



Methodology for assessing the level of innovative development of the territories

Metodología de evaluación del nivel de desarrollo innovador de los territorios

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ABSTRACT:

The main participants of the territorial innovation system and its distribution by the subsystems have been identified by the authors. A proper approach to the structure of the territorial innovation system is proposed which suggests that the socio-economic development of the territory is included as a support subsystem in the territorial innovation system. The author's model of the territorial innovation system is taken as the basis for the elaboration of the methodological approach to assess the level of development of the territorial innovation system.

Keywords: regional innovation system; evaluation of the level of innovative development of the regions; socioeconomic environment; green economy

RESUMEN:

Los principales participantes del sistema de innovación territorial y su distribución por los subsistemas han sido identificados por los autores. Se propone un enfoque propio de la estructura del sistema de innovación territorial el cual sugiere que el desarrollo socioeconómico del territorio se incluye como un subsistema de soporte en el sistema de innovación territorial. El modelo del autor del sistema de innovación territorial se toma como base para la elaboración del enfoque metodológico de evaluación del nivel de desarrollo del sistema de innovación territorial.

Palabras clave: sistema de innovación regional; evaluación del nivel de desarrollo innovador de las regiones; entorno socioeconómico; economía verde

1. Introduction

In the context of Ukraine's integration into the European Union and the reforming of the local self-government, which is called to resolve a number of obsolete problems in territorial management and provide real opportunities for the development, issues of the formation and development problems of the eco-friendly regional innovation systems (RIS) become. The main requirement for the countries intending to enter the European Union (EU) is to ensure the sustainable development of the territories on the basis of the innovation-oriented economy, the economy based on environmentally friendly technologies (including energy-saving ones), which are the basis of Ukraine's innovative transformations and will provide the "green growth" to which the whole world endeavors. In 1994 in Ukraine a course to implement the "innovative model of sustainable development" and to accelerate the integration of the state's economy into the world

economy with a high level of competition was launched, but neither strategic nor tactical measures were fully implemented. The reason for this is the low efficiency and quality of the innovation development management, both at the country level and at the regional level. In connection with this, lately, questions arise regarding the management of the development of the eco-friendly regional innovation system, which ensures an increase in the quality of the population life through the innovative development of the economy.

2. Methodology

In designing the structure of the eco-oriented RIS we proceeded from the fact that it has a number of common positions with the Triple Helix concept (Arnkil etc., 2010), the Quadruple Helix concept, which along with universities, industry and the state, a key role in the innovation process presents to the society - the end user of the innovations (Carayannis & Campbell, 2012) and the Quintuple Helix concept, which forms knowledge and innovations in the context of the environment and which is interpreted as an approach consistent with the principles of the sustainability development and the social ecology (Carayannis, Barth & Campbell, 2012).

The methods of the theoretical and empirical research are used in this study, namely: the methods of the analysis and synthesis are used in determining the euro integration landmarks and the formation of the eco-oriented regional innovation system development, the study of the world and domestic experience and the best practices of the innovative development of the territories on the basis of the concept of sustainable development, the substantiation of the mutual influence of the quality life and innovations. Methods of comparison and analogy are used while studying foreign assessing methods of the innovation development in the regions. Classification methods are used while studying the theoretical foundations of the innovation development.

3. Results

A significant contribution to the study and the formation of the innovative economy, the development of the national and eco-friendly regional innovation systems have made scientists as V. Gusev, H. Kuznetsova, R. Coase, R. Lucas, S. Metcalf, L. Melnyk, D. North, R. Nelson, R. Solou, V. Tolkovanova, I. Chikarenko, K. Freeman, M. Filyak, B. Chizhevsky, F. Hayek, J. Schumpeter, Y. Sharov and others. Chikarenko I while studying the problems of the formation of the management system for innovation development indicates that regional innovation systems (RIS) presuppose the presence of the environment that affects the internal processes of the RIS, on parameters and results and also the RIS structure includes subsystem of knowledge generation and the subsystem of innovations distribution and using and has a number of common positions with the Triple Helix concept. (Chikarenko, 2014). In the study regarding the socio-economic potential of the sustainable development is indicated that the economic growth ensuring directly affects the environmental pollution and degradation, climate changes, loss of biodiversity, human health and other processes and, therefore, one of the promising directions for eliminating the environmental, economic and social threats is to ensure the sustainable development on the basis of the transition to a "green" economy (Libanova etc., 2017). At the same time few scientific works cover the issue of managing the eco-friendly development of the innovation system in the region on the basis of the assessment of the mutual influence of the socio-economic and the innovation environment with studying the place of the "green" economy in the regional innovation systems. To the issues that require detailed elaboration in this context it is possible to refer the development of a structural model of the eco-oriented regional innovation system (RIS) taking into account the interconnection of the RIS subsystems, macro components, as well as elements of Triple Helix, Quadruple Helix, Quintuple Helix for the development of innovation and methodological recommendations regarding the assessment of the eco-oriented RIS development taking into account the interaction of the socio-economic and innovative environment with allocation of the evaluation block of the "green" economy development.

