of industrial enterprises, requires significant support, qualified personnel, corporate culture and proper reporting.

The projected economic effect of the digital transformation of industrial enterprises is as follows: reduction of costs by 10-50 %, reduction of production time up to 4 times, profit growth up to 2 times, increase in the number of new products by 50-70 %, reduction in the number of equipment units by 7-15%, increase in predictability up to 4 times [28].

5. The performance of reindustrialization of industrial complexes, steel industry, namely infrastructure development, increase of employment in the manufacturing sector and the share of industrial production in GDP, the broad use of environmentally friendly technology, encouraging research and enhancing technological capabilities of industrial sectors, should be assessed using the proposed methodology calculate the KPI on the basis of a correlation with the development of industrial complexes in terms of global benchmarking [27].

In the future, constant monitoring will allow you to track the position of competitors and changes in their development coordinates. In these conditions, the critical factor is not lagging behind in a number of KPIs at the start, but a lack of understanding of the target level and the necessary trajectory of development of industrial complexes of the Russian

Federation [11]. The developed methodology for assessing the effectiveness of industrial complexes reindustrialization allows to measure the level of achievement of goals, conduct global benchmarking, identify weaknesses and eliminate them [12].

III. CONCLUSION

The research results and their practical implementation allows to speak about the solution of scientific problems that have important socioeconomic and economic importance, namely, to ground the conceptual and methodological principles of management of development of industrial complexes in the conditions of re-industrialization, which is the basis for global competitiveness in high-tech markets, raising the level and quality of life of the population, growth of labor productivity and employment in manufacturing industries.

Main conclusions and recommendations received personally by the author:

1. The complex analysis of features and tendencies of development of industrial steelmaking complexes is carried out. It is established that the basic trend of development of industrial complexes is reindustrialization, characterized by a stable and steady nature of industrial development, taking into account the interests and interactions of all actors of industrial complexes.

2. The conceptual provisions of the ecosystem approach to the management of the development of industrial complexes are formed as a paradigm shift in the management of complex conditions, expressed in the simultaneous unity (common image of the future, productive cooperation and symbiotic) and variability (retention of diversity, evolutionary search) of the goals and protocols of economic systems development by analogy with natural processes and phenomena.

3. The methodology of management of development of industrial complexes in the conditions of reindustrialization is developed, including a set of theoretical provisions regarding hypotheses, applied concepts and fundamental laws, principles and approaches, basic prerequisites of management of development, the author's idea of logic of institutional transformations at reindustrialization, the incentives and barriers arising in an ecosystem and influencing development processes; organizational and administrative mechanisms; estimates of efficiency and effectiveness, including methodical approaches, techniques and KPI.

4. The system of management of development of industrial complexes as set of the subject (actors of ecosystem of industrial complexes) and object - process of development of industrial complexes and the enterprises entering into their structure in the conditions of reindustrialization is formed; subsystems of goal-setting, feedback and providing subsystems.

5. A methodological approach to the assessment of the level of technological development of industrial complexes, allowing to calculate the index of technological development from 2010 to 2017, is developed; trends of scientific and technological development until 2030 are constructed;

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it is proved that only when the forced scenario of breakthrough development is implemented, the target indicators established in a number of Federal regulations will be achieved.

6. The scenarios of scientific and technological development of industrial complexes in the conditions of reindustrialization are offered, including: target forced scenario of breakthrough development; innovative; conservative scenario. Reference points of scenario conditions are determined by indicators of resources and results of scientific and technological development. It is possible to create a vision for the future of industrial complexes, which in future will provide technological upgrading of traditional industries, promotion of Russian technologies to new global markets, increasing the share of products new high-tech and knowledge-intensive industries in GDP.

7. The procedure of introduction of digital platforms of key industries is offered, allowing to optimize transactions, to minimize time of output of production to the market, and also time of preparation, acceptance and execution of decisions.

8. The program of digital transformation of industrial enterprises in the conditions of reindustrialization was developed, which consists in creating a common Foundation for the implementation of the digital agenda and advanced production, including support for the architecture of business processes and digital projects, synchronization of already implemented projects at the enterprise.

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