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COGNITIVE MODELLING AS A TOOL FOR STRATEGIC PLANNING OF AN INDUSTRIAL DEVELOPMENT

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Abstract

This article is devoted to the need substantiation of the strategic plans formation for making forecasts of the economic development of Russia, namely, the industrial complex. At present, the country's industrial complex has a lack of strategic development guidelines, and industrial production indices have not been growing over the past 5 years. One of the problems of this situation is the lack of long-term development plans and, accordingly, state forms of support. Strategic planning is an important aspect of strategic management in industry. Strategic planning helps coordinate processes. The article presents the main trends in the development of Russian industry, analyzes the tools of strategic planning. And it is concluded that the cognitive modeling toolkit is an appropriate tool of a long-term forecast making for development points. Cognitive modeling allows you to develop points of growth (elements) and identify the functions of communication between these points or elements of development. This approach is based on the systematic planning of complex systems. The authors propose to use a cognitive modeling tool to determine the vectors of development in the industrial complex. The article can be useful to everyone who deals with the problems of industrial development and studies the tools of strategic planning.

Keywords: Cognitive modelling, industrial complex, strategic planning

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1. Introduction

The toolkit for cognitive modeling of complex systems allows you to simulate the structure, state, and behavior of the latter to anticipate their development to make and justify the adoption of appropriate management decisions. There is a wealth of experience in the practical application of this toolkit in various spheres and fields of activity. These are: a regional socio-economic mechanism; education system (Republic of Adygea, Rostov Region, Krasnodar Territory); research of federal target programs for the development of education; labor market (Rostov region); tourism (South of Russia); industrial production and enterprises; small and medium businesses; ecological systems; geopolitical systems (Black Sea-Caucasian-Caspian area); interregional economic exchange; financial regulation of reproduction and capital accumulation in the real sector of the economy, etc.

In theoretical terms, the main research is carried out in the following areas: the composition of cognitive modeling methods and methods for analyzing big data, scientific foresight, methods of system dynamics, analysis and synthesis of cognitive models; structural analysis; compositions of cognitive modeling with models and methods of decision-making; software development for cognitive modeling of complex systems; design of intelligent decision support systems; expanding the scope of practical application of cognitive modeling tools, etc.

Since at present many industrial enterprises are included in the system of various cluster formations, it is proposed to use the cognitive modeling toolkit for the development of industrial-innovative clusters.

2. Problem Statement

Cognitive modeling is a separate kind of semantic analysis method. This type of modeling allows you to effectively investigate the behavior of complex, poorly formalized systems that do not lend themselves to precise mathematical analysis, due to the use of linguistic variables and fuzzy algorithms, which differs from the traditional operational type of modeling. Fuzzy logic, graph theory and matrix theory are the main set of tools for mathematical formalization and building cognitive models. As Khrustalev (2010) states, the range of application of cognitive models is very wide: socio-economic, military-political, ecological systems and phenomena are a far from complete list of this tool application areas.

The advantages of using cognitive modeling primarily include the ability to overcome the phenomenon of the socio-economic systems presenting complexity for perception and analysis. The "phenomenon of complexity" exists due to the five most important features of modern strategic management. Today practical management faces them everywhere. As noted by Karayev and Sadikhova (2020), such features are: the uniqueness of each strategic project, multifactoriality, multidimensionality (multidisciplinarity), the dynamism and uncertainty of the strategic choice task, the high role of the strategy developers' mentality, as well as strategic decisions makers' mentality.

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3. Research Questions

The following questions were raised during the study:

- How and for what purpose is the cognitive modeling toolkit used?
- What methods are used in strategic planning?
- What are the challenges of applying industry cognitive modeling?

4. Purpose of the Study

The purpose of this study is to develop recommendations for the cognitive modeling use and strategic planning tools in predicting the industrial complex development.

5. Research Methods

Industry is one of the driving forces of the Russian economy development. Therefore, the study of institutional formations that contribute to the development of the country's industry is an important scientific and practical task. Figure 1 shows the dynamics of indices of industrial production, labor productivity, physical volume of investments in fixed assets. The industrial production index has a constant dynamic of growth from 2015 to 2019, compared to 2011 and even in 2020, despite the pandemic, the labor productivity index is slightly more than 100%, does not have growth dynamics, the index of physical volume of investment in fixed assets has been declining in 2019, 2020.

