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SEARCH FOR OPTIMAL SOCIO-ECONOMIC DETERMINANT VALUES OF TERRITORY DEVELOPMENT SUSTAINABILITY

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Abstract

The global factors destabilizing the socio-economic development of countries and regions is having a negative impact on the quality of life and functioning of production systems. Exposure of the open socio-economic systems to external influences combined with internal processes and phenomena lead to the instability of their development. The territories as socio-economic systems being observed in the framework of the development sustainability monitoring are complex objects of the evaluation due to the presence of a large number of interconnections between the constituent elements and hierarchical levels (sectors and spheres). An effective monitoring program development is designed to provide authorities with adequate information for decision-making. The article presents the results of a study aimed at developing an approach to evaluate optimal values of socio-economic determinants of sustainable development of territories. The proposed approach is adapted to solve the problem of finding the optimal level of stability and its components. The application of dynamic programming method allowed us to estimate the required indicators of socio-economic sphere with a focus on the production aspect to ensure a high level of stability of the site values. The required level of investments in fixed capital, providing the optimal values of the studied indicators is estimated. The results of the study can be applied to management decisions development as the basis for monitoring of socio-economic processes.

Keywords: Monitoring program, socio-economic sphere, development sustainability, dynamic programming method, territory management.

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1. Introduction

Ensuring the stability of the territory socio-economic development requires constant monitoring of the current and future state of the region to update management decisions and adjust the trajectory of the analysed processes. Monitoring of socio-economic processes is a necessary tool in the framework of solving the complex tasks of managing the territory. Effective organization and high-quality design of the monitoring process allows us to establish accurate relationships between indicators of socio-economic development and to respond quickly to negative trends in these indicators. The relevance of research in the development of effective monitoring programs and methods for assessing indicators of territories development sustainability is due to continuously ongoing processes that destabilize socio-economic systems.

2. Problem Statement

The tools used by the authors to evaluate and analyse socio-economic information are diverse. New methods for monitoring processes and phenomena in the regions are constantly being developed and adapted, the search for approaches to assessing their sustainability continues.

The most used approaches to conducting the monitoring procedure and assessing the stability of territories are standardization, weighing and aggregation methods. The standardization method is used to bring particular assessment indicators to uniform dimensionless values with the goal of further aggregating into a composite index or using other data processing methods. The most problematic stage of the assessment is the procedure for weighing or determining the significance of indicators within the chosen monitoring method. To solve this problem, the authors use methods of expert assessments (Mikhalev, 2011), analytical hierarchy (Krajnc & Glavic, 2005; Veisi et al., 2016), the Delphi method (García-Melón et al., 2012).

The authors apply methods based on determining the significance of assessment indicators, the strength of the relationship between them and the degree of variation among a set of particular indicators. These approaches are complicated by the need to use an exact mathematical apparatus. Methods for calculating the degree of variation between different indicators, the principal component method (Grzebyk & Stec, 2015; Tan & Lu, 2016), the entropy method (Shen et al., 2015; Zhao & Chai, 2016), correlation and factor analysis (Lee, 2013) are the examples. Methods overcome the main drawback of expert assessments - the subjectivity of the approach, but they are more difficult to implement. A dynamic analysis of indicators for certain aspects of sustainability is also used (rapid assessment of the territory's stability as part of monitoring indicators) (Tkhakushinov, 2014), compiling regional ratings based on a coefficient analysis using statistical and expert data (Kovalenko, 2012), methods of artificial neural networks (Polyakova et al., 2019), a scenario approach, etc. Many of the author's approaches culminate in the construction of typological groupings of territories based on integral indicators of development sustainability (division by the level of stability). Sometimes authors propose threshold or normative values of the sustainability of socio-economic systems (Polovova, 2013). These and other assessment methods have limitations and application features, which is recognized by the authors and contributes to the continuation of the search for approaches to socio-economic processes monitoring.

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The most important requirement when developing a program for the socio-economic process monitoring is the effectiveness of the procedure, i.e. obtaining the necessary quantity and quality of information in the formation and study of the optimal set of indicators that describe the process. The specified requirement is observed when taking into account the patterns and relationships of processes and phenomena in which the monitoring objects are involved. For this reason, the formation of a system of characteristics of the variability of its condition, i.e. the solution to the problem of assessing the sustainability of the development of the region is carried out in the conditions of spatio-temporal dynamics.

