SECTION 4. INNOVATION POLICY AND INNOVATION INFRASTRUCTURE: NATIONAL AND REGIONAL ASPECTS

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**METHODOLOGICAL BASES FOR ASSESSING
THE EFFECTIVENESS OF CLUSTERING OF THE ECONOMY**

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Abstract. The relevance of assessing the effectiveness of clustering the economy is confirmed by the low rates of cluster organization in the Republic of Belarus, the lack of a methodology for developing cluster policy and managing the clustering process. At the same time, the cluster approach is recognized in many economies as effective in terms of competitiveness and innovation. The article provides a theoretical study of the conceptual apparatus of clustering. Principles of building a system of performance indicators for clustering; directions for assessing the effectiveness of clustering and a system of indicators are developed. A methodology for assessing the effectiveness of clustering has been developed, which, in contrast to the existing ones, allows, firstly, to conduct an in-depth analysis of clustering due to: a) evaluating particular indicators of the effectiveness of clusters in dynamics and in comparison with target indicators; b) an integrated assessment of the effectiveness of clustering for all indicators for comparison across regions; secondly, it allows assessing the contribution of clusters to the socio-economic and innovative development of regions. The practical significance of the sound method is that the results can be used by government bodies to develop and adjust cluster policy. An integrated assessment of clustering at the regional level will make it possible to objectively distribute resources, attract investors and labor resources to competitive clusters.

Introduction

In the Republic of Belarus, cluster policy is becoming an important tool for stimulating the innovative development of the economy, defined in a number of State programs and concepts (Concept of the State Program for Innovative Development of the Republic of Belarus for 2021–2025 [1]; Draft Strategy for Sustainable Development of the Vitebsk Region for 2016–2025 years [2]; Concept of the National Strategy for Sustainable Development of the Republic of Belarus for the Period up to 2035 [3], Concept of Formation and Development of Innovative and Industrial Clusters in the Republic of Belarus (Resolution of the Government of the Republic of Belarus №. 27 of January 16, 2014) [4].

At the same time, the clustering processes in Belarus are not active enough in comparison with foreign countries. As of 01.08.2021, there are 4 active clusters in the Republic of Belarus [5]. Whereas in other countries, for example, in the USA - 380 clusters, in Italy - 206 clusters, in the UK - 168 clusters [6], in the Russian Federation - 117 clusters [7].

One of the tasks of the cluster policy, provided for in the Concept of the formation and development of innovative and industrial clusters in the Republic of Belarus (Resolution of the Government of the Republic of Belarus №. 27 of January 16, 2014,) [4] is «the organization and implementation of regular monitoring of the processes of formation and development of clusters on the basis of small and medium-sized businesses, including in the regional context, the definition of priority areas for their formation» [4].

Assessment of the effectiveness of clustering allows you to identify problem areas in the country's cluster policy and make timely management decisions. Nevertheless, the scientific and methodological support for assessing the effectiveness of clustering in Belarus has not been developed at present and there is no practical experience.

The purpose of the article: to develop a methodology for assessing the effectiveness of clustering.

Based on the purpose of the article, the following research objectives have been identified:
- to substantiate the system of indicators for assessing the effectiveness of clustering;
- to develop a methodology for assessing the effectiveness of clustering.

The process of clustering the economy is the activity of government bodies and business entities to develop cluster initiatives and create clusters. The cluster of commodity producers is considered as a network organization of complementary, geographically interconnected relations of cooperation of enterprises and organizations (including specialized suppliers, including services, as well as manufacturers and buyers), united around a research and educational centre, which is linked by partnership relations with local institutions and bodies state and regional administration in order to increase the competitiveness of enterprises, regions and the national economy [8].

Based on the goals of the cluster policy in the Republic of Belarus, the effectiveness of clustering is understood as the growth of indicators of the country's / region's competitiveness, since clusters are territorial and sectoral structures.

Theoretical and methodological aspects of the formation of regional innovation clusters are detailed in the works of such authors as P.A. Samoilov [9], A. A. Sozinova [10, 11,12], E. G. Popkova, Y. G. Tyurina, L. V. Bychkova, O. M. Zemskova, M. F. Serebryakova, N. V. Lazareva [11], P. A. Kalinin [12] and other scientists.

The role of clusters in economic development and activation of innovation activity was noted by many researchers – M. H. Best [13], М. Портер [14], A. Grove [15], A. Saxenian [16], Ö. Sölvell [17] and others.