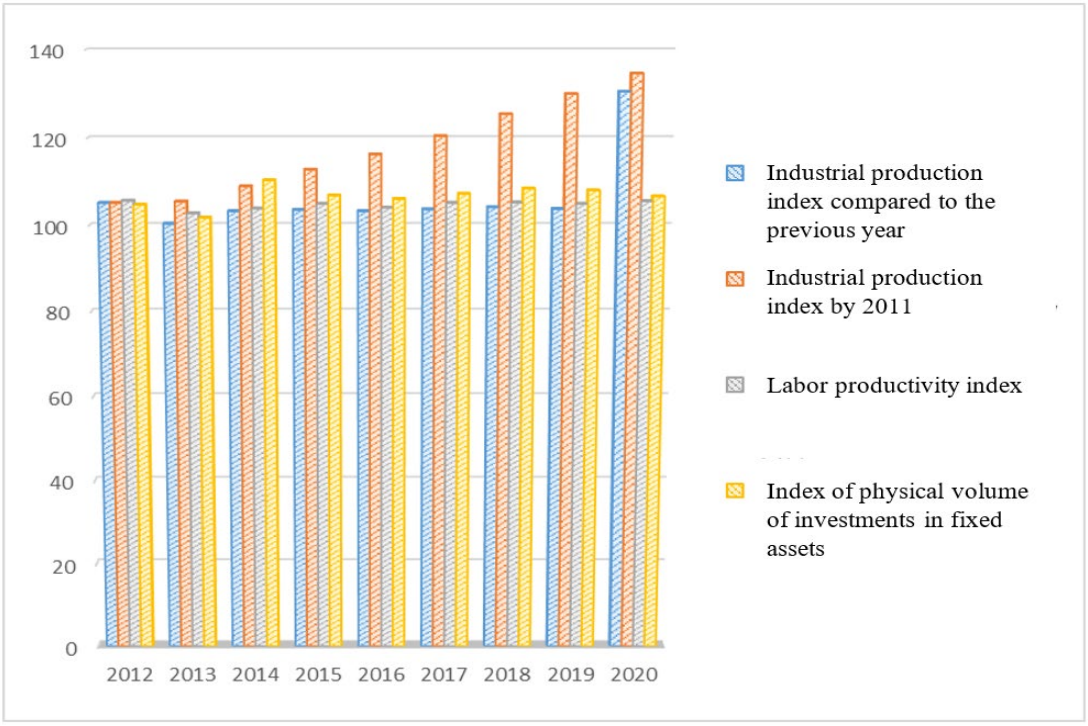

Figure 1. Development trends of industrial production indices, labor productivity, physical volume of investments in fixed assets. Source: (Federal State Statistic Service, 2021)

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The following macroeconomic indicators can also be considered:

- internal expenditures on research and development, in % of GDP, amount to 1.2% in Russia, and in 2018 - 1% to GDP, lower than in comparable countries - Germany, Denmark, USA, China (see Figure 2);