When developing a monitoring program, it is necessary to take into account the specifics of the territory socio-economic development, the sectoral structure of the economy, objective and manageable prerequisites and development restrictions, socio-demographic features, the relationship with other territories and the associated effects of the development of industries and regions (Abashev & Yanovskiy, 2018).

3. Research Questions

In this study, the authors presented and disclosed the following: the components of the monitoring system of socio-economic processes, in the framework of which the territory development stability of the is evaluated and analysed; aspects of sustainability monitoring; stages of a program for monitoring the sustainability of the development of the territory as a complex socio-economic process; proposed methods for assessing the sustainability of the development of the territory and determining the optimal values of socio-economic determinants in the framework of the developed monitoring program. The program for monitoring the sustainability of the development of the territory as a complex socio-economic process includes several stages (Figure 01).

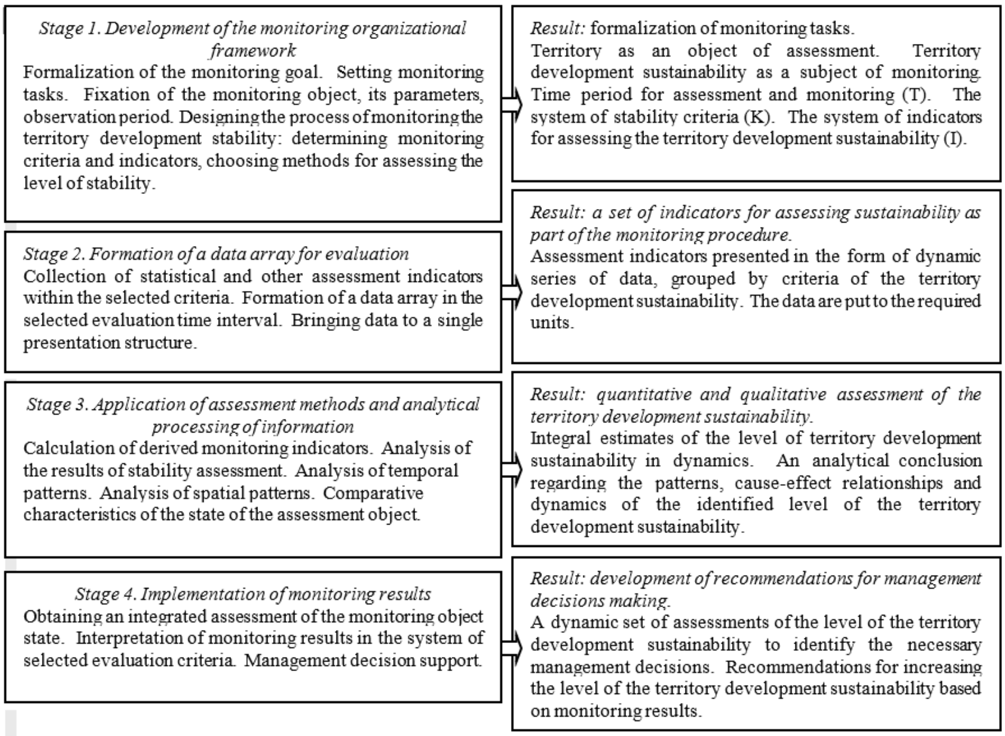

Figure 01. Monitoring program for the territory development sustainability

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4. Purpose of the Study

The use of effective methods for assessing the sustainability of development in the program framework for monitoring socio-economic processes at the regional level is designed to maximize the satisfaction of the information needs of government bodies. The effectiveness of managing socio-economic processes largely depends on achieving the goal of developing and adapting a set of methods and approaches to assessment the territory development sustainability.

The authors of the article set the following goal: to show the application of methods for assessing the level of the territory development sustainability and the search for optimal values of socio-economic determinants in the framework of the proposed monitoring program. Achieving this goal contributes to the development of the applied aspect of the topic under study - the development of effective and relevant recommendations in the field of decision-making on the management of socio-economic processes.

5. Research Methods

5.1. General description of the technique

In the framework of assessing the territories development sustainability, we establish the following requirement to achieve indicators of socio-economic development in the identified areas of sustainability: as close to the planned level of socio-economic development and as far from the negative version of the development level as possible. It is possible to assess the fulfilment of this requirement by applying the method of ordered preference through similarities with the ideal solution (TOPSIS). Many of the criteria that are proposed in the framework of this method have been reduced to the identified areas (aspects) of sustainability. The application of the method was described in detail and tested by the authors on the example of the Krasnoyarsk Territory (Ferova et al., 2019; Lobkova, 2020).