The conducted scientific analysis of the regional development in the EU countries shows that the main factor of the regional development is the management of the RIS development considering the ecologization of the region economy, and the research on the RIS development allowed to state that, firstly, the RIS has several representation forms: 1) the RIS as a set of regional public and private education, science and business institutions, which initiate, create and distribute innovations in the region and beyond; 2) the RIS as a functional subsystem of the regional economy, a set of interacting education, science and innovation business institutions integrated into the regional economy; 3) the RIS as a spatially organized subsystem of the national innovation system (NIS), which is aimed at forming the innovative type of economic development

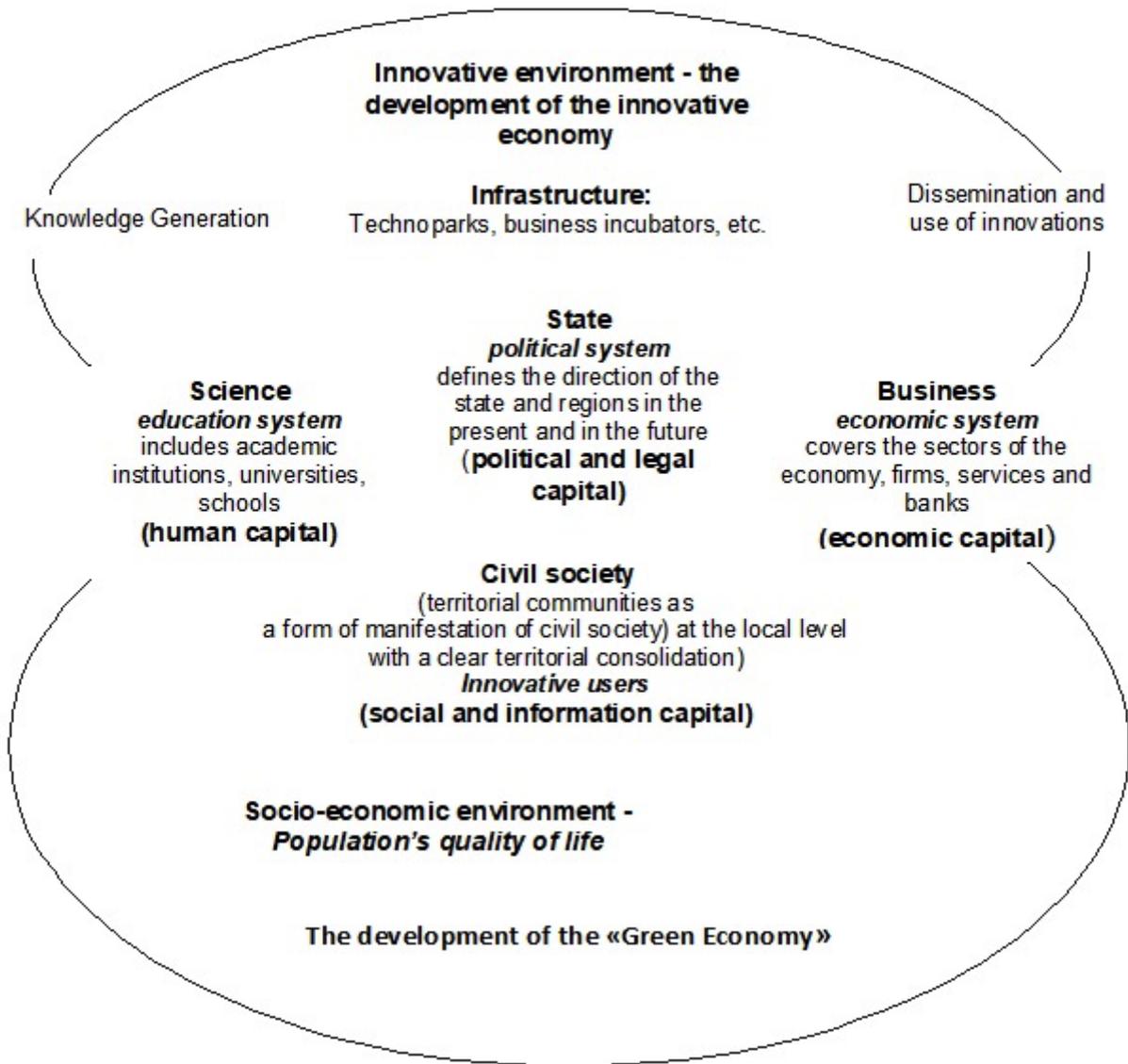
in the country; secondly, the regional innovation system is an open system, the process of the new knowledge (technologies) diffusion that is directed both beyond its boundaries and within its boundaries (this accelerates the circulation of knowledge within the system and ensures the appearance of innovations), that is, other the RISs, NIS and international factors influence on the RIS ; thirdly, in the Ukrainian economic science there is no integral RIS concept, namely, there is no single approach to the RIS structure. The RIS in most cases is considered by scientists as a set of institutionalized territorial NIS subsystems; such conception of the RIS does not provide an idea of the interdependence between the innovation development level and the development of the socio-economic environment of the regions. Therefore, in the context of our research we follow the approach to the RIS as a functional, spatially-organized system of the regional economy (Nondo, C., Gebremedhin, T., 2014) that combines the science, business, the state, the society and the environment and provides processes for generation, transfer, production, commercialization, distribution and use of new knowledge (technologies), as well as we pay our attention to the socio-economic (which includes the block of eco-friendly economy, that is, the "green economy") and the innovative environment, where through the processes of generation and the spread of new knowledge (technologies) with the help of the interaction of the RIS participants the innovative development in the region is provided.

