ISSN 2658-5014 (Print)
2020. Т. 2, № 1 (3). С. 40–47
СИИТ
СИСТЕМНАЯ ИНЖЕНЕРИЯ И ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ
ISSN 2686-7044 (Online)
http://siit.ugatu.su

УДК 330.47

INFORMATION SUPPORT IN WORKING-OUT THE INNOVATION DEVELOPMENT STRATEGY AT THE REGIONAL LEVEL

M.M. NIZAMUTDINOV[1], N.I. FEDOROVA[2], V.V. ORESHNIKOV[3], A.YU. KLIMENTYEVA[4]

[1] marsel_n@mail.ru, [2]nf_2002@mail.ru, [3]VOresh@mail.ru, [4]annakobzeva@gmail.com

[1, 3, 4] Institute of Social and Economic Research, Ufa Federal Research Center, Russian Academy of Sciences, Ufa, Russia
[2] Ufa State Aviation Technical University (UGATU), Ufa, Russia

Поступила в редакцию 30 июня 2020 г.

Abstract. The article deals with the development of strategies for the innovative development of Russian regions. The formalized description of the methodology for assessing the effectiveness of the regional innovation subsystems development is presented. The proposed integrated indicator of resource availability for the regional innovation subsystem. Classes of situations for the formation of the resource efficiency matrix of the regional innovation subsystem are defined. The database structure has been developed for a system of information support for decision making in the construction of the region innovative development strategy. The list of necessary data is defined. A number of practical issues of decision support in this area are considered.

Keywords: regional system, innovation, decision support, development strategy, development stages, database, resource availability, classification, resource intensity, practical implementation

INTRODUCTION

In the 21st century one of the dominant trends in economic development is globalization. Global competition in developed countries occurs for the rights to various types of intellectual property, financial resources, migration flows. It is obvious that the successful development of the state is closely connected with the territorial development and with the increase of regional competitiveness. Therefore, it is not surprising that close attention is paid to the regional level of governance. In turn, regional economic growth is largely determined by the development of the innovation sphere.

In this regard, the study of the functioning processes and the assessment of the regional innovation system's development level are due to the need to develop and substantiate decisions in the field of managing the regional innovation system development, ensuring an increase in the quality of population life through the innovative development of the economy. And as a result of this is changing and modernizing the social sphere. Innovations, as one of the significant factors of the regional economic development, are the result of a number of targeted actions by various participants in the innovation system, as well as the result of the effective functioning of its elements.

The study was performed within the framework of the RFBR, No. 18-00-00345 (18-00-00343)

REVIEW OF EXISTING APPROACHES

Analysis of the current state of research in the field of organizing decision support for the development of strategies promoting innovative development of the regions implies a comprehensive review of issues of strategic management, the theory of innovative economics and development of decision support systems (DSS). Separately, we should mention the issues of developing economic and mathematical models in relation to the problem under consideration.

These areas have a well-developed scientific base. In particular, the basic tenets of the theory of innovative economics were formed already by J. Schumpeter. A number of aspects are considered in studies of Kondratiev's long waves, diffusions of C. Freeman's innovations, and also the technological paradigm of S.Yu. Glazyev, C. Peres, D.S. Lvov, Yu.V. Yakovets et al.

However, the majority of the available studies are not fully focused on quantitative assessment and forecast of the influence of factors of innovative development on the evolution of territorial social and economic systems.

In order to solve this problem, it seems necessary to use specialized tools, in particular, decision support systems (DSS). However, unfortunately, within the framework of the problems being studied, most of the existing technologies are focused on the tasks of managing the development of individual enterprises or activities. However, at the regional level, where issues of developing strategies for innovative development are being addressed, these systems do not find practical application. Certain works in this area (information and analytical DSS on managing innovative activity in regions, DSS on strategy for innovative development of regions, etc. [1]) only partially reflect such an essential property of the regional system as adaptability of behavior of key economic entities, or have exclusively theoretical or industry-specific significance.