The study of cluster efficiency problems is presented in a number of scientific works of domestic and foreign scientists: A. A. Sozinova [18, 19], P. A. Kalinin, M. A. Podyachev [19], I. S. Ferova [20], F. V. Shutilov [21], N. I. Klepikova [22], O. V. Nesmachnykh [23], E. G. Patrusheva, E. A. Bolshakova [24] and others.

While recognizing the theoretical and practical significance of research in the field of clusters, as well as concepts and methodological documents adopted in the Republic of Belarus, we nevertheless believe that the methodological

foundations for analyzing the effectiveness of clustering in a comparative assessment by regions are not sufficiently traced in previous studies.

Methods

The following methods were used: general scientific methods – perception, analysis and synthesis, comparative analysis, the method of analogy, etc.; special methods – economic and statistical, input-output, interview.

Results and Discussion

Theoretical justification of indicators for assessing the efficiency of clusterization

Since the clustering of the economy is considered as a process (activity) of organizing clusters [25, 26], it is advisable to use the process approach to assess the process. The result of the process is the achievement of the goal, therefore the system of assessment indicators should include: quantitative indicators for clusters; cluster performance indicators. The work uses the term "effectiveness", which differs from the concept of "efficiency". Efficiency implies a balance between results and costs. Since for practical use it is difficult to single out the direct and indirect costs of supporting clusters in the region, as well as due to the lack and unavailability of information on countries, it is proposed to evaluate the clustering result.

Another theoretical and methodological issue is assessment tools. It is proposed to use a system of indicators and an integrated assessment of clustering at the regional level. It will allow making comparative analysis, objectively allocating resources, attracting investors and labor resources.

Due to the complexity and versatility of the clustering process, its effectiveness can be assessed from the point of view of a systematic approach, a system of indicators. To fully realize the potential of the scorecard, it must meet certain requirements (principles).

The analysis of literary sources [8, 27] allowed the authors to formulate the basic principles of constructing a system of indicators, the use of which will contribute to the selection of indicators characterizing the key features of the clustering process, target orientation and problems of their functioning.

The principles of building a system of performance indicators for clustering are as follows:
- information accessibility;
- comparability of the indicators used;
- unambiguous interpretation;
- taking into account the effect of clustering;
- accounting for causal relationships.

To form a system of indicators for assessing the effectiveness of clustering in a region, the following justification is proposed. The importance of clusters for the development of the regional / national economy in accordance with the theoretical foundations of the cluster [8] lies in the «scale of clustering», which manifests itself in the growth of the number of clusters and cluster stakeholders.

For interregional comparison and accounting for the scale of economies, it is proposed to use a relative indicator – «the number of clusters per $ 1 of GDP in PPP». An important indicator of cluster involvement is the number of people employed in a cluster, which contributes to overall employment in the region. The indicator «share of innovatively active organizations in a cluster» is proposed to be used to assess the impact of clustering on innovative activity in the region. The indicator «the share of a cluster in the volume of industrial production in the region» is a criterion for assessing the importance of a cluster for the region. It characterizes the contribution of the cluster to the regional economy. Thus, based on this evidence, a system of indicators for assessing the importance of a cluster for the development of a region is proposed, which is presented in Table 1.

Table 1 – Indicators for assessing the effectiveness of clustering

Directions for assessing the performance of clusterization	Indicators
Clustering scale	Number of clusters per $ 1 of GDP at PPP
Promotion of general employment	Number of employees in the cluster
Influence of clustering on innovative activity	Share of innovatively active organizations in the cluster
Cluster's contribution to the regional economy	Share of the cluster in the volume of industrial production in the region
Influence of clusters on the development of entrepreneurship	Share of SMEs in clusters

Compiled by the authors.

Methodology for assessing the performance of clusterization

Thus, on the basis of the conducted theoretical research and taking into account the formulated methodological provisions, a methodology for assessing the effectiveness of clustering in the region is proposed, which includes the following stages.

1. Calculation of indicators for evaluating the effectiveness of clustering.
2. Calculation of dimensionless estimates of clustering performance indicators.
3. Calculation of a generalizing indicator of the effectiveness of clustering in the region.

Stage 1. Calculation of indicators for evaluating the effectiveness of clustering. The system of indicators has been determined and the calculation formulas are given in Table 2.

