ARZIANTSEVA D.A.,
PhD (Economy),
Associate Professor,
Assistant Professor
of the Department of
Management,
Finance, Banking and
Insurance
Khmelnytsky University
of Management and Law

ZAKHARKEVYCH N.P.,
PhD (Economy),
Associate Professor,
Assistant Professor
of the Department of
Management,
Finance, Banking and
Insurance
Khmelnytsky University
of Management and Law

UDC 338.24:330.342+334.722.8(477)

THE METHODICAL BASES OF ASSESSMENT OF THE INNOVATIVE DEVELOPMENT OF REGIONS

The author's methodological tools of assessment of the level of the innovative development of a region by means of calculating the integral index have been proposed. The proposed calculation method includes six consecutive stages:

the determination of the system of indicators influencing the level of innovative development of a region; the formation of the statistical array of indicators for assessment; the rationing of the indicators for assessment; the calculation of weighting coefficients for each of the indicators by using the expert method; the determination of the intermediate and overall indexes of the level of innovative development of a region; the interpretation of the results of assessment and rating the regions in terms of innovative development.

Keywords: innovation, innovative development, scientific potential, production capacity, integral index of assessing the level of innovative development of a region.

Articulation of the issue in general and its relation to the important scientific and practical tasks. An important aspect of management of any economic system is the availability of tools for assessing the basic indicators of the development of the system and the achieved results, comparing them with other subjects, as well as monitoring the trends of change. It is on the basis of this assessment that makes it possible to choose the effective instruments of influence on the dynamics of the indicators of the development of economic systems.

Innovations are one of the priorities of the vector of development defined in the Strategy for Sustainable Development «Ukraine - 2020» [1]; the Program of Innovative Development should be worked out to support

their implementation. Despite these strategic aims the appropriate national target programs to support innovative development have not been developed yet and they are not functioning at the present time.

Moreover, the integral and generally accepted (universal) methodology for assessing the innovative development of economic systems (including regional ones) has not been created in the domestic science and practice. It prevents to formulate the appropriate conclusions and to develop the effective programming documents.

The analysis of recent research works and publications, in which the solution of this problem has been originated; the identification of the unsolved aspects of the problem, which this article is dedicated to. The following scientific papers are devoted to the issue of assessing the innovative development and innovation potential, namely by: Alexandrov V., Burkynskyi B.,Vovkanych S., Halchynskyi A., Hranberh A., Heyets V., Danylyshyn B., Denysyuk V., Koponosov G., Lazutin G., Lapko O., Molina O., Makoveyev P., Mrynska T., Onikiyenko V., Pepi T., Syzonenko V., Sharco M. However, the innovative development is thought by the scientists primarily at the state level, and practically, it is not researched as a matter of assessing the innovative activity of the regions of Ukraine.

The dynamic conditions of the functioning of the world economy require constant adjustment and improvement of the regional innovation strategies based on assessment of their current status. In view of this, the problems of search of the universal tools for assessing the real level of innovative development of a region are particularly actualized.

The formulation of research objectives (set of the problem). Taking into account the aforesaid, the purpose of the research study is to examine in detail the methodological principles of assessing the level of innovative development of regions, on the basis of which it is possible to rank regions and by combining them into the groups to choose the basic strategies of innovative development.

Presentation of the basic materials of the research. The essence and the methodological tools of assessing innovative development are still controversial issues that cause the need for their research and rationale. Therefore, to assess the innovative development of a region it is advisable to build a methodology that appropriately highlights the progress in achieving a certain level of innovative activity and allows, by ranking the regions, to develop the integrated group strategies to support and stimulate innovations. We propose to implement the elaborated methodical approach in the sequence specified in Fig. 1.