Various directions have also developed in the field of economic and mathematical modeling of social and economic processes (general economic equilibrium models, simulation modeling, probabilistic-statistical models, etc.). At the same time, the models used in practice are mainly mixed and combine the features of several different approaches. The most famous foreign models in this area are the Wharton annual model of the US economy, the LIFT model, the Brookings model of the US economy and the model of US fiscal policy. Among Russian technologies, a special place is occupied by the modelling software systems "SIRENA" and "SIRENA-2" (Institute of economy and industrial engineering of the RAS Siberian branch), the modelling complex "POLIGON-2" (Novosibirsk State University), the "RIM" model (Institute for National Economic Forecasts of RAS), and the "Intersectoral Interactions Model" (Institute of the economy and scientific and technical progress forecasts, USSR Academy of Sciences), the CGE-model "RUSEC," the "Econometric model of the Russian economy," the "CGE-model of the social and economic system of Russia with integrated neural networks" (Central Economic and Mathematical Institute of RAS), the "Model of the Region of the Russian North" (Syktyvkar State University), the model "Governor," the "Agent-based model of Moscow" (Central Economic and Mathematical Institute of RAS), etc.. Many complex information and analytical systems, including the information and analytical complex "Prognoz" (CJSC "Prognoz"), are based on the use of simulation models [2].

Despite the advantages of the models presented, the parameters of innovative development of the regions are presented extremely incompletely in them. At the same time, many models, in particular, those based on econometric equations, do not reflect the adaptive properties of agents of the regional system, all of which causes a decrease in the accuracy of the forecasts obtained.

In this regard, the aim of this study is to develop the concept of a decision support system for the process of formulating strategies for innovative development of regions. To achieve this goal, it is necessary to solve a number of problems, including determining the conceptual framework for the development of DSS and considering the practical aspects of organizing the decision support process.

INNOVATION DEVELOPMENT STRATEGIES

The region's innovative development strategy is constructed to manage innovation development. It's a tool needed to solve a variety of different tasks. It is designed to link the priorities of highly prospective development with the level of potential innovation and to provide a new level in production and management. The innovative potential of a region is considered to be a combination of financial, material, labor, information and communication, intellectual, infrastructural resources.

The strategy of innovative development determines:

- innovative activity of the region aimed at obtaining new types of products, services and technologies, as well as applying new developed methods in research and development, production, management and marketing;
- transition to the latest organizational structures;
- introduction new types of resources and new developed approaches using region's traditional resources.

At the same time the unified and generally accepted definition of the concept "innovation strategy" has not been worked out until now. Whereas, the problem of strategizing innovation development is researched by many domestic and foreign scientists [3]. For example, G. Pisano understands the strategy as the coordinated model of behavior aimed at achieving a competitive goal [4].

It's made it possible to identify three ways to reflect the innovation strategy in the methodological support by studying the regulatory support of state authorities' activities in the Russian Federation regions presented on their official websites. In accordance with the first, the innovation strategy is drawn up as an independent document, complementing the set of strategic planning documents for the socio-economic development of the region. Currently, the development and implementation of "actually" innovative strategies is carried out only in nine regions of the Russian Federation. In the number of regions innovative strategies have been prepared earlier, but have lost their legal force due to the expiration of the validity period by the current moment.

The second method involves the formation of an innovation strategy as part of a regional socio-economic policy, defining goals, objectives and measures of economic, social, innovation, financial nature of the territories' development in the long term. With this method, the goals, attitudes and priorities of innovation activities are disclosed, as a rule, in a separate section (paragraph) of the goal-setting document (strategy) of socio-economic development. The third way is to design the results of the Russian Federation region's innovation development strategy as a set of interrelated documents reflecting the aspects of goal-setting, forecasting, planning and programming the innovative development of the territory and forming as a result a common innovation strategy. With this method of formalization there is no innovation strategy as an independent document in the region [5].

Anyway, the innovation development strategy of the region is aimed to improve the innovation development system and its description involves the following steps:

1. Select the goals and objectives of the region's innovative development;
2. Determine the system description method of innovative development;
3. Develop a general scheme for the innovative development system, as well as describe its subsystems;
4. Form the description of the strategic development process and its process subsystem;
5. Determine the structure and characteristics of the functional subsystem;
6. To determine the composition and characteristics of the performance subsystem;
7. Outline the relationship in the system of innovative development of the enterprise;
8. Determine the outgoing and incoming information flow of the system;
9. Develop recommendations for innovative development systems' introduction;
10. Present the work's results the of the region innovative development system.