In this article, the authors conducted a study in the direction of finding the optimal values of the socio-economic determinants of the territory development sustainability on the basis of previously obtained assessment results.

The sustainability of the development of the territory socio-economic system depends on the totality of specialization industries, supporting and related industries, types of economic activity (testing was carried out by the authors on the example of the Krasnoyarsk Territory). Several aspects of sustainability assessment and a set of private indicators of assessment are highlighted:

- metallurgical production (R_{me}): the share of the industry in the structure of the region's added value,% (X_1); share of people employed in the industry,% (X_2); the ratio of the average monthly accrued wages per employee in the industry to the average wage in the region (X_3); return on sales of goods, products (works, services) of industry organizations,% (X_4);
- oil and natural gas (R_p) production: specific gravity of the industry in the region's added value structure,% (X_5); share of people employed in the industry,% (X_6); the ratio of the average monthly accrued wages per employee in the industry to the average wage in the region (X_7); profitability of sold goods, products (works, services) of industry organizations,% (X_8);
- electricity generation (R_{eg}): the share of the industry in the structure of the region's added value,% (X_9); share of people employed in the industry,% (X_{10}); the ratio of the average monthly accrued

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wages per employee in the industry to the average wage in the region (X_{11}); return on sales of goods, products (works, services) of industry organizations,% (X_{12});

- agriculture (R_{ag}): share of the industry in the structure of the region's added value,% (X_{13}); share of people employed in the industry,% (X_{14}); the ratio of the average monthly accrued wages per employee in the industry to the average wage in the region (X_{15}); return on sales of goods, products (works, services) of industry organizations,% (X_{16});
- trade (R_t): the share of the industry in the structure of the region's added value,% (X_{17}); share of people employed in the industry,% (X_{18}); the ratio of the average monthly accrued wages per employee in the industry to the average wage in the region (X_{19}); profitability of sold goods, products (works, services) of industry organizations,% (X_{20});
- social aspect (M_s): life expectancy at birth, years (X_{21}); the proportion of the population with cash incomes above the subsistence level established in the subject of the Russian Federation,% (X_{22}); level of employment in working age,% (X_{23}); the ratio of per capita cash income to the cost of living (X_{24});
- financial and investment aspect (R_{fi}): ratio of revenues and expenses of the consolidated budget of the region, % (X_{25}); share of unprofitable organizations, in% of the total number of organizations (X_{26}); arrears of wages per employee, to which there is arrears, rub. (X_{27}); investment in fixed assets per capita, rub. (X_{28});
- transport sector (R_{tr}): departure of passengers by public railway, thousand people (X_{29}); dispatch of goods by public rail, million tons (X_{30}); freight turnover of automobile transport of organizations of all types of activity, mln t-km. (X_{31}); the proportion of paved roads in the total length of public roads, % (X_{32}).

For each aspect of sustainability, including a set of private assessment indicators, an integral level indicator was calculated using the TOPSIS method. In the study of the optimal level of development sustainability components based on the dynamic programming method, the authors used an indicator of the volume of investments in fixed assets by types of economic activity and assessment aspects for the analysed period.

5.2. Statement of the dynamic programming problem

In the framework of the task, it is required to determine the level of particular indicators for assessing sustainability and each of the eight components that maximize the composite indicator of the territory development sustainability with the available volumes of investment in the socio-economic sphere.

The territory development sustainability is considered as the state of the controlled system *S*. As a multi-step task process, we consider the process of investing in the fixed capital of the *i*-th volume of monetary units by type of economic activity. With a step-by-step solution of the problem, a maximum of the composite indicator of the territory development sustainability is searched.

To compile a recurrence equation of the problem, a number of procedures are required. The dynamic programming problem is solved by the step-by-step control method. As the *i*-th step of the methodology, we take the amount of investment in the totality of economic activities during the planning period. The number of steps *N* in this task should be taken equal to eight, which corresponds to the number of types of

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economic activity (aspects or components) by which the level of the territory development sustainability is estimated. At each step of the assessment, y_i volume of conventional units for the development of the territory in the areas of production, social, financial, investment and transport are considered. Decisions implemented by the volume of investment of conventional units and the type of economic activity (direction of assessment) fall at one step.

