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ANALYZING THE SUSTAINABILITY OF REGIONAL ECONOMIES USING MULTI-CRITERIA INDICES AND MODEL OPTIMIZATION

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Abstract: The article proposes an integrative methodological approach that combines multi-criteria key performance indicators and scenario modeling methods for a more flexible, sustainable and adaptive assessment of regional strategies. The author justifies the need to move from narrowly focused economic indicators to complex indicators that cover social, environmental, institutional and innovative aspects of development. Based on the analysis of international experience, a weighted KPI system was developed, integrated into a scenario model that takes into account alternative trajectories of external and internal problems. The proposed approach can be adapted for use in developed and developing regions, which emphasizes its methodological versatility and practical significance.

Key words: regional development, strategy evaluation, multi-criteria KPI, scenario modeling, strategic planning, sustainable development indicators, adaptive territorial management, performance evaluation.

Annotatsiya: Ushbu maqolada mintaqaviy strategiyalarni yanada moslashuvchan, barqaror va adaptiv baholash uchun ko‘p mezonli asosiy samaradorlik ko‘rsatkichlari (KPI) va stsenariy modellashtirish usullarini birlashtiruvchi integratsion metodologik yondashuv taklif etiladi. Muallif tor iqtisodiy ko‘rsatkichlardan voz kechib, ijtimoiy, ekologik, institutsional va innovatsion jihatlarni qamrab oluvchi murakkab indikatorlarga o‘tish zarurligini asoslab beradi. Xalqaro tajriba tahliliga asoslanib, tashqi va ichki muammolarning muqobil trayektoriyalarini hisobga oluvchi og‘irlik koeffitsiyentli KPI tizimi ishlab chiqildi va u stsenariy modeliga integratsiya qilindi. Taklif etilgan yondashuv rivojlangan hamda rivojlanayotgan hududlarda qo‘llanilishi mumkin bo‘lib, uning metodologik universalligi va amaliy ahamiyatini ta’kidlaydi.

Kalit so‘zlar: mintaqaviy rivojlanish, strategiyani baholash, ko‘p mezonli KPI, stsenariy modellashtirish, strategik rejalashtirish, barqaror rivojlanish ko‘rsatkichlari, adaptiv hududiy boshqaruv, samaradorlikni baholash.

Аннотация: В статье предлагается интегративный методологический подход, объединяющий многокритериальные ключевые показатели эффективности (KPI) и методы сценарного моделирования для более гибкой, устойчивой и адаптивной оценки региональных стратегий. Автор обосновывает необходимость перехода от узконаправленных экономических показателей к комплексным индикаторам, охватывающим социальные, экологические, институциональные и инновационные аспекты развития. На основе анализа международного опыта разработана система взвешенных KPI, интегрированная в сценарную модель, учитывающую альтернативные траектории внешних и внутренних проблем. Предложенный подход может быть адаптирован для использования как в развитых, так и в развивающихся регионах, что подчеркивает его методологическую универсальность и практическую значимость.

Ключевые слова: региональное развитие, оценка стратегии, многокритериальные KPI, сценарное моделирование, стратегическое планирование, индикаторы устойчивого развития, адаптивное территориальное управление, оценка эффективности.

INTRODUCTION

The modern challenges of global instability, technological transformations and socio-ecological risks require regional governance systems to move from a reactive to a proactive, strategically oriented approach. The effectiveness of regional policy is increasingly determined not by the volume of allocated resources, but by the quality of strategic planning, the ability to adapt to external shocks and balance the interests of different stakeholder groups. In such conditions, the evaluation of regional development strategies is becoming not an auxiliary procedure, but a central element of the management cycle, which allows for feedback, course correction and justification of political decisions. Traditional assessment methods based on macroeconomic aggregates such as GRP per capita, unemployment or investment volume are increasingly being replaced by complex, multidimensional approaches. This is because single-dimensional indicators cannot fully reflect the social well-being, environmental sustainability, institutional quality and innovative potential of the region. Furthermore, in the face of high future uncertainty caused by geopolitical tensions, climate change, and digital transformation, linear projections are losing their predictive value.[1] This requires the integration of alternative future scenarios into modeling processes and assessing the sustainability of strategies in a changing environment.

Review of literature on the subject

U. Otajonov says that “Building an effective model of economic development should be based on the global trend towards the formation of stable socially oriented self-developing territorial systems, in which conditions are created for social stability and economic well-being of the population” [2, p. 87].

Scientists such as I.V. Panshin, I.F. Zhukovskaya, O.B. Yares propose using intellectual capital as an indicator of the investment attractiveness of a region, which serves as a basis for measuring the quality and volume of innovative, information, digital and institutional infrastructure in the constituent entities of the regions [3, p. 63].