The management of the region's innovative development involves the selection and definition of effective tools as the result of complexity in solving these problems and that are necessary for managerial influence.

METHODS FOR ASSESSING THE EFFECTIVENESS OF REGIONAL INNOVATION SUBSYSTEMS DEVELOPMENT

One of the most important stages in construction regional innovative development strategy is to evaluate the effectiveness of the regional innovation subsystem development. The approach to solving this problem is presented in the study by A. Yu. Klimentyeva [6]. According to the study it is necessary to perform the following stages for each region:

1. The choice of indicators reflecting the resource support of the innovation process.
2. Rationing of specific values of selected indicators.
3. Calculation of aggregate indicators.

To obtain intermediate results of assessing the resources availability, it is necessary to calculate cumulative values for each group of indicators: staffing, financial security, informational and organizational security, as well as the cumulative indicator of the innovation process result by calculating the arithmetic average.

4. The calculation of the total integral index.

Since the obtained aggregate indicators reflect specific categories of resources, it is proposed to determine the integral indicator of resource availability for the regional innovation subsystem by the formula (1).

$$Y_i = \sqrt{\sum_{i=1}^{3} (I_K + I_F + I_U)^2}\ , \qquad (1)$$

where Y_i – the resource availability integral indicator for the regional innovation subsystem;

I_K – the value of the cumulative indicator for the group of personnel security;

I_F – the value of the aggregate indicator for the group of financial security;

I_U – the value of the cumulative indicator which reflects the information on the group of information and organizational security.

To build the matrix of resource efficiency for the regional innovation subsystem it is necessary to determine the class of the situation, the parameters for the definition are presented in Table 1. Then the cluster is determined according to the data given in Table 2.

Table 1. Situation Classes

Class boundaries		Class
Lower	Upper	
0	0,5	Low
0,5	0,99	Middle
0,99		High

Table 2. Clusters

Cluster	Integral indicator of the regional innovation subsystem	Integral indicator
D – low security zone	Low	Low
C – inefficient resource management area	Middle	Low
	High	Low
B – underutilization of resource provision	Low	Middle
	Low	High
A – efficient resource management area	High	Middle
	High	High
	Middle	Middle
	Middle	High

The presented methodology for assessing the effectiveness of the regional innovation subsystems development in conjunction with a set of relevant models, functional blocks, databases and other elements could be the basis for the formation of decision making tools for managing the region's innovative development.

THE DATABASE STRUCTURE OF DSS FOR THE WORKING REGIONAL INNOVATIVE DEVELOPMENT STRATEGY

From a practical point of view, solving the problem of managing the region’s innovative development today is impossible without using modern information technologies and decision support systems (DSS).

The decision-making process is directly related to the processing and structuring of large volumes of information [7]. Decision support systems in the modern world are based on vari-

ous mathematical methods that allow freeing up human resources at the stage of data processing and structuring. It should be noted that the role of the DSS in the decision-making process is solely in support, while the direct decision-making, of course, remains only for the person [8]. Decision support systems in full swing cover more and more areas in human life.

Having a system that can automatically collect information, prepare it and process this information is one of the required conditions for the development of a region. Already today, the most successful in the business world are those regions where corporations and enterprises are able to quickly gather information, process it, analyze it and make optimal decisions based on this, i.e. use any modern information tools and technologies. As noted earlier, the core of the DSS is a model complex that describes the functioning of the area of public life activity. An information model is the basis for its formation. It is such an object model, which is presented as information, describing the most important aspects for this process, considering the parameters and variables of the object, relations between the objects, input and output parameters of the object, in order to simulate all possible states of the object. At the same time, an information model is cumulative information that characterizes important properties and the state in which an object, process or phenomena is located, as well as its connection with the outside world.

The following tables could be created for the resource efficiency evaluating module in the regional innovation subsystem based on the above description allowing organizing the storage and processing of the necessary data: 1) Personnel security; 2) Financial security; 3) Information and organizational security; 4) Results of the “Regional Innovation Subsystem”; 5) List of regions; 6) List of years; 7) List of classes; 8) List of clusters; 9) Class of security; 10) Cluster of regions.