The state of the managed system *S* (the territory development sustainability is considered) before each *i*-th step of the task is characterized by the variable y_i - the total investment of conventional units aimed at the development of types of economic activity (in the areas of assessment) that determine the territory development sustainability. The control variable u_i is also introduced, which is the amount of conventional units invested that are obtained at the *i*-th step of solving the problem for the *i*-th type of economic activity (direction of assessment) by the accumulated result (taking into account the previous evaluation steps).

The following limitations are formulated in the problem:

- the minimum value of the investment of conventional units at the *i*-th step of the task should correspond to the amount of necessary investment resources to ensure the *i*-th type of economic activity;
- the maximum value of the volume of investment of conventional units used at the *i*-th step of the task should correspond to the total amount of investment in fixed assets acceptable for the fulfilment at the *i*-th step of the limit values of the *i*-th type of economic activity;
- the total value of the volume of conventional units investment used to solve the problem at the *i*-th step should not exceed the allowable value of the volume of investment of conventional units for all types of economic activity in the territory;
- particular indicators of sustainability assessment with the lowest level of significance in the group within the framework of the criterion (direction) should not be lower than the maximum value for the evaluation period; other private indicators of sustainability should not be lower than the minimum value for the evaluation period.

As the “gain parameter”, the main economic effect of solving the problem is taken, which is the total value of the expected private indicators for assessing the territory development sustainability from the P_i-th type of economic activity (direction of assessment). The problem is solved as a maximum search. The private economic effect of P_i at the *i*-th step of the problem depends on the u_i-th volume of investment in the P_i-th type of economic activity (direction), i.e. $P_i = P_i\ (u_i)$. The total economic effect for all *N* steps will be equal to (1):

$$P_i = \sum_{i=1}^{N} P_i(u_1) \qquad (1)$$

where P_i is the value of the main economic effect of the task obtained from the managerial impact - “step control” u_i for all *N* steps of the multi-step process;

$P_i\ (u_i)$ - the value of the private economic effect P_i obtained from the managerial impact - “step management” u_i at the task step i = 1 according to the *i*-th type of economic activity (direction).

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The summary (total) level of the territory development sustainability R_{ds} at the *i*-th step is determined as follows (2):

$$R_{ds} = R_{me}(u_1) + R_p(u_2) + R_{eg}(u_3) + R_{ag}(u_4) + R_t(u_5) + R_s(u_6) + R_{fi}(u_7) + R_{tr}(u_8)\,, \quad (2)$$

where P_{ds} is the value of the composite indicator of the territory development sustainability, including a set of directions or aspects of the assessment (types of economic activity) for all *N* steps of a multi-step process.

The function of the multi-step process $x_i = f_i(y_{i-1}; u_i)$, which determines the law of change of the controlled system *S*, for this problem is determined by the formula (3):

$$y_i = (y_{i-1} + u_i), \quad (3)$$

This equality has the following meaning: x_i the volume of investment of conventional units at the *i*-th step of the task for the *i*-th type of activity is determined by the cumulative total after the current step with number *i* and is equal to the total amount of investment of conventional units of a particular *i*-th type of economic activity (direction) by the previous step (y_{i-1}) plus the amount of investment of conventional units u_i aimed at the p_i -th type of economic activity (direction of sustainability) at the current step of the task.

Therefore, under the action of “step control” u_i at the *i*-th step of the problem, the controlled system *S* goes into a new state (4):

$$s_{i-1} = s_i - u_i\,, \quad (4)$$

At the next stage of the technique, a recurrence equation is introduced. We denote by fi (*S*) the maximum level of the composite indicator of the territory development sustainability of P_{ds} for the i last control steps. Then the main recurrent equation of the dynamic control problem expressing the conditional “optimal gain” of the P_{ds} problem will have the following form (5):

$$f_i(S) = max\,[P_{ds\,i} + f_i\text{-}1\,(S_{i-1})] = max\,[P_{ds\,i} + f_{i-1}\,(S_i - u_i)] \quad (5)$$

Based on the above approach to determining the optimal level of values of particular indicators and components of the territory development sustainability, the authors performed calculations by the dynamic programming method on the example of the Krasnoyarsk territory.

6. Findings

The optimal values of the components of the territory development sustainability are:

- The levels of particular indicators X_j calculated by the dynamic programming method within the framework of evaluation criteria (directions);
- P_i components integrated by the TOPSIS method on the basis of optimal partial assessment indicators that maximize the value of the composite indicator of stability of P_{ds} with the existing volume of investments in fixed assets for a certain period of time (Table 1).