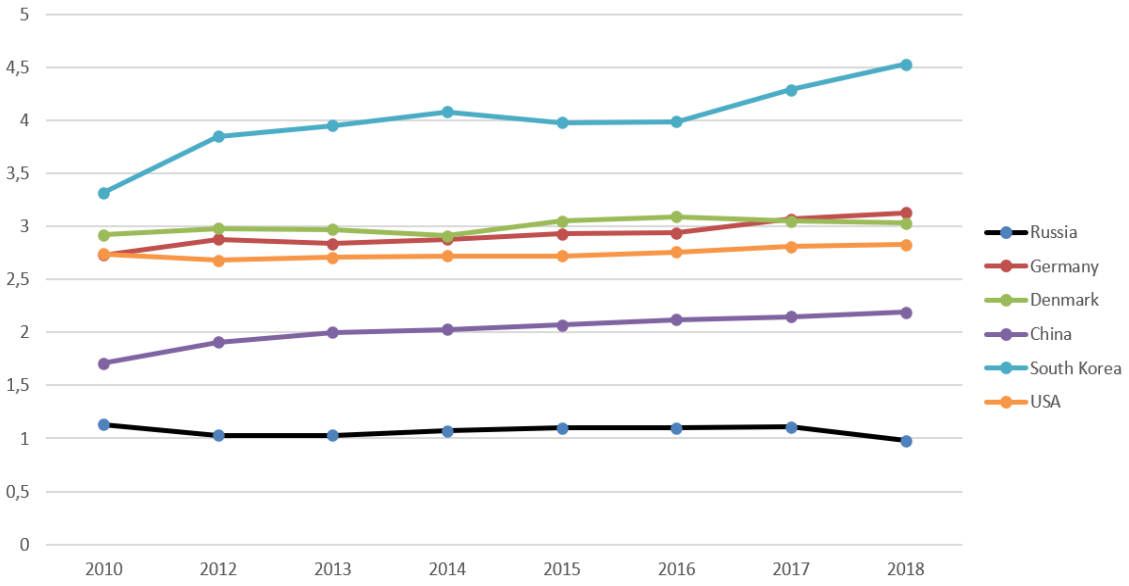

Figure 2. Internal expenditures on research and development, % of GDP. Source: (Federal State Statistic Service, 2019)

- the share of internal costs for research and development in priority areas of development of science, techniques and technology, in the total volume of internal costs for research and development in the Russian Federation as a whole has grown only in medium-tech types of economic activity and is 80%; in high-tech types of economic activity, there is a decrease in this indicator in 2017, 2018.
- the coefficient of inventive activity (the number of domestic patent applications for inventions filed in Russia, per 10 thousand people) is falling compared to 2015 and is 1.59 in 2019, in 2015 it was, for example, 2.0.

The development of industry is characterized by the following factors:

- high rates of privatization processes (at best, development-neutral);
- preservation of the “resource model” of the Russian economy;
- low level of innovative activity of industrial enterprises;
- low degree of planning functionality and, accordingly, the problem of determining strategic guidelines and targets;
- failure to achieve the target indicators planned values.

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The above problems of the Russian industrial complex indicate that there is no long-term planning system that would contribute to systemic development.

Strategic planning is vital to an industrial complex because it provides direction and targets, anticipates certain scenarios and plans the necessary actions to avoid them. Constantly changing technologies, industry trends and global markets can challenge industrial enterprises. Many of today's leading industrial enterprises will not be able to remain leaders in the near future without a robust strategic planning process.

Strategic planning is a process that has inputs, actions, and results. Strategic planning uses a variety of tools and techniques. They provide the basis for strategic planning. Such tools include:

1. Expert method. The essence lies in the preparation and development of the necessary procedures with the help of the specialists (experts) involvement. The formulation of expert assessments is carried out:

- by studying the characteristics of a similar object (competitor);
- by the method of speculative comparison of alternative probabilities;
- using an expert survey in the form of an interview;
- by the “third point” method, when the expert selects the optimal scenario, which is in the middle between the optimistic and pessimistic options.

2. Socio-economic analysis studies the structure of socio-economic factors, the logic and tendency of their interrelationships, their influence on each other. This is a strategic planning method that allows researchers to build high-quality connections with the target audience with high efficiency and it is used to address issues of any structuredness degree.

3. The balance method implies a system of methods for agreeing and coordinating related indicators of business processes. This technique serves as an important forecasting tool, since it demonstrates the state of the company's production facilities, the dynamics of financial flows, the structure and organization of working time or the operation of equipment. Understanding the economic picture of the present time allows you to build viable development plans for the next period.

4. Engineering and economic calculations are used in production development projects. In particular, they predict the level of market demand for a manufactured product. The object of engineering and economic calculations are the operating factors of equipment, the norms for processing raw materials, the cost size, quality indicators of a product or service, and other factors.

5. The method of constructing economic and mathematical schemes. This planning approach is used in the process of solutions developing for standard or structured interconnections of business processes: production lines loading, product composition calculating, production cycles program drawing up.

