

Algorithm for assessing the business activity of the region in the decision-making system at the regional management level

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Abstract. The article presents an algorithm for assessing the business activity of the region as an objective quantitative indicator of processes in the regional system. This algorithm considers the effect of the main regional complex subsystems: resources, production, innovation, society, entrepreneurship, finance, investment, information, infrastructure, environmental subsystem, which is reflected in the model of business activity formation in the region. The business activity model of the region includes 10 blocks that characterize the mechanisms of the regional complex functioning. The formed system of evaluation indicators reflects various aspects of the regional complex business activity. The formalization of the complex indicator of regional business activity is carried out in the form of a function that determines the type of mathematical model, considering the justified blocks of region business activity and considering the impact of factors and the results of its functioning on the regional complex. When developing an algorithm for assessing the region business activity as an indicator of socio-economic processes, a sequence of calculation procedures is justified, which allows identifying both basic and chain indicators of the business activity of the region for management purposes. The presented algorithm makes it possible to assess the dynamics of the region business activity level on the basis of objective statistically significant information, as well as to determine the features of the processes taking place in the regional complex that have a different impact on the efficiency level of the region. The practical use of the proposed algorithm can be a source of objective information for the development of solutions at the regional management level, considering the specific factors of a particular region functioning, which is provided by the procedure of the algorithm for assessing the business activity of the region.

1 Introduction

The information used in the decision-making system at the regional management level should characterize the parameters of the regional complex as an integral ecological, socio-economic

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system that interacts with the external environment. In particular, information on the entrepreneurship development level, the use of natural resource potential, the activity of innovation and investment activities, infrastructure security, the structure of the economic complex of the region and its development trends, the effectiveness of solving social problems is relevant.

The development of modern regional complexes is carried out in conditions of high uncertainty of the external environment, which has a significant impact on the functioning of the regional subsystems. To determine the effectiveness of the regional complex as a whole, we consider it possible to use an algorithm for assessing the business activity of the region, based on a generalization of the characteristics of the ecological, socio-economic functioning development of the region.

In this regard, the object of this article is the process of assessing the functioning of the regional complex as a whole and its components to justify decisions at the regional management level, and the subject is the algorithm for assessing the region business activity.

Various approaches are devoted to the formation of information security of management decisions, reflecting the development of information technologies and the significant role of information in ensuring the effective functioning of modern business entities. Thus, the fundamental principles of making effective management decisions using modern information technologies are substantiated, the features of the formation of indicator systems used in the process of managing an economic entity, forecasting and planning its activities are determined [1, 2].

Nevertheless, to increase the effectiveness of decisions taken at the regional management level, there is a need to form an algorithm for assessing the processes taking place in the regional system on the basis of objective both private and complex characteristics and indicators. The business activity of the region can act as such a characteristic, reflecting the peculiarities of the functioning of the regional complex and its subsystems.

At the same time, we have defined the business activity of the region as a process of interaction of the structural components of the region as an ecological, socio-economic system, the purpose of which is to ensure the effective use of the natural resource potential of the regional complex in the conditions of the system of regulation of socio-economic relations to achieve the target level of regional development.

2 Materials and Methods

To consider theoretical approaches to assessing the effectiveness of the regional complex functioning as an ecological, socio-economic system, the methods of system analysis, correlation and regression analysis, economic and mathematical modeling, the author's methodology for calculating the complex indicator of business activity of the region are used in the article.

Methods and approaches of correlation and regression analysis were used to determine the characteristics reflecting various aspects of the regional complex business activity and to formalize the complex indicator of the business activity of the region.

When developing an algorithm for assessing the business activity of a region as an indicator of socio-economic processes and choosing a function that considers the impact on the regional complex of factors and the results of its functioning, methods of economic and mathematical modeling were used.

3 Results

The rationale for using the business activity of the region as an indicator of the regional system state required the analysis of scientific works by leading scientists who developed scientific approaches to assessing business activity at various management levels - the individual level, micro-level, macro-level, meso-level [3-11].

At the individual level, socio-psychological indicators are considered to characterize business activity – psychological stability, ability to take risky actions, including investments, intuition, sociability, etc. The basics of assessing business activity at the level of a separate economic entity – the microlevel - have been widely developed as a result of calculating indicators characterizing the efficiency of using various types of company capital, as well as assets at its disposal [3].