For example, let’s consider the table "Personnel security." The table contains the “idKadr” field, which is the primary key (one or more fields in the table, the combination of which is unique for each record [9]). The following fields are used to store the input data that is needed to calculate the assessment of the regional innovation subsystem.

Table 3. Personnel security

Name	Description	Type	Primary key (PK)	Foreign key (FK)
idKadr	Code	integer	+	-
K1	Number of staff	float	-	-
K2	Doctors of Sciences	float	-	-
K3	Candidates of Science	float	-	-
K4	Admission to graduate school	float	-	-
K5	Graduation from graduate school	float	-	-
K6	Admission to the doctoral program	float	-	-
K7	Doctoral degree	float	-	-
K8	Average number of employed	float	-	-
K1y	Staff share	float	-	-
K2y	Proportion of Doctors of Science	float	-	-
K3y	Share of candidates of science	float	-	-
K4y	Percentage accepted in graduate school	float	-	-
K5y	Proportion of graduates	float	-	-
K6y	Percentage accepted for doctoral studies	float	-	-
K7y	Percentage released from doctoral studies	float	-	-
K1yNorm	Normalized value	float	-	-
K2yNorm	Normalized value	float	-	-
K3yNorm	Normalized value	float	-	-
K4yNorm	Normalized value	float	-	-
K5yNorm	Normalized value	float	-	-
K6yNorm	Normalized value	float	-	-
K7yNorm	Normalized value	float	-	-
IK	Cumulative value	float	-	-
idRegions	Foreign key (region)	integer	-	+
idYear	Foreign key (year)	integer	-	+

Field "K1" - the number of personnel engaged in scientific research, pers.; "K2" - the number of staff with a scientific degree of doctor of science; "K3" - the number of staff with a scientific degree of candidate of science; "K4" - admission to graduate school; "K5" -

graduation from graduate school; "K6" - admission to doctoral studies; "K7" - graduation from doctoral studies; "K8" - the average annual number of employed people. For storing intermediate calculated data, fields K1y, K2y, K3y, K4y, K5y, K6y, K7y, K1yNorm, K2yNorm, K3yNorm, K4yNorm, K5yNorm, are created. "IK" is an integral indicator. The "idRegions" and "idYear" fields are foreign keys for communicating with the "List of Regions" and "List of Years" tables, respectively. All used fields are presented in table 3.

Also, by analogy, other tables of the information model are created. A fragment of the database structure for the module for assessing the efficiency of resource use in the regional innovation subsystem is shown in Fig. 1. This shows the primary keys of the tables, the types of data fields, and the relationships between the tables.

The presented database structure allows linking all the necessary information to assess the effectiveness of the development of regional innovation subsystems within a single toolkit and becomes part of a decision support system in this area.

PRACTICAL ASPECTS OF THE ORGANIZATION OF DS (DECISION SUPPORT) USING THE ADAPTIVE-SIMULATION MODEL

From a practical standpoint, the set of tasks to be solved with the use of the decision support tools we developed is determined based on the sequence of stages in the development of a strategy for innovative development of a region and the need to take into account the advantages and disadvantages of individual approaches. In this regard the following are among the basic tasks:

- collection and storage of factual information, including structured (in the form of decision-making rules) and weekly structured information (in the form of ontologies and precedent bases);
- assessment of observed and predicted situations using a problem-oriented knowledge base with a logical inference mechanism;
- making a forecast of changes of the situation in certain conditions on the basis of an adaptive-simulation model;