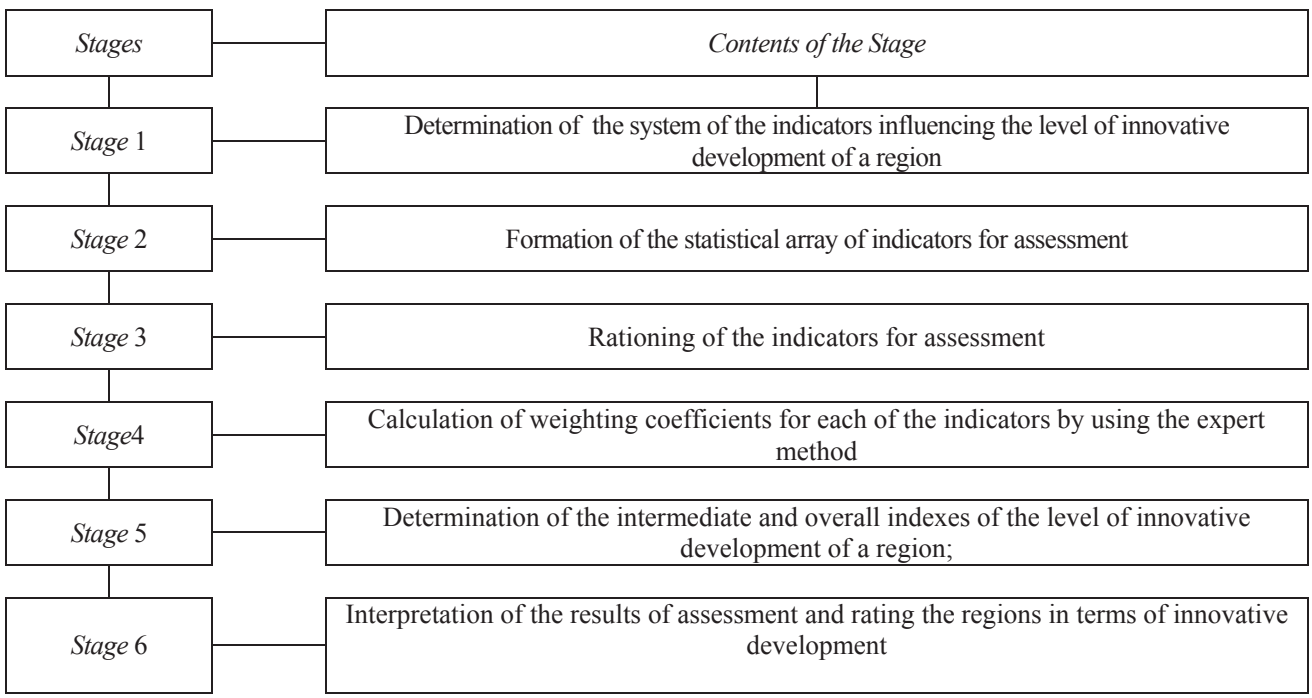

Figure 1. Consistency of assessing the innovative development of a region
Note. Developed by the authors

Table 1.

THE LIST OF INDICATORS FOR ASSESSMENT OF INNOVATIVE DEVELOPMENT OF A REGION

Group of indicators	Indicators	
Indicators for assessment of the level of development of scientific potential of a region	1.1.	1.1. The number of scientific organizations performing scientific and research and techology works in a region , units.
	1.2.	Number of researchers per a research organization which carries out scientific and research and techology works in a region, persons/ units.
	1.3.	The share of financing of internal costs to implement scientific and research and techology works in a region in gross regional product,%
	1.4.	The amount of scientific and research and techology works performed on their own per a scientific organization, which carries out scientific and research and techology works in a region, thousand UAH / units.
	1.5.	Capital expenditures to implement scientific and research and techology works per a scientific organization, which carries out scientific and research and techology works in a region, thousand UAH / units.
	1.6.	The number of performed scientific and research and techology works per a scientific organization, which carries out scientific and research and techology works in a region, number/ units
	1.7.	Number of implemented scientific and research and techology works per a scientific organization, which carries out scientific and research and techology works in a region, thousand UAH / units.
Indicators for assessing the level of development of production potential of a region	2.1.	The number of industrial enterprises involved in innovation activities in a region, units.
	2.2.	The cost of innovation per one innovativon active company in a region, thousand UAH / units.
	2.3.	Amount of innovation financing the from the own sources per one innovative active company in a region, thousand UAH / units.
	2.4.	The share of industrial enterprises that implemented innovations in a region,%
	2.5.	Number of introduced innovative products per one innovative active company in a region, quantity / units.
	2.6.	The share of sold innovative products in the gross regional product,%
	2.7.	The share of sold innovative products in the region, which was new for the market,%