In determining the RIS structural model we proceed from the following: 1) the RIS structure should be applied and this will allow it to be applied in the approaches to the study and analysis of the regional economy, regional development and regional competitiveness; 2) the RIS structure involves, of course, the environment that affects the RIS internal processes, the conditions' parameters (input) and results (output) (Rozenbaum & Klimchenko, 2016); 3) the RIS structure is represented by subsystems that form its system properties, namely, a subsystem of the knowledge generation (innovation infrastructure) and subsystem of the distribution and use of innovations (interaction of the RIS participants); 4) the RIS structure has a number of common positions with the Triple Helix concept, the Quadruple Helix concept, which along with universities, industry and the state a key role in the innovation process presents to the society - the end consumer of innovations (Carayannis & Campbell, 2012) and allows simultaneous integration of these four sectoral spaces on the basis of dynamically balanced approaches a "top-down" (the government, universities, industry) and "bottom-up" (the civil society), as well as the Quintuple Helix concept, which forms knowledge and innovation in the context of the external environment; and it is the model that is interpreted as an approach to the principles of the sustainable development and social ecology (Carayannis, Barth etc., 2012), it is within this model the natural environment, the society and the economy are considered as drivers of knowledge generation, innovation and the formation of opportunities for the economy knowledge; it is the model that considers future progress as a stable balance between the society development and the economy with their natural environment, forms the relationship between ecology, knowledge and innovations ensuring coordination between the economy and the society (Carayannis, Barth etc., 2012).