Table 2 – System of indicators for evaluating the effectiveness of clustering

Indicators	Calculation formula (designation, data source)
N_{GDP} – the number of clusters per \$ 1 of GDP at PPP	$N_{GDP} = N_{cl} / GDP$, where N_{cl} is the number of active clusters in the country / region based on official statistics (Cluster maps, reports of organizations and government bodies)
N_{empl} – the number of employees in the cluster	The number of employees in a cluster in a country / region based on official statistics (Cluster maps, reports of organizations and government bodies)
N_{innov} – number of innovatively active organizations in the cluster	The number of innovatively active organizations in a cluster based on official statistics (Cluster maps, reports of organizations and government bodies)
SH_{cl} – the share of the cluster in the volume of industrial production in the region	$SH_{cl} = VIP_{cl} / VIP_{reg}$, where VIP_{cl} is the volume of industrial production by all clusters of the region; VIP_{reg} is the volume of industrial production in the region.
SH_{SMEs} – share of SMEs in clusters	$SH_{SMEs} = N_{SMEs} / N_{org}$, where N_{SMEs} is the number of SMEs in all clusters of the region; N_{org} - the number of all organizations - stakeholders of all clusters in the region.

Compiled by the authors.

Stage 2. Calculation of dimensionless estimates of clustering performance indicators. To convert the dimensional estimates of indicators into dimensionless, it is proposed to use the index method. Evaluation indices are determined by formula (1) for positive indicators, since all recommended indicators should tend to grow.

$$O_i = X_i / X_i^{max} \tag{1}$$

where O_i – the index of assessment of the i indicator for assessing the effectiveness of clustering;

X_i – the value of the i dimensional indicator for assessing the effectiveness of clustering;

X_i^{max} – the maximum value of the i dimensional indicator for assessing the effectiveness of clustering.

Stage 3. Calculation of a generalizing indicator of the effectiveness of clustering in the region.
To obtain an integral assessment of the effectiveness of clustering for each region at the same time for all these indicators that have different units of measurement (dimensional indicators), it is necessary to determine the method of their comparison. In mathematical statistics, in this case, the rank, point, index methods and the method of the desirability function are used. The index method seems to be the most adequate method for comparing the dimensional indicators of the assessment.
To obtain a comprehensive assessment, we use the geometric mean method, since it allows us to take into account the mutual influence of indicators in the overall assessment of the competitiveness of the cluster. A comprehensive assessment of the effectiveness of clustering is determined on the basis of the indices of the following indicators according to formula (2).

$$IPC = \sqrt[5]{IN_{GDP} \times IN_{empl} \times IN_{innov} \times ISH_{cl} \times ISH_{SMEs}}, \tag{2}$$

where IPC – the regional clustering performance index;

IN_{GDP} – the index of the number of clusters per \$ 1 of GDP at PPP;

IN_{empl} – the index of the number of employees in the cluster;

IN_{innov} – index of the number of innovatively active organizations in the cluster;

ISH_{cl} – the index of the cluster's share in the volume of industrial production in the region;

ISH_{SMEs} – an index of the share of SMEs in clusters.

The maximum values of indicators for assessing the competitiveness of a cluster are determined on the basis of their comparison between regions. If only one cluster has been identified in a region, then the maximum values of indicators for evaluating clusters in other regions can be used to assess its competitiveness. The values for evaluating the effectiveness of clustering can theoretically vary from 0 to 1 (ratio 3):

$$IPC = 0 \div 1. \tag{3}$$

Consequently, the regions that have received a comprehensive assessment, the value of which is close to one, will be effective. In fact, the value of the coefficient will be less than one. To select the most promising region for state support of clusters within the framework of public-private partnerships (PPP) projects, attracting foreign investment or receiving donor assistance, it is advisable to use the selection criterion, which is determined by function (4).

$$IPC \rightarrow max. \tag{4}$$

Conclusions
The developed methodology for assessing the effectiveness of clustering in the region, in contrast to the existing ones, allows, firstly, to conduct an in-depth analysis of clustering by: a) assessing the individual performance indicators

of clusters in dynamics and in comparison with target indicators; b) an integrated assessment of the effectiveness of clustering for all indicators for comparison across regions; secondly, it allows assessing the contribution of clusters to the socio-economic and innovative development of regions.

The practical significance of the sound method is that the results can be used by government bodies to develop and adjust cluster policy.

An integrated assessment of clustering at the regional level will make it possible to objectively distribute resources, attract investors and labor resources to competitive clusters.

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