The proposed approach allowed the authors to make estimates of the optimal level of investment in fixed assets (y_i), differentiated by direction (criteria) of stability, as well as calculate the optimal summary value of the level of sustainability of development of the Krasnoyarsk Territory (P_{ds}) and the total optimal investment in fixed capital corresponding to the estimates made (*Y*). The specific gravities of the optimal investment volumes distributed by types of activity and areas of assessment (w_i) are also estimated.

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Table 01. Optimal values of private and integrated indicators, a composite indicator for assessing the level of the Krasnoyarsk Territory development sustainability

Steelmaking industry							**Oil and natural gas production**						
X_1	X_2	X_3	X_4	P_{ME}	y_{ME}	w_{ME}	X_5	X_6	X_7	X_8	P_p	y_p	w_p
20,81	3,41	1,72	51,30	0,50	72788,5	0,26	14,9	1,4	2,34	22,8	0,59	94719,3	0,33
Electricity generation							**Agriculture**						
X_9	X_{10}	X_{11}	X_{12}	P_{eg}	Y_{eg}	W_{eg}	X_{13}	X_{14}	X_{15}	X_{16}	P_{ag}	y_{ag}	w_{ag}
7,45	3,59	1,28	2,80	0,63	33303,4	0,12	2,5	7,50	0,73	2,40	0,50	5276,24	0,02
Trade							**Social aspect**						
X_{17}	X_{18}	X_{19}	X_{20}	P_t	y_t	w_t	X_{21}	X_{22}	X_{23}	X_{24}	P_s	y_s	w_s
21,24	16,1	0,67	5,20	0,51	3579,96	0,01	70,6	81,1	75,03	2,47	0,36	16 808	0,06
Financial and investment aspect							**Transport sector**						
X_{25}	X_{26}	X_{27}	X_{28}	P_{fi}	Y_{fi}	W_{fi}	X_{29}	X_{30}	X_{31}	X_{32}	P_{tr}	y_{tr}	w_{tr}
84,2	32	41 961	127 445	0,37	11 447	0,04	7 290	45	2 704	82,9	0,374	45163	0,2

Source*:* calculated and compiled by the authors.

The authors obtained the following results:

- the optimal level of the composite indicator of the Krasnoyarsk Territory development sustainability was R_{ds} = 0.50;
- to achieve the optimal level of the composite indicator and its sustainability indicators, the volume of investments in fixed assets equal to 283,085.8 million roubles is required;
- the largest share in the optimal investment structure is occupied by the oil and natural gas production sector - 0.33%, which corresponds to 94 719.25 million roubles;
- optimal estimates of the specific gravities of industries in the added value structure of the Krasnoyarsk Territory allow us to speak about the required adjustments in the current structure of the region's production sector in the direction of ensuring the optimal level of sustainable territory development (an increase in the share of agricultural products to 2.53% at a current level of about 1.5 %; a decrease in the specific gravity of metallurgical production to 20.81% at an existing level of about 23%; an increase in the specific gravity of oil and natural gas production to 14.95% with an average level of the study period is about 13.6%, etc.);
- to ensure the optimal level of the Krasnoyarsk Territory development sustainability, the necessary requirement is to maintain all social indicators at a level not lower than that achieved during the study period;
- the following levels of the sustainability components of the development of the territory should be ensured by types of economic activity and directions: metallurgical production (R_{me}) - 0.50; oil and natural gas production (R_p) - 0.59; electric energy production (R_{eg}) - 0.63; agriculture (R_{ag}) - 0.50; trade (R_t) - 0.51; social sphere (R_s) - 0.36; financial investment sphere (R_{fi}) - 0.37; transport sector (R_{tr}) - 0.374.

Thus, the proposed statement of the problem on the basis of the dynamic programming method allows us to determine the optimal levels of socio-economic determinants (private and integrated) that ensure the development of the territory at a given level of investment, with the aim of developing adequate and effective management decisions within the framework of the monitoring procedure for social and economic processes in the region.

7. Conclusion

Analysis of socio-economic processes as a tool for diagnosing the level and dynamics of development of the territory is a necessary condition for ensuring sustainable socio-economic development of the region. As part of an effective management process, special attention should be paid to a detailed analysis of managerial decisions aimed at ensuring sustainable balanced development of the region and creating a favourable socio-economic climate for the growth of economic sectors and improving the quality of life of the population.