In the proposed structural model of the eco-friendly RIS (fig. 1) the relationship between the RIS subsystems and the components of the macro environment is presented, as well as the place of the Triple Helix, Quadruple Helix, Quintuple Helix elements that allows to determine the degree of various subsystems developments, their individual elements and contributes to typization of the regional innovation systems for comparative assessments in order to find ways to further RIS development: either the formation of the interregional eco-friendly innovation system or RIS creation with the capacity to carry out eco-oriented innovative activity. In this connection, there is a necessity for the regions' classification according to the RIS development level, for example, 1) the RIS with a full cycle of innovation; 2) the RIS where processes of knowledge "production" prevail; 3) the RIS where subsystems of distribution, use of knowledge and implementation of their results prevail; 4) the institutional RIS (there are no internal sources for innovations in the region, a significant role in the innovation process belongs to the state and large enterprises); 5) the entrepreneurial eco-friendly RIS (there is a demand for innovation, there are favorable conditions for the development of entrepreneurship, generation and diffusion of

Figure 1
The structural model of the eco-friendly regional innovation system (RIS)

International factors, National innovation system and other regional innovation systems



Source: developed by the authors

innovations take place in the innovation-active small and medium business) - this will allow to determine the directions of the regional strategies and programs development (Doloreux & Parto, 2005).

It should be noted that in the eco-friendly RIS structure different participants of the innovation activity interact: 1) business sector: companies, firms, enterprises (including small enterprises), financial institutions, as well as elements of the innovation infrastructure of the region; 2) public sector: local authorities, which create systemic links and help to distribute innovations to the region's economy; 3) research and development sector: universities, research institutes, also business incubators, transfer and technology commercialization offices, etc.; 4) citizens (civil society), users of innovations, it is them who specially determine the innovation process in the region and they are its driving force, they participate both in the development of innovations and in the proposals for new innovations, resulting in establishing users relations with others - citizens in business, science and government, which in their turn support innovation activities of citizens, providing them with tools, information, skills, platforms for innovation development and creation, and which will be able to use created innovations profitably (Mohapatra, 2012). Such a selection of the eco-friendly RIS components allows exerting purposeful influence on the regional innovation process represented by the generation of new knowledge, its transfer and transformation into innovation, which is a prerequisite for the innovative development of the territory.

Through examination of the composition and conditions of the eco-friendly RIS development we became aware that to a large extent its development is determined by the state of the socio-economic and innovation environment, which in close mutual influence and interaction, form the

innovative potential of the territory - the most important institutional factor that determines the prospects and directions of the RIS development. In this context we note that:

1) the incoming resources to the eco-friendly RIS are created in the socio-economic environment and the innovation environment ensures the transformation of these resources into innovations and changing living conditions and activities of the citizens. The socio-economic environment includes basic institutions and relationships that increase the well-being of citizens and is characterized through the integral indicator of the "life quality", while raising the well-being of citizens should occur during reducing the negative impact on the environment, and it is possible in the transition to "green" economy and this transition should take place within a specific region and each region allocates its most promising branches from the viewpoint of the "green growth". The innovation environment is made up of relationship, activity and resources of the socio-economic environment, which are involved in innovation processes and have an appropriate functional orientation (in most cases the innovation environment is evaluated through the effectiveness of the innovation activity, namely, its economic efficiency);

2) the conditions of the socio-economic development and the innovative environment determine the degree of accumulation of innovation potential in the region, an assessment of which is carried out on the basis of a set of interrelated factors. We consider to note that in our research on the concept of innovative potential of the region we have already indicated the different approaches to its understanding, on the one hand, under the innovative potential of the region we understand the ability or opportunity of the subjects of the socio-economic environment in the region to innovate and produce innovation, on the other hand, it is a collection of various resource subsystems, one way or another, connected with the innovation activity. At the same time, the application of different approaches leads to different assessments and different interpretations of the results, therefore, we proceed from the fact that the innovative potential of the region is the ability of regional business entities to innovate and it leads to the improvement in the quality of the citizens' life due to certain factors of the socio-economic and innovation environment in the region. It is through innovative potential the level of the eco-friendly RIS innovative development is estimated.

There are numerous methods for assessing the level of the territories innovation development (for example, the European Innovation Union Scoreboard - EIS, the Regional Innovation Scoreboard - RIS, RIS3, etc.) that are used both abroad and in Ukraine, but none of the methods fully covers all the parameters of the innovation development and existing methods do not take into account the significant interconnection and the interaction between the socio-economic and the innovation development (the standard of living in a society is increased by the introduction of new ideas and the innovation activity is intensified in the conditions of the socio-economic well-being), and also the level of the "green" economy development do not include. Therefore, based on the synthesis of the most common methods of assessing the level of the RIS innovative development we suggest conducting this assessment taking into account, firstly, the type of the RIS development; and secondly, taking into account the mutual influence of the socio-economic and the innovative environment. Below the stages of conducting an assessment of the RIS innovative development level are given.