To assess business activity at the macro level in various countries, complex indicators of LEI, PMI, TANKAN have become widespread, which are essentially diffuse indices based on the results of a survey of experts who expressed their opinion on entrepreneurial activity (availability of orders for products, price stability, the situation on the labor market, export opportunities) [4]. In addition, indicators of the country's business activity have been developed [4, 5].

At the regional level, the use of these macroeconomic indicators is not very common and many of them have a high degree of subjectivity due to the expert basis, which reduces the objectivity level of the estimates obtained. Therefore, to assess the processes taking place in the regional system, methods for determining integral indicators [6] characterizing various aspects of the regional socio-economic development, as well as rating assessments of the region development level are more often used [7, 8]. Some scientists propose to assess the business activity of the region (using the definition of "business activity" used by the authors of this article to assess the business environment of the territory and the country) by means of an entrepreneurial activity indicator, using various approaches:

1) based on the study of the dependence of the number of enterprises in the region (as an explicable variable) and the real gross regional product per capita, average monthly real wages, unemployment rate, inflation rate, fixed capital investment per capita (explanatory variables);

2) based on the study of the dependencies of the gross regional product per capita and the provision of enterprises in the region with banking infrastructure, the necessary amounts of credit resources using spatial econometrics methods. At the same time, the volume of lending is considered as the main factor in the development of enterprises and the region as a whole.

In addition, scientists use various approaches to identify the structural elements of business activity, through which its assessment is carried out:

- production activity; labor activity, investment, innovation activity [7]. At the same time, a network scheme is used that considers the components justified by the author and allows assessing the possibilities of socio-economic development of the region due to the available resource potential;

- production activity, labor activity, financial activity, investment activity [7]. In this approach, the author emphasizes the presence of synergetic interaction between the elements;

- summary indicators for the following components: industry, construction, retail trade, wholesale trade, paid services to the population [6]. In this approach, it is proposed to calculate a composite index of regional economic activity based on the transformation of official statistics data using constructed dichotomous variables;

- summary indicators for the selected categories (production, financial sector, resource base of the economy, consumer market), calculated on the basis of official statistical data, and the results of expert surveys. Mathematical data processing is carried out using cross-

correlation analysis, the results of which allow to determine the significance of each component of the region business activity [9].

Considering the analysis, in our opinion, when forming an algorithm for assessing the region business activity to obtain an objective quantitative indicator of the processes in the regional system, the influence of its constituent subsystems should be taken into account: resource component, production subsystem, the development of innovation, entrepreneurship, efforts to solve social problems, financial security, investment attractiveness, information component, infrastructure subsystem, environmental safety, which is reflected in the model of the formation of the algorithm for assessing the region business activity (see Fig. 1).

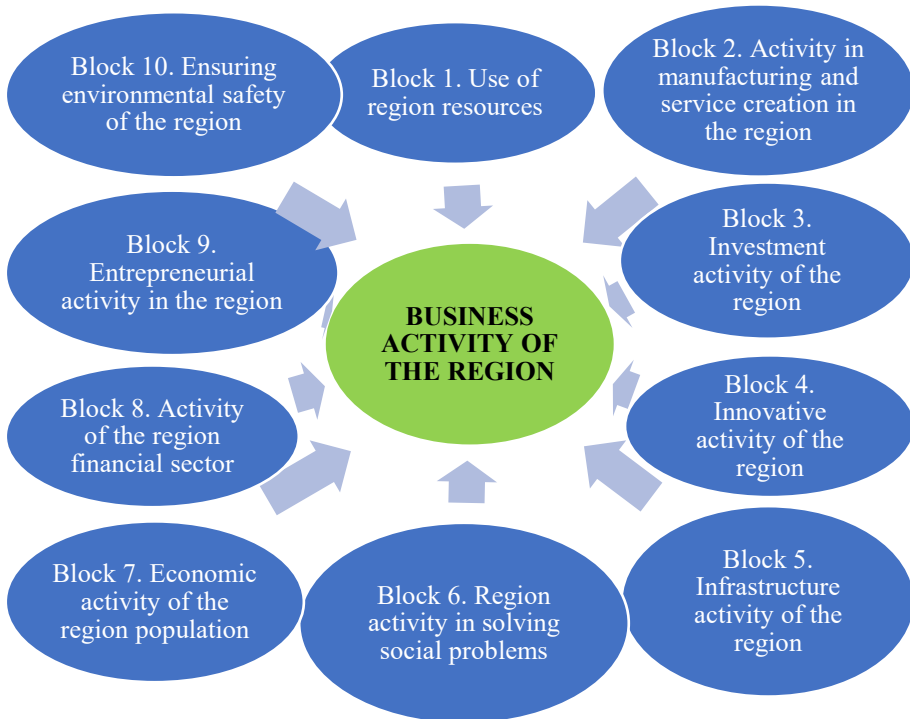


Fig. 1. Models for the formation of an algorithm for assessing the region business activity.