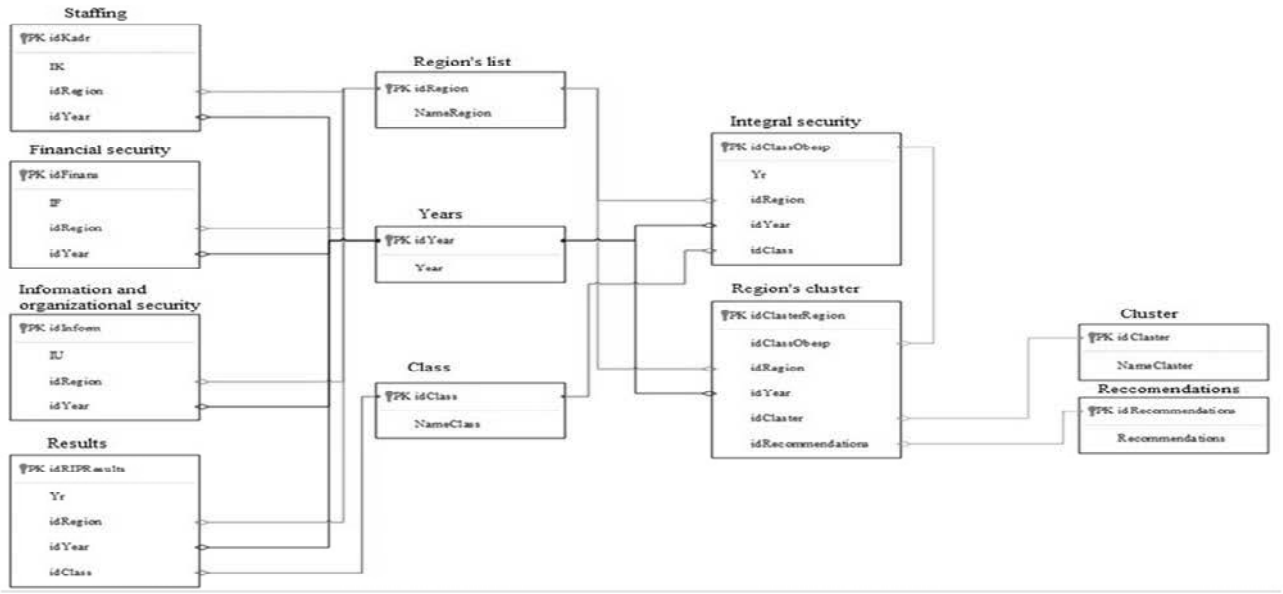

Fig. 1. Fragment of the database structure

- substantiation of a set of recommendations for the development and adjustment of key parameters to manage the region's innovative development.

Taking into account the features of the functioning and development of the control object, as well as taking into account the goals and objectives of the development of tools, it is advisable to use a simulation model reflecting the adaptive properties of the behavior of economic agents as its core [10]. At the same time, the characteristics of the agent in question and decision-making rules based on both their own experience and the analysis of the behavior of other agents are important. The solution to these problems is ensured by using the capabilities of the adaptive-simulation model of the region, which integrates three key levels within the framework of a single design – economic agents, government, and the macro-environment.

Of the entire set of parameters describing the external environment of the agent (including the characteristics of contractors), only a limited part of them is perceived by the economic agent. In addition, information on the state of the agent is also available to him only partially. Based on this, decisions are made by the agent on the basis of limited knowledge. Based on this information, as well as taking into account the existing rule bases and knowledge base, the agent classifies situations and makes decisions. Simultaneously with the decision itself, the agent forms an image of the desired result of the implementation of the strategy. Moreover, the decision within the framework of this study also means the possible refusal of the agent to take any actions. The implementation of the decision and, therefore, the consequences of this decision are influenced by the parameters of the external environment, including the active reaction from the contractors. Thus, the consequences of the decision to one degree or another differ from the expected results. In the course of comparison by the agent of the expected and obtained results, either the rules and knowledge of the agent are confirmed (if the results coincide), or a correction of its rules and knowledge bases takes place.

CONCLUSION

During the study, the following key results were obtained:

- the efficiency of the country's economy as a whole is largely determined by the national innovation system;
- it is the analysis of the regional aspect of innovation activity that allows to take into account the specifics and characteristics of a particular territory, the established sectoral specialization of the regions and other factors that influence the development efficiency of the region, and, as a result, the country as a whole;
- proposed a methodology for assessing the effectiveness of the development of regional innovation subsystems;
- the structure of the database of information support for decision making in this area has been developed.

REFERENCES

1. **Krasnoselskaya D. Kh.** "Improving the organizational and economic aspects of managing capital accumulation in a region" (in Russian), in *Upravleniye ekonomicheskimi sistemami: elektronnyy nauchnyy zhurnal,* no. 8(80), p. 27, 2015.

2. **Nizamutdinov M. M., Oreshnikov V. V** "Determining the parameters of regional development management based on fuzzy logic algorithms" (in Russian), in *Ekonomika i matematicheskiye metody*, vol. 52, no. 2, pp. 30-39, 2016.