Stage 1 - Definition of indicators. The selection of indicators should be conducted taking into account the following requirements: 1) indicators should reflect the most relevant aspects of the region's development; 2) the analysis was based on indicators from the Official Ukrainian database (data collection from statistical directories and calculation of indicators socio-economic development and innovative development) (table 1).

Table 1
Indicators socio-economic development
and innovative development

| Indicators socio-economic development | | Indicators innovative development | |
|---|-----------------|---|------------------|
| 1 The demographic situation | | 1 Institutional factors (determined by experts in points) | |
| 1.1 Growth (reduction) of population (thousand persons) | X ₁₁ | 1.1 the absence of obstacles for the creation of new enterprises | Y ₁₁ |
| 2 Factors in the level of economic development | | 1.2 high level of trust between science and business, between business and regional and local authorities | Y ₁₂ |
| 2.1 The share of the economically active population in the amount of population, % | X ₂₁ | 1.3 availability of production, information and financial infrastructure | Y ₁₃ |
| 2.2 GRP per capita, % | X ₂₂ | | |
| 2.3 Unemployment rate, % | X ₂₃ | 1.4 availability of tax incentives for producers | Y ₁₄ |
| 2.4 Investments per capita thousand UAH | X ₂₄ | 1.5 level of competition | Y ₁₅ |
| 2.5 Exports share in the foreign trade turnover, % | X ₂₅ | 1.6 level of education | Y ₁₆ |
| 2.6 The share of agricultural products,% | X ₂₆ | 1.6 level of education | Y _{1m} |
| 2.7 The level of the economic activity | X ₂₇ | 2 Factors of the innovation climate | |
| 3 Factors of living standards of the population | | 2.1 The development of the innovation infrastructure | |
| 3.1 Cash incomes per capita, thsd. UAH | X ₃₁ | 2.1.1 Number of organizations involved in research work per 10,000 thousand people | Y ₂₁₁ |
| 3.2 The ratio of the average monthly wage to the subsistence minimum,% | X ₃₂ | 2.1.2 The share of innovation-active enterprises in the total number of industrial enterprises,% | Y ₂₁₂ |
| 3.3 People with incomes lower than the subsistence minimum % | X ₃₃ | 2.1.3 The share of innovation-active small and medium businesses in the total number of innovation-active enterprises,% | Y ₂₁₃ |
| 3.4 Average monthly income in calculation per person, UAH | X ₃₄ | 2.1.4 Number of innovation-active enterprises, units | Y ₂₁₄ |
| 4 Factors of entrepreneurship development | | 2.2 The development of the innovation economy | |
| 4.1 Number of small and medium enterprises (SMEs), thsd | X ₄₁ | 2.2.1 The number of issued patents | Y ₂₂₁ |
| 4.2 Number of citizens involved in small business, mln. persons | X ₄₂ | 2.2.2 Number of used innovative technologies | Y ₂₂₂ |
| 4.3 Number of small enterprises per capita, thsd. | X ₄₃ | 2.2.3 The specific weight of innovative goods, works, services in total,% | Y ₂₂₃ |
| 4.4 The share of SMEs in the total sales volume of enterprises,% | X ₄₄ | 2.2.4 The ratio of the innovation products amount to the total cost of scientific development,% | Y ₂₂₄ |
| 4.5 The share of SMEs in the total number of employees in enterprises,% | X ₄₅ | 2.2.5 Volume of the realized innovative products, mln. | Y ₂₂₅ |
| 4.6 The share of SMEs in the total sales volume of enterprises,% | X ₄₆ | 2.3 The development of science and education | |
| 4.7 Assessment of the difficulty of the business start up, points | X ₄₇ | 2.3.1 The specific weight of the volume of performed scientific and scientific-technical works in the GRP,% | Y ₂₃₁ |
| 4.8 The level of business trust to the regional authority,% | X ₄₈ | 2.3.2 Number of specialists who performed scientific and scientific and technical works, thousand people | Y ₂₃₂ |
| 4.9 Assessment of difficulty in obtaining a loan in the region, in points | X ₄₉ | 2.3.3 Enterprises expenses for conducting (ordering) GDR, thsd UAH | Y ₂₃₃ |
| 5 Factors of the education and public health | | 3. Factors for the effectiveness of innovations | |
| 5.1 Number of higher educational institutions of the III-IV accreditation level, units. | X ₅₁ | 3.1 The share of realized innovative products in the total volume of the realized industrial products, % | Y ₃₁ |
| 5.2 Planned capacity of outpatient clinics, visits per shift for 10,000 people | X ₅₂ | | |
| 5.3 Number of hospital beds, units. per 10000 population | X ₅₃ | | |
| 5.4 Number of hospitals, units. | X ₅₄ | | |
| 6 Factors for the development of the "green" economy | | | |
| 6.1 The share of renewable sources in the total energy production, % | | | Z ₆₁ |
| 6.2 Emissions of pollutants into atmosphere per area unit | | | Z ₆₂ |
| 6.3 Emissions of pollutants into the air per unit of GRP | | | Z ₆₃ |
| 6.4 Emissions of pollutants into atmospheric air per capita | | | Z ₆₄ |
| 6.5 Formation of production waste and consumption per area unit. | | | Z ₆₅ |