T.N. Shushunova, emphasizing the need for monitoring the investment climate in the regions, believes that periodic systematic monitoring allows assessing the investment attractiveness of regions and identifying difficulties in destabilizing the regional investment climate [4, p. 98]. It is important to understand that the investment attractiveness of the region is not only a prerequisite for sustainable economic development, but also a factor in preventing unexpected investment risks [4].

I.A. Zueva, G.V. Sakharov, T.A. Burtseva believe that, “... the goal of regional policy for the current medium-term period is to maintain a favorable investment climate, stimulate economic growth and modernize production...” [5, p. 56]. It is necessary to share the opinion of the authors and recognize the need for long-term stimulation of economic growth through the modernization of production in the regions, while maintaining a favorable investment climate at the required level.

BSC (Balanced Scorecard) proposed by Harvard School of Economics professors David Norton and Robert Kaplan [6]. The essence of this approach is to distinguish strategic goals, establish links with the company’s operational goals and objectives, and monitor the achievement of these goals using key performance indicators (KPIs). The basis of a unified management concept is BSC, and KPI is only its result.

RESEARCH METHODOLOGY

This study aims to develop and empirically test a comprehensive methodology for assessing regional development strategies, which combines two approaches: a multi-criteria system of complementary key performance indicators (KPIs) and scenario modeling methods. This integration overcomes the limitations of both indicator-based and forecast-based models, simultaneously measuring the current state and assessing strategic sustainability under uncertainty.

The relevance of this topic stems from both the theoretical need to improve the methodological foundations of regional economics and the practical need of state and municipal governments for tools capable of improving the quality of strategic planning. This problem is especially relevant in countries with transition economies, where strategic management institutions are still in the process of formation and where data for analysis are often scattered or not comparable.

The proposed methodology is based on the principle of two-way assessment:

horizontal assessment - measuring the current state of the region using a set of multi-criteria KPIs;

vertical assessment - modeling the dynamics of the same indicators in alternative future scenarios.

This approach allows not only to determine how successfully the strategy is being implemented today, but also to assess its resilience to possible changes in the future. Integration is achieved through the use of a single system of indicators in the static and dynamic parts of the analysis.

ANALYSIS AND RESULTS

Historically, the assessment of regional development was based on neoclassical economic theory, which viewed regions as production systems that maximize incomes given their resources. Accordingly, the main indicators were economic growth indicators - GRP growth rates, labor productivity and industrial output [6]. Such an approach, despite its simplicity and clarity, neglected social, environmental and institutional aspects, leading to a distorted picture of the real well-being of the population.

Since the end of the 20th century, the sustainable development paradigm formulated in the report “Our Common Future” has dominated the scientific literature. This concept has required expanding the set of assessment criteria to include environmental and social indicators. Instruments such as the Human Development Index, the Ecological Footprint, the Social Progress Index, etc. have emerged[7]. In the context of regional analysis, this has led to the development of a three-component assessment model:

economic efficiency;

social well-being;

ecological sustainability.

However, in the context of the growing complexity and interconnectedness of systems, this extended model has proven to be insufficient.

Modern research increasingly emphasizes the importance of the fourth dimension, institutional quality and management competence[8].

The concept of “KPI” derived from corporate governance has become widespread in the public sector due to new public management initiatives. In the context of regional development, KPI is used to measure the achievement of strategic goals set in strategic planning documents, such as socio-economic development strategies, regional development programs, etc.

At the same time, the application of KPI in the public sphere faces a number of methodological problems:

first, regional development goals are often multifaceted and contradictory (for example, stimulating economic growth may conflict with environmental constraints);

second, it is difficult to define many goals (for example, “improving the quality of life”);

third, there is no single methodology for generalizing individual indicators into a general assessment.

In response to these problems, the field of multi-criteria decision analysis has been actively developing in recent years. This approach allows you to consider several different criteria, rank alternatives, and determine the trade-off between competing goals. In particular, the weighted sum, analytic hierarchy process, Topsis, and Promethee methods are used in the assessment of regional policy [7]. The advantage of these methods is the ability to clearly take into account the preferences of experts or stakeholders when assigning weights to criteria, which increases the legitimacy and transparency of the assessment.

Multi-criteria KPIs are a way to answer the question “Where are we?” answers the question. Scenario modeling helps answer the question “Where can we go?”

A scenario is a logically consistent, but not necessarily predictive, picture of a possible future, based on an analysis of the main uncertainties and drivers of change.

The scenario method was first systematically used by Shell corporations in strategic planning and later became a standard tool in conditions of high uncertainty. In regional economics, scenario modeling is used to assess the resilience of strategies to external influences - economic, demographic, technological and climatic.

It should be noted that the purpose of scenarios is not to predict the future, but to prepare for it by testing the robustness of the strategy under different conditions.