Note: Developed by the authors

The first stage of the assessment is to determine the system of indicators that influence the level of innovative development. We propose to take the system of indicators of the European Innovation Scoreboard [2, p.56], adapting them to local realities, as the basis for the assessment. Thus, the assessment of the level of innovative development is proposed to be done by calculating two sets of indicators:

The first group describes the scientific potential of a region, reflecting the state of scientific and technical sphere of a region in the context of applied research and amounts of its financing;

The second group is represented by indicators that characterize the state of innovation promotion in production within a particular regional entity.

Each group is presented by seven indicators that are calculated on the basis of the official statistical data accumulated and officially released by the State Statistics Service. In this case we consider that it is necessary to define the following criteria for the selection of the indicators:

First, the selected indicators must be clear, understandable and accessible, that is, the specified parameters should be maintained with regular statistical recording that is in the public domain and may be used for systematic monitoring;

Secondly, the system of assessment should be optimal in terms of absence of duplication of the indicators, it should not to be overloaded by secondary indicators and objectively reflects the level of innovative development of each region.

The proposed indicators for assessment of innovative development of a region are presented in Table. [1]

The next step is to form a statistical array of the indicators for assessment. The official data of the State Statistics Service, on the base of which the initial values of all fourteen indicators are calculated, is the source of information. This assessment should be carried out for a respective calendar year on the basis of the systematic statistics.

Since the proposed indicators for assessment of the level of innovative development of a region have a different dimension and cannot be aggregated as the integral coefficient it is necessary to apply the procedure of rationing (unification). The options of rationing values are quite diverse and include several options for unification: the maximum, average, standard, and so on. The options of rationing of economic indicators have been described in the work in details [3, p.20]. As far as in the methods we use only indicators - stimulants, whose growth is desirable for the development of an economic system, then, when calculating, we apply the standard approach, which is represented by the tools of mathematical statistics. Thus, among all values of statistical data on time variation of a given index the minimum x_{min} and maximum x_{max} are evaluated, and by using these values the rationing is calculated under the formula below:

$$\overline{x_i} = \frac{x_j - x_{\min}}{x_{\max} - x_{\min}}, \quad (1)$$

where $\overline{x_i}$ - a rated value of index *i* in region *j;*

x_{ij} – value of index *i* in region *j;*

x_{min} – minimum value of index *i* in all regions;

x_{max} – the maximum value of the index *i* in all regions [4, p.10].

In this connection, $\overline{\delta_i} = 0$, when $x_{ij} = x_{min}$, and $\overline{\delta_i} = 1$, when $x_{ij} = x_{max}$.

Another procedure for assessing the level of innovative development of a region is to determine the weighting coefficients of indicators for assessment. This is due to different levels of impact of indicators on the development and dynamics of the corresponding phenomenon. For this purpose, different approaches are used, such as the method of ranking and expert evaluation. In practice, the expert method of determining the weighting values of indicators is the most widely used due to the relative simplicity of its application. However, this method comes with the inherent high level of subjectivity and complexity of collecting results.

In order to test the adequacy of expert assessment, to determine the degree of objectivity of the presented weighting values of indicators and to establish the degree of coherence of opinions on all parameters, the concordance coefficient (K_{con}) is used:

$$K_{con} = \frac{\sum_{j=1}^{n} d_j^2}{\frac{1}{12}\left[m^2\left(n^3 - n\right) - m\sum_{i=1}^{m} T_i \right]}, \quad (2)$$

where d_j - deviation amount of points factor *j* of the average amount;

m - number of experts;

n - number of factors;

T_i - the results of intermediate calculations [5].

In its turn, the deviation of amount of points of factor *j* of the average amount is calculated as follows:

$$d_j = S_j - \frac{\sum_{j=1}^{n} S_j}{n}, \quad (3)$$

where S_j – amount of ranks, which is calculated using formula 3:

$$S_j = \sum_{i=1}^{m} R_{ij}, \quad (4)$$

where R_{ij} – the matrix of experts' assessment of factors:

The intermediate calculation is made as follows:

$$T_i = \sum_{l=1}^{L} \left(t_l^3 - t_l\right), \quad (5)$$

where *L* - the number of groups of related (similar) ranks;

t_l - number of connected ranks in each group.