At the same time, complex systems are in a constant process of change: the stage of stable functioning can go into a stage of uncertainty, the system can be in the functioning development, and then transform into a shrinking system [10], therefore, characteristics of trends, dynamics are often used to assess their state [11], reflecting the transition from one stage to another, the transition from one state to another state.

Thus, there is a problem of scientific substantiation of the possibility of using the category "business activity of the region" as an indicator of ecological, socio-economic processes in the regional system, as well as the specification of the methodology for its definition.

Based on the essence of the business activity of the region, the indicator of the process reflecting the parameters of the regional system functioning to achieve development goals is the trend of the dynamics of the complex indicator of region business activity, which is determined on the basis of the basic or chain (depending on management tasks) rates of the complex indicator change. Therefore, the formalization of the complex region business activity indicator is carried out in the form of a function (f) that determines the type of mathematical model considering the justified blocks (A_i) of region business activity (see Fig.

1) and considers the impact on the regional complex of factors and the results of its functioning (see Fig. 2).



Fig. 2. The model for determining the level of region business activity.

Each allocated block (A_i) of the BAR can be characterized by a set of indicators that form a model to reflect the ongoing processes – resources, mechanisms of their interaction, and economic conditions in the region.

The proposed and implemented in the research algorithm for assessing the region business activity includes the following steps (see Fig. 3).

During the research, information about the processes taking place in the ecological, socio-economic system of the region is collected from official sources. In the analytical processing of information, it is advisable to use modern statistical methods to substantiate the method of assessing the region business activity as an indicator of socio-economic processes.

