Tools for Predicative Analytics in the Development of the Ecosystem "Education – Research – High Technology Industry"

Trifonov V.A.
Yaroslav-the-Wise Novgorod State University,
Veliky Novgorod, Russia,
tva@novsu.ru

Daneykin Yu.V.
Yaroslav-the-Wise Novgorod State University,
Veliky Novgorod, Russia,
yury.daneykin@novsu.ru

Ivanova O.P.
Yaroslav-the-Wise Novgorod State University,
Veliky Novgorod, Russia,
prof-ivanova@mail.ru

Tumin V.M.
Moscow Polytechnic University,
Moscow, Russia,
vm@tumin.net

Kozlov D.A.
Russian representative office of Kilit Global Holding,
Association "Personnel and Career Development National Union",
Vladimir, Russia,
1607kda@gmail.com

Abstract—**The article presents the authors' vision on the use of predictive analytics in determining the strategic prospects for the development of ecosystems "Education – Research – High-tech industry" in order to overcome the technological imbalance in the Russian Federation. The authors have detailed the participants and their role in the regional consortia "Education – Research – High-tech industry". It is proposed to use the tools of predictive analytics for the choice of vectors of development of the integrated system "Education – Research – High-tech industry", including, for example, scientific and technological center "Intellectual Electronics – Valdai" implemented in the Novgorod "Education – Research – High-tech industry" is presented; the predictors used in the model are described. Predictors are proposed to determine the impact of the regional ecosystem "Education – Research – High-tech industry" in the region on the level of its innovative development. The research results presented in the article can be applied when strategizing innovative scientific and technological centers created in the Russian Federation and adjusting programs to overcome technological imbalance.**

Keywords—*predictive analytics, regional ecosystem "Education-Research-High-tech industry", innovative scientific and technological center*

I. INTRODUCTION

In Russia, the technological imbalance continues to grow. Technological imbalance is a serious obstacle to the sustainable development of the national economy, ensuring the economic security of the country; it is an imbalance in the technological development of the national economy. Therefore, a solution to the problem of overcoming technological imbalances in the development of the country's economy is needed, ensuring a significant increase in the contribution to the socio-economic development of the Russian Federation through the use of predictive analytics tools to determine the strategy and effectiveness of the creation and development in the regions of integrated systems (consortia) "Education – Research – High-tech industry".

Despite the fact that the issues of integration of industry, science and education, modifications of the "Triple Helix" were developed by many scientists, in particular, G. Itzkowitz, L. Leidesdorf, I. Kai, M. Ranga, A. Brehm, C. Jou, N.E. Bondarenko, O. G. Golichenko, G.A. Grebenshchikova, S.V. Istomina, T.A. Lychagina, E.A. Malyshev, T.P. Maksimova, E.N. Pavlova and other scientists, solving the problem of overcoming the imbalances in the technological development of the Russian economy by integrating the efforts and potentials of industry, science and education is still incomplete, and requires understanding and development to improve both state and regional policies in this area. Until now, the place in domestic economic science and management practice of predictive analytics tools has not been determined in order to build decisions on the choice of vectors of progress for associations – regional ecosystems "Education – Research – High-tech industry".

The actors of the "Education" component are organizations of secondary specialized education, universities of the Russian Federation, including flagship universities, planning to participate in the strategic academic leadership program. The functional purpose of the actors in the consortium are the following: creation, accumulation, storage and dissemination of knowledge, personnel training, the formation of human capital for the implementation of innovative activities, the formation of an effective system for monitoring and forecasting the needs of the actor of the component "High-tech industry" in personnel of various qualifications, including having unique competencies, expanding the volume and improving the quality of training specialists for the subsequent employment of graduates at the enterprises of the actor of the component "High-tech industry", the development of organizational mechanisms for cooperation of the consortium in the field of education, the introduction and development of modern educational methods and technologies, including modular and network training programs, project approach to the formation of practice-oriented skills, using the capabilities of the network model of education to create interregional training programs for the purposes of the actor component a "High-tech industry", the implementation of educational programs aimed at the formation of new competencies of the 21st century (flexible thinking, creativity, entrepreneurial ability), the development of a system of continuing education, retraining and advanced training of scientific, engineering, technical and managerial personnel, researchers, system development additional education for children creating conditions for the cultivation of motivated applicants, the development of a circle movement, the creation of a complex of innovative creativity centers for youth and adolescents, children's technoparks, specialized classes in schools, the holding of olympiads for schoolchildren on innovative and technological entrepreneurship, the initiation of joint research, participation in the creation new knowledge-intensive firms, ensuring communication with external systems, transfer of innovations between entities.