3. **Ataeva A. G., Ulyaeva A. G.** "Innovative aspects of the development of the regional economy and the industry problems of land management of municipalities in the context of increasing the financial independence of local territories" (in Russian), in *Nauchnyye trudy Vol'nogo ekonomicheskogo obshchestva Rossii*, no. 166, pp. 140-145, 2012.

4. **Koshchegulova I. R., Ivanov P. A.** "Regional innovation system and risk factors" (in Russian), in *Ekonomika i upravleniye: nauchno-prakticheskiy zhurnal*, no. 104, pp. 75-80, 2011.

5. **Pechatkin V.V.** "Toolkit for assessing regional wealth and the possibility of its use in the practice of territorial management" (in Russian), in *Imushchestvennyye otnosheniya v Rossiyskoy Federatsii*, no. 149, pp. 55-61, 2014.

6. **Klimentyeva A. Yu.** "Resource support of the innovative development of the Russia regions and evaluation of its effectiveness" (in Russian), in *Innovatsionnoye razvitiye ekonomiki*, no. 44, pp. 43-50, 2018.

7. **Chernyakhovskaya L. R., Atnabaeva A. R.** "Ontological engineering of risk management in the production process to ensure food safety" (in Russian), in *Sovremennyye naukoyemkiye tekhnologii*, no. 8, pp. 161-166, 2018.

8. **Nizamutdinov M. M., Oreshnikov V. V.** "The concept of implementing a decision support system in the field of regional innovation management based on an adaptive simulation model" (in Russian), in *Informatsionnyye tekhnologii*, vol. 23, no. 10, pp. 714-721, 2017.

9. **Latypova R. R.** "Database. Lecture course", (in Russian). Moscow: Higher School, 2016.

10. **Gubanova E. V., Grishkovskaya Yu. N.** "Investments in human capital as a key factor in the development of the region" (in Russian), in *Kaluzhskiy ekonomicheskiy vestnik*, no. 2, pp. 66-71, 2019.

METADATA

Title: Information support in working-out the innovation development strategy at the regional level.

Authors: M. M. Nizamutdinov[1], N. I. Fedorova[2], V. V. Oreshnikov[3], A. Yu. Klimentyeva[4]

Affiliation:

[1, 3, 4]Institute of Social and Economic Research, Ufa Federal Research Center, Russian Academy of Sciences, Ufa, Russia

[2] Ufa State Aviation Technical University (UGATU), Ufa, Russia.

Email:[1]marsel_n@mail.ru,[2]nf_2002@mail.ru,[3]VOresh@mail.ru, [4]annakobzeva@gmail.com

Language: English.

Source: SIIT (scientific journal of Ufa State Aviation Technical University), vol. 2, no. 1 (3), pp. 40-47, 2020. ISSN 2686-7044 (Online), ISSN 2658-5014 (Print).

Abstract: The article deals with the development of strategies for the innovative development of Russian regions. The formalized description of the methodology for assessing the effectiveness of the regional innovation subsystems development is presented. The pro-posed integrated indicator of resource availability for the regional innovation subsystem. Classes of situations for the formation of the resource efficiency matrix of the regional in-novation subsystem are defined. The database structure has been developed for a system of information support for decision making in the construction of the region innovative development strategy. The list of necessary data is defined. A number of practical issues of decision support in this area are considered.

Key words: regional system, innovation, decision support, development strategy, development stages, database, resource availability, classification, resource intensity, practical implementation.

About authors:

NIZAMUTDINOV, Marsel Malikhovich, Ph.D., Associate Professor, Head of the Economic and Mathematical Modeling Sector, Institute of Social and Economic Research, Ufa Federal Research Center

FEDOROVA, Natalya Ivanovna, PhD in Technical Science Associate Professor, Department of Technical Cybernetics, Ufa State Aviation Technical University

ORESHNIKOV, Vladimir Vladimirovich, Ph.D., Senior Research Fellow, Economic and Mathematical Modeling Sector, Institute of Social and Economic Research, Ufa Federal Research Center

KLIMENTYEVA, Anna Yuryevna, Scientific Associate, Institute of Socio-Economic Studies, Ufa Federal Research Center of the Russian Academy of Sciences