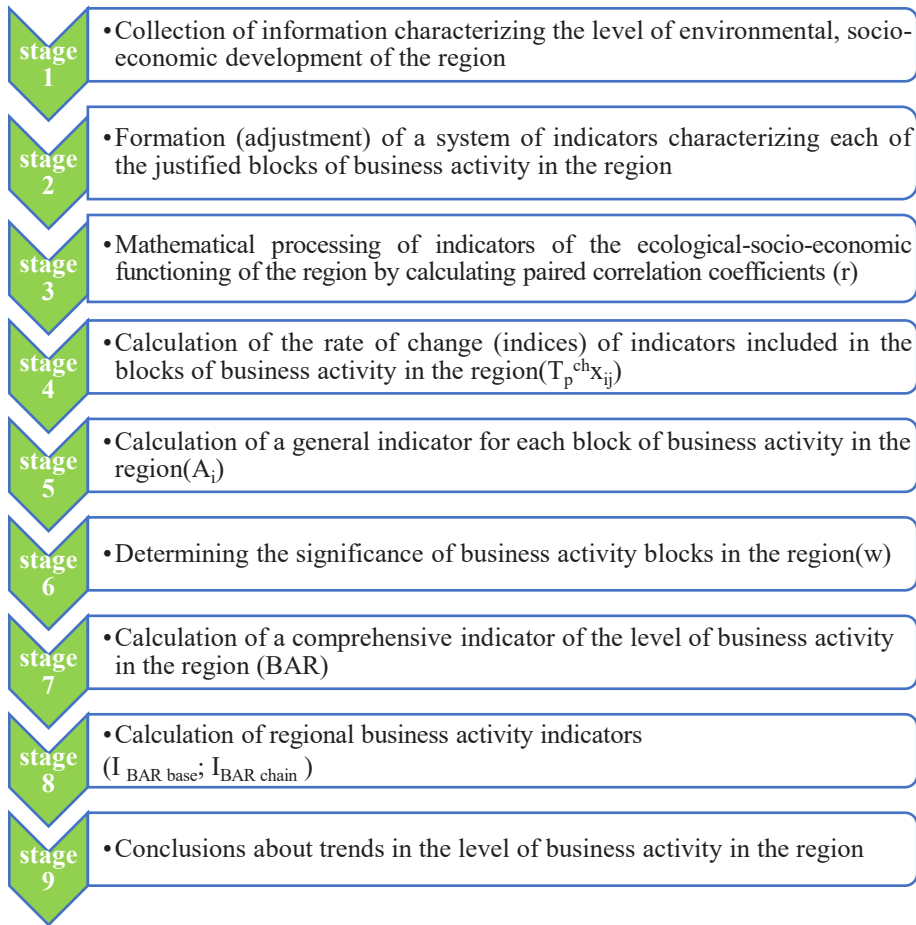


Fig. 3. The algorithm for assessing the region business activity.

4 Discussion

The implementation of the algorithm for assessing the region business activity required a logical justification of the system of indicators of the ecological, socio-economic functioning of the region, in which 10 blocks are identified that characterize the region business activity (see Fig. 4, 5).

Block 1 "Use of regional resources" includes characteristics reflecting the available resources of the territory that can be used to ensure the functioning of the production subsystem of the region (depending on the characteristics of the region).