The concordance coefficient takes values from 0 to 1. The bigger is the coefficient of concordance, the higher is the degree of consistency of experts' opinions. When $K_{con} = 1$ there is full consistency of experts' opinions; if $K_{con} = 0$, then consistency is virtually absent. The calculation of concordance in the group of indicators to assess the level of scientific potential (actual value is 0.63) indicates a sufficient level of consistency of experts' opinions and the possibility of using the calculated weight coefficients for calculating the integrated indicators. Almost similar situation is observed in the group of indicators to assess the level of development of industrial potential of a region - the estimated coefficient of concordance is 0.64.

The next stage involves determination of the intermediate and overall indexes of development of scientific and production potential, and to do it we propose to use formulas 6 and 7.

$$I_{sprj} = \sum_{i-1}^{n} k_w \cdot \overline{x_{sij}}, \quad (6)$$

where I_{sprj} - integral index of the scientific potential of region *j*;

$\overline{x_{sij}}$ - rationing value of indicator *i* of the scientific potential of region *j*;

k_w - weighting ratio of indicator *i*.

$$I_{pprj} = \sum_{i-1}^{n} k_w \cdot \overline{x_{pij}}, \quad (7)$$

where I_{ppnj} - integral index of production potential of region *j*;

$\overline{x_{pij}}$ - rationing value of indicator *i* of production potential of region *j*;

k_w - weighting ratio of indicator *i*.

The calculation of the integral coefficient of innovative development of a region is suggested to make using a multiplicative model according to formula 8:

$$I_{idrj} = \sqrt{I_{srj} \cdot I_{pprj}}, \quad (8)$$

where I_{idrj} - integral index of innovative development of region *j*;

The next step involves the interpretation of the results of the assessment and regions ranking in terms of innovative development. In determining the type of innovative development of a region it is important to identify the key points, achieving of which means a certain level of development and implementation. The processed model of integral index (formula 8) provides that when $I_{idrj} = 0$, the level of innovative development of the *j*-region is much lower than average on aggregate, and at $I_{idrj} = 1$, on the contrary, it is much higher. For a more thorough interpretation of the achieved results we offer to allocate three groups of regions that meet the low, medium and high levels of innovative development by means of interval distribution of values of the integral indicator (tab. 4):

In addition, the obtained numerical values for the integral index allow ranking regions in terms of innovative development from the smallest number (closest to 0) to the highest (the one, which is close to 1).

Table 4.

THE GROUPING OF REGIONS ACCORDING TO THE SIZE RANGE

Interval index of innovative development of a region	Interpretation of indicator values
(0-0,33)	Regions with low levels of innovative development
(0,34-0,66)	Regions with an average level of innovative development
(0,67-1)	Regions with a high level of innovative development

Note: Developed by the authors

For simultaneous mapping of two calculated integral indices, we offer additionally to use a matrix method and two-dimensional system of coordinates, each axis of which reflects the type of scientific and industrial potential. For this the matrix of innovative development of regions is built (Fig. 2). Taking into account that for each integral index we have defined three types of estimates (low, medium, high), the obtained matrix is divided into 9 squares, to each of which corresponds a certain type of innovative development of areas.

The final procedure of assessment implies the establishment of the segment to which the study area belongs to on the basis of the values of the obtained integral indices. In order to smooth the existing territorial disparities in the innovative development of the respective areas the strategy of innovative development with the respective system of measures related to their implementation can be developed.

Conclusions and perspectives for further research. So, the developed methodical approach is relatively simple for usage. It allows the systematic monitoring of innovative development of Ukraine's regions and their subsequent ranking and grouping in terms of development and innovation. The approach makes it possible subsequently to develop appropriate and effective strategy of innovative development of regions and to build the model of innovative development. The further innovative research is possible in the context of complementing or reviewing aggregate indicators of assessment in case of occurrence of additional static data that is accumulated by the State Statistics Service. Moreover, a separate study should be devoted to issues related to creating the mechanisms to encourage innovative development and innovation.