Actors of the "Research" component are scientific institutes, research institutes, design and engineering organizations for the development and modernization of production products that meet the criteria of high-tech products, enterprises engaged in R&D, universities of the Russian Federation, including universities planning to participate in the strategic academic leadership program. The functional purpose of the actors in the consortium are the following: scientific substantiation of the priority areas of long-term scientific and technological policy, including for the markets of the National Technology Initiative, audit of existing scientific groundwork in the field of fundamental and applied science, achievements of scientific and technological progress in the country and abroad, substantiation of the framework and content programs of fundamental and exploratory research for the "High-tech industry" actor, formation of databases and examination of scientific information, scientific and methodological support of the "Education" actor, research, technological developments for the production process, new product development, engineering, development or implementation of new digital solutions, information systems for the production process, advice on production, organizational and financial issues, construction of production and business processes, long-term forecast of technology development and market situation, the

emergence of new markets, market development of the National Technology Initiative.

Actors of the component "High-tech industry" is a set of companies, enterprises (firms) for the production, repair and modernization of production products that meet the criteria for high-tech products. High-tech products include products, in the cost price or added value of which the costs of research and development work are much higher than the average for products of the industries of this type of activity. The functional purpose of the actors in the consortium: the formation of a request for research and development, for training, participation in the conduct and financing of R&D.

When developing strategies for socio-economic development, predicative tools have been increasingly used lately, synthesizing various areas of knowledge in the process of creating a target image of systems. The forecasting procedure combines not only analytical, but also predictive actions to identify risk factors, problem situations, and develop methods for solving problems. At the same time, it becomes essential not only to determine the potential, risk situations, but also to study the mechanisms of innovative development [1-9].

The toolkit of predictive analytics for the choice of vectors of development of the integrated system "Education – Research – High-tech industry" can be tested on the example of the Intellectual Electronics – Valdai Innovative Science and Technology Center (ISTC), which is being implemented in the Novgorod region, created in accordance with Federal Law No. 216-FZ of July 29, 2017 "On innovative scientific and technological centers and on amendments to certain legislative acts of the Russian Federation". The main developers of the Intellectual Electronics-Valdai project are Yaroslav-the-Wise Novgorod State University, the regional government and enterprises of the electronic industry. The goals of creating the ISTC are the deployment, promotion, commercialization of applied research of software and hardware electronic systems for monitoring, forecasting and decision-making for medicine, military-industrial and fuel and energy complexes. The priority high-tech areas of the ISTC "Intellectual Electronics-Valdai" are the following: development and creation of a high-tech electronic component base, professional and consumer electronics; quantum sensors, devices based on quantum technologies; new and portable energy sources; biomedical technologies and molecular genetics; 5th generation mobile communication networks; internet of things (devices, devices, systems, software platforms). It is planned to create several research, production and educational sites with developed infrastructure in Veliky Novgorod and Valdai. For the region, the benefits of the creation of the ISTC are primarily in the growth of tax revenues and the creation of new jobs. The interest of universities and scientific organizations is scientific research and attracting personnel. The Intellectual Electronics-Valdai ISTC is important not only for the Novgorod region, but also for the technological, innovative development of the country's electronic industry as a whole, to overcome the technological imbalance.