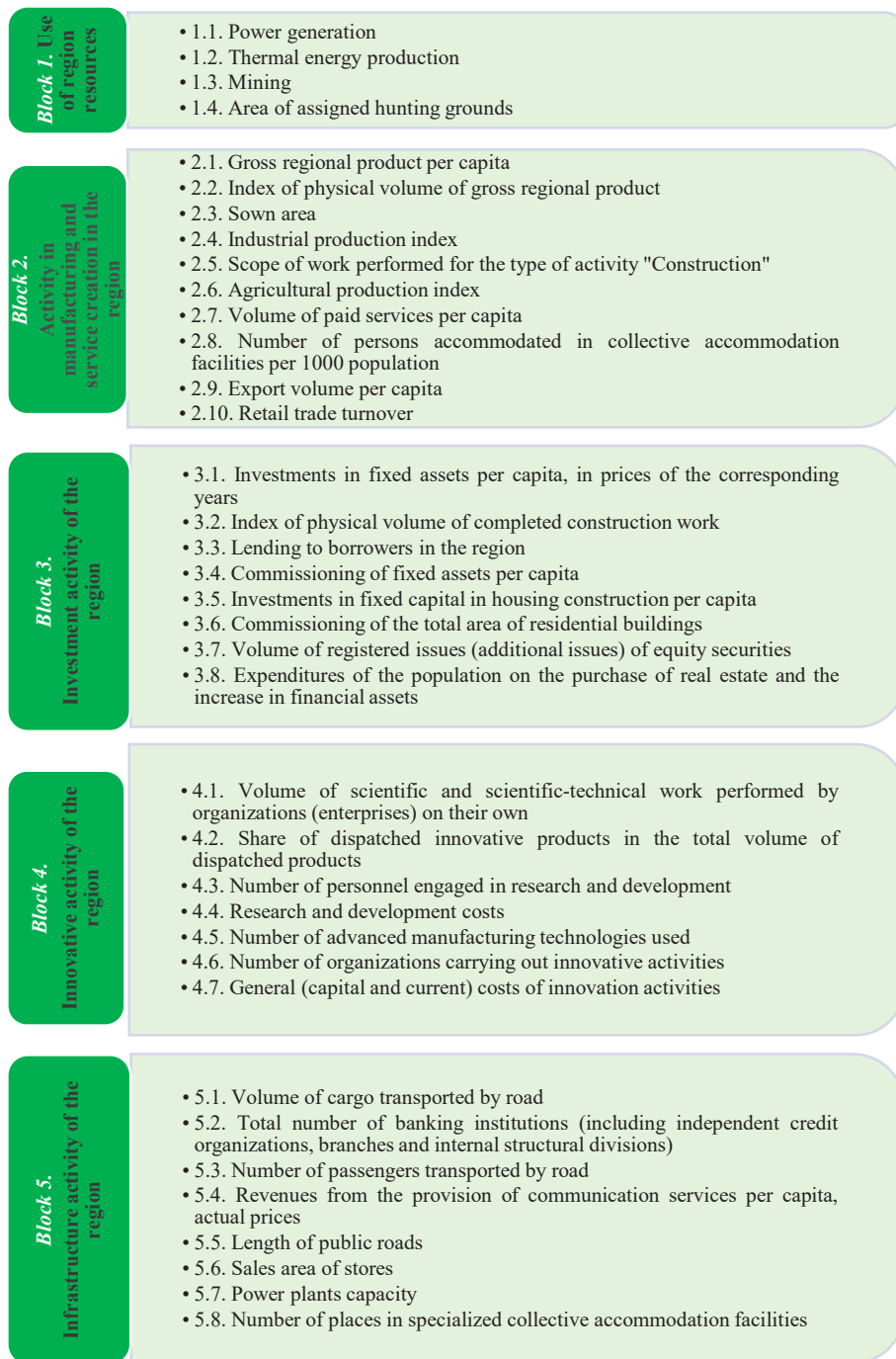


Fig. 4. The list of environmental socio-economic region functioning indicators (blocks 1-5).

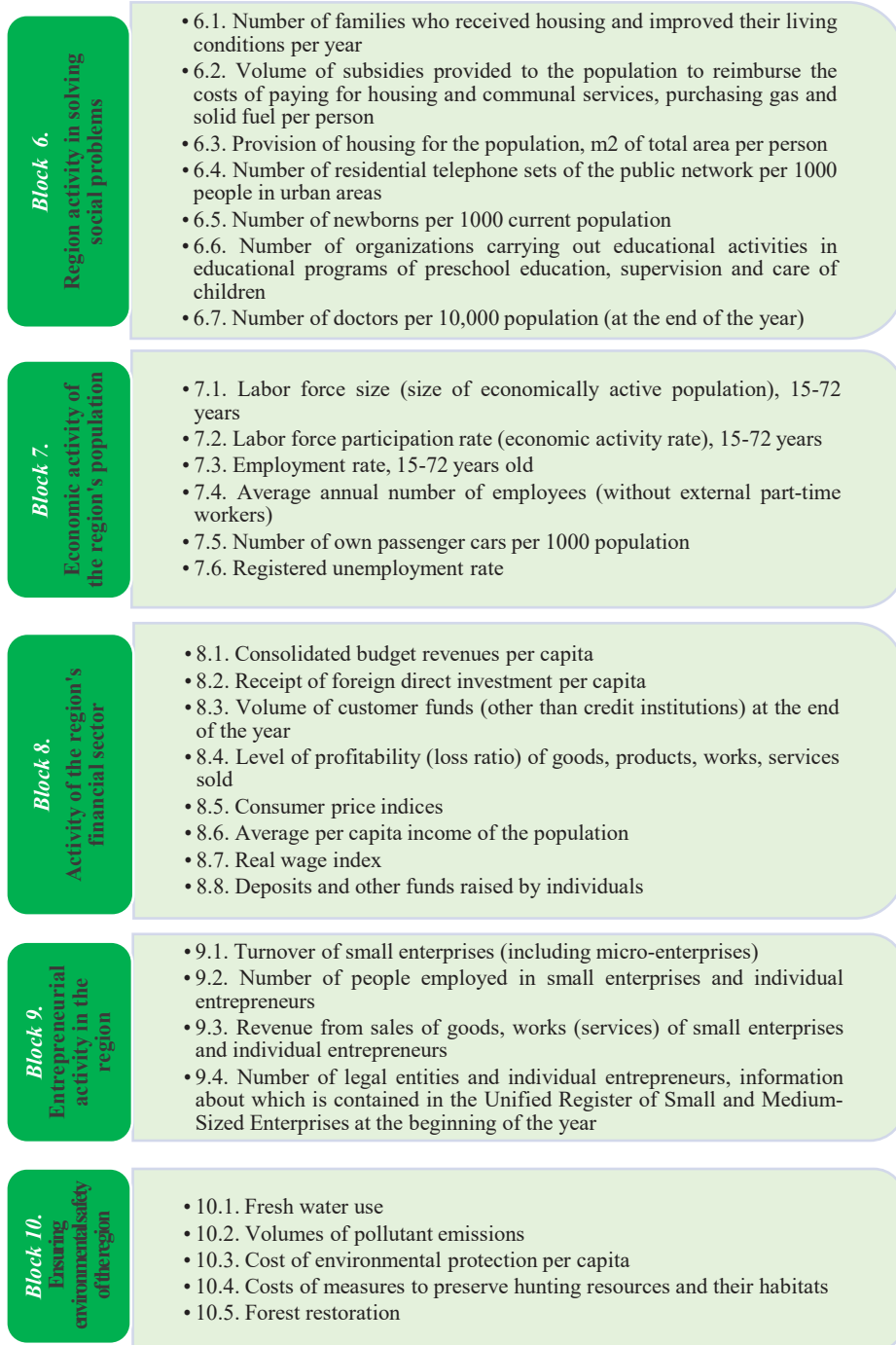


Fig. 5. The list of environmental socio-economic region functioning indicators (blocks 6-10).