Modern approaches to scenario modeling are increasingly integrated with quantitative methods - system dynamics, agent-based modeling and machine learning. This allows not only to describe qualitative scenarios, but also to assess their quantitative consequences for key indicators of regional development [3].

Despite the growing interest in both approaches - multi-criteria assessment and scenario modeling, their synthesis into a single methodology has not yet been developed. Most studies are aimed at measuring the current state or predicting the future, but these two aspects are rarely combined in a single analytical process. This study aims to fill this gap.

The KPI system was developed based on the analysis of international frameworks (the «Europe 2020» strategy and the OECD Regional Prosperity Framework). This synthesis identified four areas of regional development:

economic dimension: gdp per capita, the share of small and medium-sized businesses, the level of investment activity and the innovative activity of enterprises;

social dimension: poverty rate, access to healthcare and education, life expectancy and satisfaction with quality of life;

environmental dimension: air quality, waste volume, green space area and waste management efficiency;

institutional dimension: governance quality index, corruption risk level, budget transparency and digital maturity index.

For each dimension, three to five specific indicators were identified, all of which are available in official statistics. The weights of the criteria were determined using the analytical hierarchy process method based on expert assessments of 25 specialists in regional economics, public administration and strategic planning.

The main uncertainties were identified using the “morphological analysis” method and include:

the pace of technological transformations;

the level of geopolitical stability;

demographic dynamics;

climate change;

the availability of financial resources.

Based on these factors, three scenarios were developed:

basal (inertial) - continuation of current trends without significant external shocks;

optimistic - accelerated digitalization, increased investment, stable external environment;

pessimistic - economic recession, worsening demographic situation, increased sanctions.

To quantitatively assess the impact of the scenarios, a system dynamics model implemented in the Vensim software environment was used. The model includes interrelated blocks in the economic, demographic, budgetary and social spheres.

The methodology was tested in three regions with different levels of development:

Denov district (high level of development);

Sherabad district (medium level);

Bandikhon district (low level).

The selection was due to the need to test the universality of the methodology in different socio-economic structures, resource bases and management cultures. Data were collected from official sources and through semi-structured interviews with representatives of regional ministries of economic development.

The analysis of the current situation revealed significant regional stratification not only in terms of level, but also in terms of development structure. Denov district shows strong results in all four areas, in particular in the economic and institutional spheres. Sherabad district shows average results, but with a clear imbalance: weak innovative activity and a low level of digitalization are compensated by relatively high social indicators. Bandikhon district is characterized by systematically low results in all areas, in particular in the institutional and environmental spheres.

Interestingly, the weighted assessment revealed «hidden» problems. For example, in Sherabad district, high satisfaction with the quality of life is combined with low attractiveness of migration, which calls into question the sustainability of social achievements.

Modeling showed that the sustainability of strategies varies greatly depending on the region. In Denov district, even in the pessimistic scenario, positive dynamics are maintained for most indicators due to a diversified economy and strong institutions. In Sherabad district, the optimistic scenario provides for significant growth, but the pessimistic scenario leads to a sharp deterioration, especially in the social sphere, which indicates the weakness of the current model. In Bandikhon district, all scenarios show weak dynamics, but the optimistic scenario suggests a possible «upturn» due to investment and demographic programs.

Institutional and environmental indicators turned out to be the most vulnerable to external influences. For example, when budget transfers are reduced, housing and communal services modernization and environmental monitoring programs will suffer first and foremost, quickly affecting the quality of life.

The integration of the two approaches allowed us to formulate differentiated recommendations:

For developed regions (Denov district): focus on increasing inclusive growth, developing a green economy, and strengthening horizontal ties with other regions.

For the middle regions (Sherabad district): a strategic reset is needed, focusing on digital transformation and attracting private investment, as well as creating buffers against external shocks.

For the lost regions (Bandikhon district): strengthening key institutions, improving governance, and targeted support for human capital are priorities.

In addition, the study showed that the effectiveness of strategies is directly related to the quality of feedback: regions with regular monitoring and data-based strategy adjustments show greater stability.

CONCLUSIONS AND SUGGESTIONS

The proposed methodology for assessing regional development strategies based on the synthesis of multi-criteria KPI and scenario modeling is a theoretically sound and practically applicable tool for improving

the quality of strategic management. It eliminates the narrowness of traditional economic indicators and the passivity of linear forecasts, providing a comprehensive, dynamic and flexible approach to assessment.

Empirical tests have confirmed that the effectiveness of regional strategies is determined not only by resources, but also by the development structure, the quality of institutions and the ability to adapt to crises. Importantly, the methodology identifies not only current achievements, but also hidden weaknesses, which makes it valuable for proactive risk management.

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