II. Results

E. Siegel considers forecasting (predictive) analytics as "a new weapon in the arsenal of the world's leading companies and government bodies" [10], as a technology that is based on

the use of experience, i.e. a variety of data "to predict the future behavior of people in order to make optimal decisions". It should be noted that the analysis and testing of a significant amount of predictive factors is becoming key in this technology. This makes it possible to identify even unexpected events, the manifestation of which is imperceptible in traditional research [10, 11]. Predictive analytics synthesizes analytical and statistical methods to predict future actions or behavior. The synergy of the scenario approach, mathematical methods, and testing provides what E. Siegel himself called the "forecasting effect". There is an interpretation of predictive analytics as a field of statistics, the purpose of which is to extract information from a data set and use it in order to predict trends and behavior patterns. Statistical predictive analytics techniques include data modeling, machine learning, artificial intelligence, deep learning algorithms, and data analytics.

The predictive analytics procedure includes data set identification, data collection, data analysis (actions to validate, cleanse, and model data to solve the problem of finding suitable information), statistical analysis to test hypotheses based on the use of standard statistical models, predictive modeling, model deployment to interpret analytical results for decision making, model monitoring.

Using an arsenal of predictive analytics tools allows us to answer an important question: how is it possible to increase the effectiveness of performing various and complex functions in public administration, healthcare, business, law enforcement and non-profit activities? Mostly, of course, the use of predictive analytics is reduced to the study of customer behavior and, based on the extraction of certain patterns in consumer behavior, companies try to improve the products produced, the services provided, change the assortment or make an effective service policy. In practice, predictive analytics tools are more often used in areas of activity that work with end users.

However, predictive analytics has the potential to be applied in almost any area where long-term planning of the future is required in the face of growing uncertainty. What prerequisites determine the possibilities and effectiveness of the implementation of predictive analytics in other areas that require forecasting options for the future development of events? These are the following: an increase in the speed of processing large amounts of data, an increase in the availability of tools for accumulating and processing aggregates of data, a real possibility of obtaining information from various sources, the development of information technologies.

The authors, within the framework of the study under the RFBR grant, substantiated the possibility of using predictive analytics to manage the development of cities, in particular, territories with a monostructure of production [12]. The creation of a strategy for the development of the ISTC as one of the formats of the integrated system "Education – Research – High-tech industry" in the region is possible with the introduction of predictive analytics tools into the strategizing process. Since the consortium "Education – Research – High-tech industry" in the region assumes interaction, synergy of cooperation between educational organizations, scientific institutes, enterprises of high-tech industry, forecasting their joint result of activities requires taking into account both many

factors related to both the elements of the actors of this system and the external environment.

When predicting the effectiveness of the development of the regional ecosystem "Education – Research – High-tech industry", we suggest using such a form of predictive analytics as regression. In the process of regression, we use a quantitative response variable (what we need to predict) and several predictor variables. The predicative model is based on the relationship between the desired variable and predictors. We accept the hypothesis of a linear relationship between the desired answer and predictors. For example, to assess the level of development of the regional ecosystem "Education – Research – High-tech industry" (RE ERHI), we suggest using the following formula:

$$y = a_0 + a_1 \times x_1 + a_2 \times x_2 + a_3 \times x_3 + \ldots + a_n \times x_n \qquad (1),$$

x_1 – the growth rate of the number of participating enterprises carrying out scientific and technological activities in the RE ERHI;

x_2 – the rate of total revenue of enterprises participating in the RE ERHI;

x_3 – the growth rate of the number of jobs created in the RE ERHI;

x_4 – the growth rate of the aggregate wage fund of persons participating in the implementation of the development program of the RE ERHI;

x_5 – the growth rate of the number of persons trained in additional education programs developed and implemented in the RE ERHI;

x_6 – the growth rate of the volume of costs for research and development of enterprises-participants of the RE ERHI;

x_7 – the growth rate of the volume of costs for research and development of enterprises-participants of the RE ERHI (Web of Science);