Block 2 combines indicators for the areas of production activities of industries, considering the economic specialization of the territory, providing the necessary level of development and meeting the social needs of the population. The activity of the region in the

sphere of formation of investment processes is an important element of economic activity in general, but at the same time forms a special entrepreneurial climate that ensures the development of all spheres of the region. Based on this, block 3 includes indicators reflecting the amount of investments in fixed assets, in the construction industry, the availability of credit resources in the region, emissions, etc.

Block 4 combines indicators reflecting the innovation activity level in the region: the volume of scientific and scientific-technical work, the cost of research and development, the degree of involvement of organizations in innovation. The infrastructure block is important for the region functioning and the allocation of block 5 "Infrastructure activity of the region" characterizes the level of development and use of infrastructure elements (transport, communications, logistics systems, services, etc).

When assessing the business activity of the region, the indicators that characterize the region activity in solving social problems of the population are important (block 6): the level of the education system, health care, characteristics of the population life quality, demographic aspects.

The economic activity of the population (block 7) reflects the level of population involvement in the processes of creating an internal regional product (number of labor force, employment level, economic activity level).

Block 8 "Level of the financial sector activity of the region" includes characteristics of the state of financial resources and their formation schemes in various spheres (government, banking, corporate and public finances), as well as price processes and their impact on the well-being of the population of the region.

Block 9 "Entrepreneurial activity of the region" is highlighted by us in connection with the increasing influence on the intensity of economic processes of business entities, considering the specialization of the region.

The ecologically safe state of the region is the goal of the society as a result of ensuring the balance of nature and productive activity, which required consideration of the indicators of block 10 when assessing the business activity of the region.

In accordance with the highlighted business activity blocks at the first stage of the assessment (see 3) information is being collected reflecting the trends of socio-economic development, considering the environmental safety of the region. It is assumed to use information obtained from the following sources:

- official information collected by statistical agencies;
- official information published by government authorities that are responsible for the data distribution within their existing powers;
- other information (analytical reviews, publications in periodicals, etc.).

As part of the second stage, based on the collected information, a system is formed that includes 67 indicators reflecting various aspects of the business activity of the regional complex.

At the third stage of the assessment, mathematical processing of the collected information is performed based on the results of calculations of the pair correlation coefficients ($r_{x_{ij}x_{km}}$.

$$r_{x_{ij}x_{km}} = \frac{\bar{x}_{ij} \cdot \bar{x}_{km} - \bar{x}_{ij} \cdot \bar{x}_{km}}{\sigma_{x_{ij}} \cdot \sigma_{x_{km}}} \quad (1)$$

where x_{ij} is the value of the indicator of the ecological, socio-economic functioning of the region of the corresponding region business activity block;

i is the sequence number of the block, $i \neq k$, $i \in [1; 10]$;

j is the sequence number of the indicator in the block A_i , $j \in [1; m_i]$

m_i – the number of indicators in the block A_i ,

$\sigma_{x_{ij}}$ – the mean square deviation of the indicator x_{ij} .

The closeness of the relationship between the studied indicators is reflected by the pair correlation coefficients ($r_{x_{ij}x_{km}}$), and among all the indicators, the base indicator (x_{st}) is determined, in relation to which the largest number of indicators have high values $r_{x_{ij}x_{km}}$.

At the fourth stage, the chain rates of change ($Tp_{x_{ij}}^{ch}$) of the indicators included in the blocks of region business activity are calculated according to the formula:

$$Tp_{x_{ij}}^{ch} = \frac{x_{ij}^{(n)}}{x_{ij}^{(n-1)}}, \quad (2)$$

where x_{ij} is the value of the indicator of the ecological, socio-economic functioning of the region of the corresponding region business activity block;

n is the sequence number of the year (period) of the study.