6. The methodology of synthesis and system analysis consists in sequential breakdown of business systems and processes into separate components. This work is necessary to identify the key links in the process, problem points and the corresponding study (optimization) of the chosen direction.

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It is important to suggest strategies for different time horizons. Each of them has different goals and requires different approaches, different frequencies and participation. Thus, for the development of the country's industrial complex, it is possible to use the tools of strategic planning.

Various researchers such as Schwenk (1988), Haleblian and Rajagopalan (2006), Porac and Thomas (2002), Eden and Ackermann (2001), have made numerous attempts to create universal tools for the cognitive support of managerial decision-making and forecasting processes for solving strategic problems. However, practice shows that in such complex and diverse conditions in which modern enterprises operate, the creation of universal tools is futile and does not justify itself. However, Balatsky (2006) believes that what is needed is not universal tools, but some unified methodology that allows constructing cognitive models for specific systems, for a specific period of time, taking into account the strategic vision of the stakeholders of these units.

6. Findings

As noted by Gorelova et al. (2019), the application of the cognitive modeling methodology in the context of industrial development forecasting, at the regional level and at the level of the entire national economy, is associated with a number of problems and contradictions of a scientific and practical nature. According to Khrustalev and Khrustalev (2013) and Makarenko and Khrustalev (2007), the first weak point of the formalization of the oriented sign graph that underlies the cognitive map is the expert's subjective assessment (group assessment is preferable) of the processes, occurring in a complex dynamic system, as well as the factors causing them. Moreover, the hierarchy and the placement of the weighting coefficients of the connection strength between the model factors is also carried out by experts and, therefore, is subjective. Gorelova et al. (2011) note that the possibility of multivariance of the results of modeling such a system as an industry is obvious, which we face when analyzing the accumulated research experience. Kim (2005) and Kazanskaya and Nalesnaya (2019) determine the possibility of checking the model by reverse verification, through the introduction of statistical information from the past years as exogenous parameters – one of the ways to solve this problem. However, it also turns out to be very difficult, since researchers are faced with the lack of complete, detailed, reliable, and timely statistical information on the industries state. Kompaniets and Kazanskaya (2013) points out that urgency, reliability, integration, lack of political pressure, continuity of methodological approaches in calculating indicators of different years are the main problem points of regional statistics. The third serious problem of the application of cognitive modeling of industry at the regional and state level is associated with the ambiguity of the indicators choice, as a consequence of the statistical parameters, on the basis of which the quantitative values of the indicators to put in the nodes of the cognitive map are determined. A wide discussion in the scientific literature regarding the subjectivity of key decision-making in the process of a model building indicates that an infinite number of different cognitive maps describing the same objectively existing system is almost inevitable even within the framework of research projects with the participation of the same experts, but at different time periods and with different initial set modeling goals. Thus, considering the totality of these problems, the creation of a cognitive model of industrial development at the regional and state level, adequately perceived by the scientific community and the authorities responsible for the industry development in the country, i.e. unambiguously of significant importance for the purposes of management

and forecasting an industrial system development, is a difficult task that requires an integrated scientific solution.

7. Conclusion

Currently, cognitive modeling of complex systems, as an element of intelligent decision support systems and artificial intelligence, is positioned within the modern direction "Cyber physical systems" (CPS).

The term "cluster" has an English-language etymology (cluster), translated as "association, accumulation". This concept is interdisciplinary and is considered in various scientific fields as a set, integration of several similar elements, which can be considered as an independent component characterized by unique properties.

Makarenya et al. (2019) note the need for regional cluster formations planning. Clusters create and enhance the existing competitive advantages of enterprises and regions. Clusters are considered as open systems, in which material, financial, labor, and other resources, separate economic units, institutions, authorities are located at the input, and products, profit, synergy effect, innovations, etc., are detected at the output.

The first step in the formation of this kind methodology is the development of a conceptual scheme of a cognitive management that is uniform for all its applications. At the same time, it is fundamental that the development of a conceptual scheme in such a complex problem environment cannot be done on the basis of traditional formal-axiomatic approaches. More appropriate here, apparently, is the empirical approach, widely used in "knowledge based" technologies.

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