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OPPORTUNITIES OF DIGITALIZING THE ECONOMY OF THE REGIONS OF RUSSIA

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Abstract

The paper considers the theoretical aspects of the relationship between the theory of industrial revolutions and the theory of technological structures. At the same time, attention is focused on the issues of modern development of industries and complexes of the economy of Russian regions. The conclusion is made about the identity of technological problems solved within the industry 4.0. and the sixth and seventh technological structures in the context of the criterion: the development of artificial intelligence, cyberphysical systems, “end-to-end” technologies. As a result of testing demonstrated the feasibility and proof nature of the application system of linear synthesis methods and statistical modeling strategic applied to nonparametric data. At each stage of the implementation of the presented methodology, the validity of each method and their combinations is emphasized, emphasizing the advantages from the standpoint of identifying special features in the development of the studied objects. The inability of prescriptive evaluation of transients is marked as a new technological way due to the lack of the system representation, separate elements and fragments of such phenomena.

Keywords: Regional economy, digitalization, industry platform, technological structure.

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1. Introduction

In the context of the development of digital technologies, the issue of technological development of the Russian economy in the context of management 4.0. becomes relevant. It requires the identification of the points of contact of these theories necessary to identify key criteria and elements of comparison and quantification of the main trends of these theoretical structures.

Based on the main aspects of the modernization theory, in particular the development of industrial and post-industrial society, we conclude that industrialization at the present stage is a key factor in development as such. In this context, it becomes necessary to determine the level of technological development of the economy of the Russian regions.

2. Problem Statement

The theory of technological structures, as part of theories of economic dynamics, focuses on fundamental technological changes, which does not contradict the theory of modernization, since it arises during the period of total industrialization. These changes are due to the complex technology underlying the production, allowing to radically increase productivity.

In turn, industrial revolutions, including technological changes, also involve various kinds of economic and social effects (Drucker, 2008). So, Shchedrovitsky (2018), speaking of the periodization of industrial revolutions, correlates key organizational forms and prevailing forms of thinking (table 1).

Table 01. Periodization of industrial revolutions according to P. Shchedrovitsky

Industrial Revolution	Organizational Form	Type of Thinking
Zero Industrial Revolution	Cluster	Engineering
First Industrial Revolution	Factory	Design
Second Industrial Revolution	Transnational corporations	Research
Third Industrial Revolution	Platform	Programming
Fourth Industrial Revolution	Cyber-physical systems and organizations	Artificial Intelligence

Thus, the basis of the change in industrial revolutions is the technology of thinking, which changes industrial technology, as a result, entails changes in the means of production (Buldygin, 2017). The effect of the change of the industrial revolution are the global changes in the system of technological, economic, social division of labor. In particular, at the present stage, the division of labor is between man and machine (robot) (Shchedrovitsky, 2018). Thus, thinking determines technological and industrial development. This point of view is close to the opinion of J. Schumpeter about the decisive role of the entrepreneur in the economy (Oshchepkov, 2019). In turn, the theory of technological technological change is based on the decisive role of technology as such, leading to fundamental production changes.

3. Research Questions

The theory of technological technological change is based on the decisive role of technology as such, leading to fundamental production changes.

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Let us try to correlate the theory of industrial revolutions with the theory of technological structures in order to identify the criteria and elements of a new structure (table 2).

Table 02. Correlation of the theory of industrial revolutions and the theory of technological structures

Name of the criterion	Theory of industrial revolutions	Theory of technological structures
Periodization criterion	Thinking technology	Production technology
Effect	Change in the system of economic, social, technological division of labor	Increased labor productivity in industries and complexes
Environment	Industrial Society	Industrial Society
Periods	4 Industrial Revolutions	7 Technological Structures
The ratio of periods	1 industrial revolution	1 technological Structure
	2 industrial revolution	2-3 technological Structures
	3 industrial revolution	4-5-6 technological Structures
	4 industrial revolution	7 technological Structure

We would like also to note that the term "new industrial revolution" is used, which is understood as the third and fourth industrial revolutions, when there is a different nature of the division of labor at the global level between human and robot. At the same time, technology of thinking within the framework of industry 4.0. is artificial intelligence, which also lies at the basis of the seventh technological order (Chekletsov, 2017).