At the fifth stage, considering the values of the pair correlation coefficients (similar to formula 1), which are calculated between the indicator defined as the base and the other characteristics of the region business activity - $r_{x_{ij}x_{st}}$, as well as considering the calculated rates of change in the characteristics of the ecological, socio-economic functioning of the region (formula 2) for each block of region business activity - A_i the numerical value of the generalizing indicator is calculated:

$$A_i = \sum_{j=1}^{m_i} r_{x_{ij}x_{st}} \cdot Tp_{x_{ij}}^{ch}, \quad (3)$$

At the same time, indicators that are weakly related to the dynamics of changes in the indicator adopted as the base x_{st} are not considered (considering the provisions of the correlation and regression analysis theory [2], when the coefficients of pair correlation $|r_{x_{ij}x_{st}}| < 0.65$).

The result of the fifth stage of the methodology is the determination of generalizing indicators (A_i) for all blocks of business activity in the region.

As part of the sixth stage, it is necessary to assess the significance (indicator of the specific weight) of each block in determining the business activity level in the region. The significance of various factors in determining the business activity level in a number of methods [7, 8] is determined using the method of expert assessments, which, in our opinion, is subjective. Therefore, we decided to use as the specific weight of the business activity block the value of the pair correlation coefficients ($w_{A_{st}A_i}$) (4) calculated between the corresponding value of the generalizing indicator of block A_i and the generalizing indicator of block A_{st} containing the base indicator x_{st} , since the pair correlation coefficient mathematically reflects the closeness of the linear correlation of each block of business activity and complex indicator BAR.

$$w_{A_{st}A_i} = \frac{\overline{A_i \cdot A_{st}} - \overline{A_i} \cdot \overline{A_{st}}}{\sigma_{A_i} \cdot \sigma_{A_{st}}}, \quad (4)$$

where A_{st} is the value of the generalizing indicator containing the base indicator x_{st} ;

A_i is the value of the generalizing indicator of the i -th block.

At the seventh stage, a comprehensive indicator of the business activity of the region (BAR) is determined:

$$BAR = \sum_{i=1}^k A_i \cdot w_{A_{st}A_i}, \quad (5)$$

Within the eighth stage, to identify trends in the BAR level relative to the base period (if the base period is adopted in accordance with the management objectives), the basic indicator of the business activity of the region (I_{BAR}) is determined:

$$I_{BAR_{basic}} = \frac{BAR_n}{BAR_{bas}}, \tag{6}$$

where the BAR_{bas} is a complex indicator of the level of region business activity for the base period.

BAR_n is a complex indicator of the level of region business activity in the study period (n).

If, in accordance with the management objectives, it is necessary to investigate the chain trends of changes in the BAR level, a chain indicator of the region business activity (I_{BAR}) is calculated:

$$I_{BAR_{chain}} = \frac{BAR_n}{BAR_{n-1}}, \tag{7}$$

where BAR_n is a complex indicator of the level of region business activity in the study period (n);

BAR_{n-1} is a comprehensive indicator of the level of region business activity for the previous period (n-1).

At the final stage of the assessment, trends in the BAR level are analyzed, as well as the dynamics and influence of all blocks A_i on the BAR level are studied, which can ensure the validity of regulatory decisions aimed at ensuring the necessary regional development level.

The presented algorithm makes it possible to assess the dynamics of the level of region business activity on the basis of objective statistically significant information, as well as to determine the nature of the processes occurring in the regional system that have both positive and negative effects on the level of region efficiency.

5 Conclusion

When solving the problem of improving the information basis for managerial decision-making based on the results of theoretical and applied research, we consider it appropriate to use the definition of "business activity of the region" as a comprehensive characteristic of the processes of ecological, socio-economic functioning of the regional system, considering the existing management mechanisms and system.

Considering the essence of the business activity of the region, an algorithm has been developed that includes mathematical models and a procedure for evaluating the system of ecological, socio-economic indicators. The proposed algorithm for assessing the business activity of the region allows to identify trends in the indicators of region business activity, as well as the dynamics of the regional complex components. The obtained quantitative results of assessing the business activity of the region show the peculiarities of the processes of the main regional complex subsystems in the conditions of ensuring environmental safety of the region.

The proposed indicator of the region business activity can be used in the formation of the management information base to solve both medium-term and current environmental, socio-economic problems.

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