The methodological approach proposed by the authors and the optimal values of the studied indicators obtained on its basis allow developing guidelines for making managerial decisions in the following areas: development of priority types of economic activity and areas; improving the structure of production; social policy; financial management (private and public finance), etc. The possibilities of the developed program for monitoring the territory development sustainability are determined by the assessment methods that are proposed and adapted to the needs of the task, which allow us to obtain results for identifying and timely responding to problems and trends in the socio-economic space of the region that arise in the process of implementation of functions by governing bodies.

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References

Abashev, D. A., & Yanovskiy, V. V. (2018). Monitoring ustoychivosti i sbalansirovannosti regional’nogo razvitiya [Monitoring the sustainability and balance of regional development]. *Management of economic systems: scientific electronic journal, 7*(113), 1. [In Rus]

Ferova, I. S., Lobkova, E. V., Tanenkova, E. N., & Kozlova, S. A. (2019). Tools for Assessing Sustainable Development of Territories Taking into Account Cluster Effects. *Journal of Siberian Federal University. Humanities & Social Sciences, 12*(4), 600–626.

García-Melón, M., Gómez-Navarro, T., & Acuña-Dutra, S. (2012). A combined ANP-Delphi approach to evaluate sustainable tourism. *Environmental Impact Assess, 34*, 41–50.

Grzebyk, M., & Stec, M. (2015). Sustainable development in EU countries: Concept and rating of levels of development. *Sustainable Development, 23*, 110–123. https://doi.org/10.1002/sd.1577

Kovalenko, E. G. (2012). Monitoring ustoychivosti sotsial’no-ekonomicheskogo razvitiya sel’skikh territoriy. [Monitoring the sustainability of the socio-economic development of rural areas]. *Bulletin of Volga State University of Technology. Series: Economy and Management, 1*(14), 43–50. [In Rus]

Krajnc, D., & Glavic, P. (2005). A model for integrated assessment of sustainable development. *Resources, Conservation and Recycling, 43*, 189–208. https://doi.org/10.1016/j.resconrec.2004.06.002

Lee, T. H. (2013). Influence analysis of community resident support for sustainable tourism development. *Tour Management, 34*, 37–46.

Lobkova, E. V. (2020). Otsenka vliyaniya sotsial’no-ekonomicheskikh kriteriev na ustoychivost’ razvitiya territorii metodom TOPSIS. [Assessment of the impact of socio-economic criteria on the sustainability of the development of the territory using the TOPSIS method]. *Regional Economics: Theory and Practice, 18, 1*(472), 84–107. [In Rus]

Mikhalev, O. V. (2011). Monitoring ekonomicheskoy ustoychivosti regional’nykh khozyaystvennykh system [Monitoring the economic sustainability of regional economic systems]. *ECO journal, 6*(444), 147–157. [In Rus]

Polovova, T. A. (2013). Upravlenie ekonomicheskoy ustoychivost’yu sotsial’no-ekonomicheskikh system: otsenka, monitoring, rezul'taty [Management of economic sustainability of socio-economic systems: assessment, monitoring, results]. *ETAP: economic theory, analysis, practice, 6*, 27–45. [In Russ.]

Polyakova, A. G., Loginov, M. P., Serebrennikova, A. I., & Thalassinos, E. I. (2019). Design of a Socio-economic Processes Monitoring System Based on Network Analysis and Big Data. *International Journal of Economics and Business Administration, 7*(1), 130–139. https/doi.org/10.35808/ijeba/200

Shen, L., Zhou, J., Skitmore, M., & Xia, B. (2015). Application of a hybrid Entropy-McKinsey Matrix method in evaluating sustainable urbanization: A China case study. *Cities, 42*, 186–194. https://doi.org/10.1016/j.cities.2014.06.006

Tan, F., & Lu, Z. (2016). Assessing regional sustainable development through an integration of nonlinear principal component analysis and Gram Schmidt orthogonalization. *Ecological Indicators, 63*, 71–81.

Tkhakushinov, A. K. (2014). Monitoring ustoychivosti razvitiya regional’noy ekonomiki: metody i instrumentariy [Monitoring the sustainability of the regional economy: methods and tools]. *New Technologies, 2, 116–119*. [In Rus]

Veisi, H., Liaghati, H., & Alipour, A. (2016). Developing an ethics-based approach to indicators of sustainable agriculture using analytic hierarchy process (AHP). *Ecological Indicators, 60*, 644–654.

Zhao, J., & Chai, L. (2016). A Novel Approach for Assessing the Performance of Sustainable Urbanization Based on Structural Equation Modeling: A China Case Study. *Sustainability, 8*(9), 910. https://doi.org/10.3390/su8090910