Thus, we can imagine the following scheme: the theory of technological revolutions (as the development of an industrial society) - the theory of technological structures (as a theory of the technological development of production). In this way, it is possible to determine the place of the theory of technological structures in the theory of development as such. Accordingly, the new technological structure acts as a phenomenon in the framework of 3-4 industrial revolutions.

4. Purpose of the Study

Let us consider some techniques aimed at identifying trends in the development of various types of technologies used at the level of large enterprises, organizations, and agencies of the Russian Federation.

First of all, we will reveal the contents of the methodological approach of the Industry Maturity Index 4.0., Based on conducting case studies and seminars (Shu et al., 2017). At the same time, case studies contribute to a detailed study of new conditions and trends, and seminars allow the participants to use the experience and organize interdisciplinary discussions. This technique involves a combination of case studies and workshops with real-time results. Its advantages include the possibility of studying phenomena and processes that have not yet been formed in the scientific and practical sense, that have a sufficient number of manifestations and trends.

From this perspective, the Rostelecom company's methodology aimed at identifying digitalization trends using the methods of semantic analysis and machine learning deserves attention (Monitoring Global Digitalization Trends, 2018). As sources of quantitative data, respectively, the following were used: scientific publications, patents, media, etc. Machine-going quantitative assessment of technological developments, their ordering and crystallization of individual tendencies. This reveals several types of

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research trends. Thus, the emergence of a trend is associated with increased interest in certain technologies of the scientific community. A patent analysis demonstrates the transition of a trend in the practical field. Thus, the life cycle of the trend is demonstrated, the key role in which the authors of the methodology assign to the technological factor.

We will also consider the Rosstat indicator system for a statistical assessment of the technological development level of economic sectors, which provides for several groups of indicators (The system of indicators of Rosstat for a statistical assessment of the level of technological development of industries, 2018):

1) macroeconomic statistics;

2) investment statistics;

3) statistics of innovations and advanced production technologies;

4) production statistics of high-tech products;

5) energy efficiency statistics;

6) construction statistics;

7) transport statistics;

8) communication statistics;

9) trade statistics.

This system is based on parametric data, however, it relies solely on the federal level, it does not provide information about the development of, for example, regional industrial complexes.

It is important to say about the methodology of statistical evaluation of the Ministry of Economic Development, which is based on data from Rosstat, departmental statistics, Rospatent, data from specialized sample surveys and monitoring; specialized foreign databases (Order of the Ministry of Economic Development of Russia, 2020).

For a statistical assessment of the level of technological development of the industry, it is recommended to calculate the integral indicator:

where: $U_{tr} = \sum_{j=1}^{g} Ind * b_j$

Utr - an integral indicator of a statistical assessment of the level of technological development by type of economic activity;

Indj - an indicator of a statistical assessment of the level of technological development by type of economic activity;

bj - weight coefficient characterizing the degree of influence of the j-th indicator on the formation of the final integral indicator by type of economic activity;

g is the number of indicator groups;

j is the serial number of the group of indicators (j = 1, ..., g).

In this case, the weighting factors which characterize the degree of influence of each parameter on the formation of the integral index of statistical evaluation of the level of technological development, established by researchers responsible for the development of a methodology, which immediately tells us about a certain level of subjectivity of this approach and, depending on the qualifications of the developer. One can also note the qualimetric nature of such a technique.

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Of particular interest is the methodology of the TAdviser Analytical Center and Rostec State Corporation (Methodology for assessing the industrial Internet market in Russia, 2020) related to the assessment of the industrial Internet of Things market in Russia. Key methods: the analytical part is connected with the analysis of reports of various analytical agencies (IDC, Accenture, Global Market Insights, J`son & Partners, etc.), consulting companies and vendors (PwC, IBM, Cisco, SAP, etc.); field studies are based on a telephone interview survey.

Thus, we will note that there are practically no works in which tools for assessing technological patterns as such are proposed in the context of the industrial development of individual countries and regions. The bulk of research is related to the micro level and individual enterprises, industries. A small circle of research is based on the mathematical apparatus as applied to the processes of technological and innovative development in various directions.