Source: Grouped and systematized by the authors according to the data (Official Ukrainian database; Sarkar, 2013; Nondo, Gebremedhin, 2014;

Stage 2

Normalized indicators are calculated (in relation to the region-standard with the maximum or minimum values of a given indicator)

$$X_{ij}^{norm} = X_{ij} / X_{i \max(\min)} \quad (1)$$

$X_{i \max(\min)}$ - normalized value and index for j region; X_{ij} - value and index for j region; $X_{i \max(\min)}$ is the maximum or minimum value and indicator for all regions.

$$Y_{ij}^{norm} = Y_{ij} / Y_{i \max(\min)} \quad (2)$$

$Y_{i \max(\min)}$ - normalized value and index for j region; Y_{ij} - value and index for j region; $Y_{i \max(\min)}$ is the maximum or minimum value and indicator for all regions

$$Z_{ij}^{norm} = Z_{ij} / Z_{i \max(\min)} \quad (3)$$

$Z_{i \max(\min)}$ - normalized value and index for j region; Z_{ij} - value and index for j region; $Z_{i \max(\min)}$ is the maximum or minimum value and indicator for all regions.

Stage 3

The choice of the ris type (institutional or business)

Stage 4

Calculation of the integral indicator of the development level (socio-economic (I_{ser}) including the green economy (I_{ze}) and innovative (Y_{inov}))

$$I_{ser} = \sum_1^j X_{ij}^{norm} \quad (4)$$

$$I_{ze} = \sum_1^j Z_{ij}^{norm} \quad (5)$$

$$I_{inov} = \sum_1^j Y_{ij}^{norm} \quad (6)$$

Stage 5

Assessment level of integral indicators interaction

Stage 6

Analysis of relations between: 1) the integral indicator of the innovative development IINOV and specific socio-economic indicators x_1-x_n , and also indicators of the green economy development z_1-z_n ; 2) the integral indicator of the socio-economic development ISER and specific factors of the innovative environment y_1-y_m . Interpretation of the received results for the correcting of the strategy and programs of the innovational development in the region is conducted.

The advantages of the suggested approach to assessing the development level of the eco-friendly RIS are, first of all, that it characterizes the results of the regional eco-friendly innovation policy and indicators can be directly used for strategic decision making within the framework of the development and the implementation of the regional eco-friendly innovation policy.

4. Conclusions

Regions in Ukraine differ from each other both in terms of scientific- technical and production potentials and in terms of the socio-economic development, and these differences affect the content of the regional eco-oriented innovation policies and individual programs designed to support and develop certain components of the regional eco-oriented innovation systems. However, the objective to ensure a high quality of the life for citizens through the innovative development is common at the level of every region, as the level factors of living standards for citizens and the innovative development in the region have an impact on each other. In order to check the availability and significance of the mutual influence of these factors a correlation

analysis of the integrated indicators of the socio-economic, natural and innovation environment development and the indicators characterizing these environments will be carried out in the future. This will allow developing the typology of the regions according to the level of the innovation development taking into account the qualification characteristic "mutual influence of the socio-economic and the innovation environment" and the "green" economy. This typology will help to determine the priorities in the selection of the regional eco-friendly strategies.

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