x_8 – the growth rate of the number of established enterprises-participants and participants - educational organizations and scientific institutes of the RE ERHI of the results of intellectual activity, including those with state registration or legal protection in the Russian Federation or outside the country;

x_9 – growth rate of the share of the number of foreign students in the total number of students enrolled in educational programs of higher education (bachelor's, specialist's, master's) in the region;

x_{10} – growth rate of the share of postgraduate and doctoral students in foreign countries in the total number of graduate students and doctoral students in the region;

x_{11} – the growth rate of the volume of investments from extra-budgetary sources attracted to the development of the RE ERHI;

x_{12} – the growth rate of the number of educational and research programs developed by the RE ERHI for young researchers, graduate students, students, schoolchildren;

We propose to use the following indicators as predictors to predict the level of innovative development of the region's

economy as a result of the creation and development in the region of the RE ERHI [12]:

x_1 – share in the total number of personnel of enterprises and organizations in the region engaged in R&D;

x_2 – share of production of new products in the total production of the region;

x_3 – share of employed in the region with higher education;

x_4 – R&D funding growth rate in the region.

III. CONCLUSIONS

The authors, within the framework of many years of research, explain the prerequisites for using predictive analytics to select the strategic prospects for the development of cities and regional ecosystems "Education – Research – High-tech industry". The presented predictive model for predicting the level of development of the regional ecosystem "Education – Research – High-tech industry" can be used to assess the performance of INSC created in the Russian Federation in accordance with "Federal Law amendments to certain legislative acts of the Russian Federation".

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References

[1] T.E. Dmitrieva, and V.N. Lazhentsev, "Organization of forecasting territorial development" [Organizatsiya prognozirovaniya territorial'nogo razvitiya], Economy of the region, 2010, vol. 4, pp. 157-164. (In Russ.).

[2] V.N. Lazhentsev, and V.A.Ivanov, "The strategy of rural development of the Northern region", Economy of the region, 2020, vol. 16(3), pp. 696-711. (In Russ.). DOI: https://doi.org/10.17059/ekon.reg.2020-3-2

[3] J.P. Blair, and M.C. Carroll, Local Economic Development: Analysis, Practices, and Globalization, London: Sage, 2008.

[4] E. Seltzer, and A. Carbonell, Regional Planning in America: Planning Regions, Iimbridge: Lincoln Institute of Land Policy, 2011.

[5] Environment and Planning, Vol. 3. Chapter 1 in the book: Reflections on "Government and Policy", in: R.J. Bennett (Ed.), London: Sage, 2012.

[6] D.A. Wolfe, D.B. Audretsch, and M. Lindenstein, Civic Governance, Social Learning and the Strategic Management of City-Regions, Chapter in the book: Creating Competitiveness: Entrepreneurship and Innovation Policies for Growth, Cheltenham: Edward Elgar Publishing, 2013.

[7] R.J. McGrath, "The Rise and Fall of Radical Civil Service Reform in the US States", Public Administration Review, 2013, vol. 73(4), pp. 638-649.

[8] R. Camagni, and R. Capello, "Regional Innovation Patterns and the EU Regional Polley Reform: Towards Smart Innovation Policies", Growth and Change, 2013, vol. 44(2), pp. 355-389.

[9] R. Crescenzi, and M. Percoco, A Comparative Spatial Dynamics Analysis Chapter in the book: Geography, Institutions and Regional Economic Performance, Verlag Berlin Heidelberg: Springer, 2013.

[10] E. Siegel, Calculate the future: Who clicks, buys, lies or dies [Proschitat' budushcheye: Kto kliknet, kupit, sovret ili umret], Moscow: Alpina Publisher, 2014.

[11] E. Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie or Die, New York: John Wiley & Sons, Inc., 2013. DOI: https://doi.org/10.4258/hir.2013.19.1.63

[12] E. Siegel, Calculate the future: Who clicks, buys, lies or dies [Proschitat' budushcheye: Kto kliknet, kupit, sovret ili umret], Moscow: Alpina Publisher, 2019.