The question arises, what is considered a new technological way of reference to the Russian reality, how to identify its elements. Based on the opinion of the majority of authors characterizing the Russian economy as multistructure, we note that expert assessments speak of individual trends in the manifestation of the sixth and seventh technological structures. So, the work of Glazyev et al. (1992), speaks of Russia's transition to the sixth technological order, the origin of which, according to the authors, takes place in 2010. According to forecast estimates, the maturity phase of the sixth order can be attributed to 2040. Moreover, nanotechnology will become the basis of this process.

In turn, Parshin and Kruglov (2014) note genetic engineering, membrane and quantum technologies, micromechanics, photonics, thermonuclear energy among the technologies of the sixth technological mode.

We would like to pay attention to the point of view of Kurcheeva (2016), who actually does not separate the sixth and seventh order, talking about the transition to them as a single process of technological breakthrough in the region.

Kibalnikov (2016) refers cognitive technologies to the seventh technological order, allocating a key role to the human mind, and as a result of artificial intelligence in different directions of economic development.

5. Research Methods

Based on the content of each of the indicated technologies, we conclude that their interconnected focus does not allow us to separate at this stage the development of the sixth and seventh technological structures. This confirms the author's assumption of using in this work as a more correct concept of a new technological structure.

In addition, in previous studies, we proved belonging to a new technological structure of science as such, in the form of fundamental scientific research and innovation. As a result, we can talk about two aspects of the development of technological system: the actual technological and scientific, which cannot be seen outside the context of each other.

We also note the inclusion of the theory of technological structures in the substantial context of the theory of industrial revolutions, which indicates the correspondence of the new technological structure (understood as the sixth-seventh structure) to the processes of the third and fourth industrial revolutions. Accordingly, this gives us the right to consider, in the framework of the transition to the new technological

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order, the concept of industrial and sectoral platform cyber-physical systems, artificial intelligence and so on.

All the available data are divided into two groups: direct production-technological, scientific and technological, and look at the totality of the sources, who can afford to quantify certain aspects of a position of formation of elements of the new technological order in the context of the development of a regional industrial complex.

We have the following sources:

- official data of statistical authorities;
- data of various levels of rating agencies and bureaus;
- data from international and Russian databases of scientific citation;
- data of state authorities of various levels and subordinate organizations;
- data on industry-forming industrial enterprises;
- expert opinions.

Based on the foregoing, we will offer the following system of quantification of the qualitative parameters of the transition of the region's economy to a new technological structure (Table 03).

Table 03. The system of quantification of the qualitative parameters of the transition of the regional economy to a new technological structure

Parameter	**Elements of the new structure**	**Indicators**
Level transition	Regional and regional level of technological development	The number of manufacturing, information technology, innovation in the regions of Russia, the main parameters
Platforming	Development of software systems and platforms	Number and main characteristics of platforms
Technologies	“End-to-end” technology development	The number and main parameters of “end-to-end” technologies

The transition level determines the development of industries and complexes in the context of identification and characteristics within and inter-industry relations. Platforming allows you to combine geographically distributed participants in production processes in the context of trends of increasing flexibility and customization based on predictive analytics and big data. Technology is the key driver of economic development inherent in the technological mode as such.

Developed methodological tools for assessing the technological development of Russian regions is based on the synthesis of linear methods, statistical and strategic modeling. The choice of methods at each stage of the assessment is justified and appropriate, taking into account the parametric and nonparametric nature of the data.

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6. Findings

To this end, in the second methodology phase we performed the quantification of non-parametric data, which allow to calculate the private synthetic indicators, including data on the development of industry software systems and digital platforms, industry and universal nature, the number of completed projects, the price and terms of implementation, performance indicators (decrease financial costs, downtime costs, increase efficiency, and so forth.).

Rank values for subjects on this indicator were determined based not on their own, but on the converted value. Since, as the initial data on this indicator, information was used about which industry-specific software systems and digital platforms implemented in the Russian Federation. The ranking of the constituent entities of the Russian Federation was carried out as follows:

At the first stage, the converted value (weight) of each platform was determined based on the indicator “number of completed projects” (values are presented in the table 4).

At the second stage, for each subject of Russia, the total converted value of the Digital Platforms indicator was calculated based on information about whether a particular platform is used in this subject (the values are also presented in Table 04).