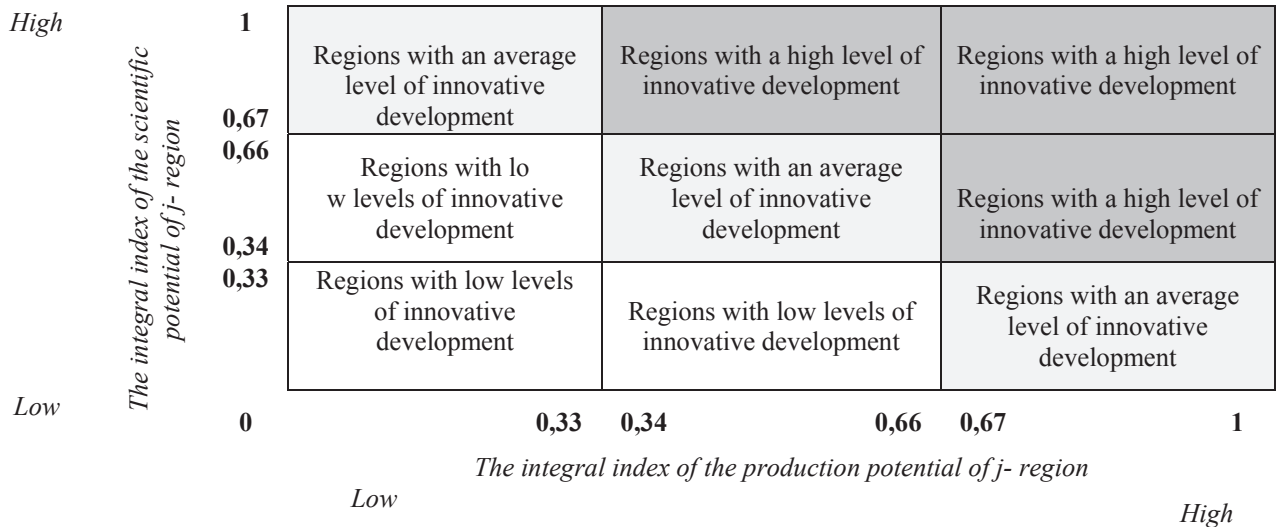

Figure 2. Matrix segmentation of regions in terms of innovative development
Note. Developed by the authors

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Арзянцева Д. А., Захаркевич Н. П. Методичні засади оцінювання інноваційного розвитку регіонів / Хмельницький університет управління та права

Опрацьовано авторський методичний інструментарій оцінки рівня інноваційного розвитку регіону шляхом розрахунку інтегрального коефіцієнту. Пропонована методика розрахунку включає шість послідовних етапів: визначення системи показників, що впливають на рівень інноваційного розвитку регіону; формування статистичного масиву оціночних показників; нормування оціночних показників; розрахунок коефіцієнтів вагомості по кожному з показників із використанням експертного методу; визначення проміжних та загального індексу рівня інноваційного розвитку регіону; інтерпретація результатів оцінки та рейтингування регіонів за рівнем інноваційного розвитку.

***Ключові слова*:** інновації, інноваційний розвиток, науковий потенціал, виробничий потенціал, інтегральний показник оцінки рівня інноваційного розвитку регіону.

Арзянцева Д. А., Захаркевич Н. П. Методические основы оценки уровня инновационного развития регионов / Хмельницкий университет управления и права

Предложен авторский методический инструментарий оценки уровня инновационного развития региона путем расчета интегрального коэффициента. Предлагаемая методика расчета включает шесть последовательных этапов: определение системы показателей, влияющих на уровень инновационного развития региона; формирование статистического массива оценочных показателей; нормирование оценочных показателей; расчет коэффициентов весомости по каждому из показателей с использованием экспертного метода; определение промежуточных и общего индекса уровня инновационного развития региона; интерпретация результатов оценки и рейтингование регионов по уровню инновационного развития.

Ключевые слова: инновации, инновационное развитие, научный потенциал, производственный потенциал, интегральный показатель оценки уровня инновационного развития региона.

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