Table 04. Determination of the converted value (weight) of indicators that make up the synthetic indicator "level of software systems and specialized digital platforms"

Name of the criterion	Number of completed projects	Converted value (weight)
The software package maintenance oil drilling "GeoNaft"	11	0.040
Complex digital "Intelligent quarry"	2	0.007
Digital platform account purchases of scrap ferrous and non-ferrous metals "PSC. ("ЦУЗ. РФ")	63	0.227
Digital platform for wholesale purchases and sales of products by SME Supl.biz (without relative to the industry)	8	0.029
Cloud platform for the mining industry «SKYEER»	12	0.043
"ASK - Mining Logistics" (mining industry)	6	0.022
Neosynthesis	7	0.025
Digital Advisor and Real-Time Management System	5	0.018
Industrial equipment monitoring system “DISPATCHER”	16	0.058
Platform Data Mining Clover “SmartMaintenace”	51	0.183
Digital Educational Platform Digital Production	85	0.306
« Technologies of the Future Factories»	9	0.032

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Name of the criterion	Number of completed projects	Converted value (weight)
“1C: MES Operational Production Management”	2	0.007
"1C: PDM Engineering Data Management"	1	0.004

And finally, at the third stage, subjects were assigned ranks in accordance with the total converted value of the indicator of quality indicators:

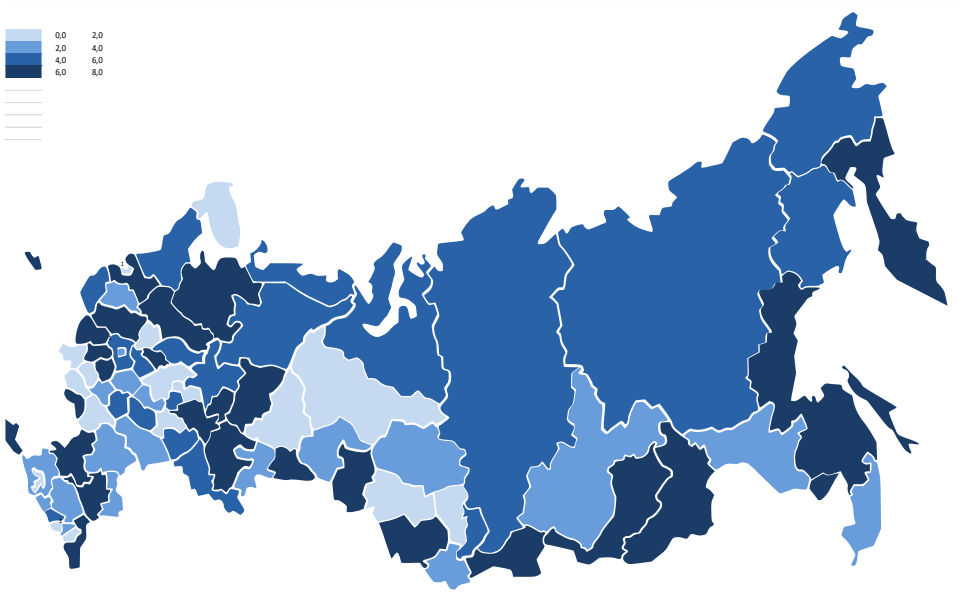

Figure 01. The level of development of industry complexes and digital platforms in the constituent entities of the Russian Federation

Thus, a particular indicator, “The level of development of industry-specific complexes and digital platforms” in the constituent entities of the Russian Federation, was calculated. Figure 01 shows the results of the analysis of the use of industry-specific systems and digital platforms in the constituent entities of the Russian Federation. The brighter the region is marked, the more actively it implements industry complexes and digital platforms. We see that the bulk of these entities are concentrated in the European part of the country. At the same time, we note the general substantial spread in the level of development of industry-specific systems and digital platforms.

7. Conclusion

The current positions of the technological development of the regions are determined; the key trends of the technological development of the industrial complexes of the regions are diagnosed in the new environment.

It should be noted that the presented sequence of steps allows us to identify current trends in the technological development of the regions, to assess the degree of their balance and proportionality within the framework of national technological development and is the basis for the explication of the

technological development of industrial complexes of individual entities with the aim of forming ideas about their technological profile.

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