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Research Article

Methodology for Determining the Optimal Strategy for Sustainable Development of Regional Economic Systems in the Context of Overcoming the Strategic Gap and Balancing the Spatial Distribution of Resources Based on a Generalized Approach Analysis

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Abstract: This study develops and validates an integrated six-dimensional generalized approach (GAP) measurement system for strategic gaps in regional development. The proposed methodology quantitatively assesses disparities between current and target regional states across six resource domains: informational, technical-technological, financial, personnel, organizational, and marketing. The model was tested on 15 Russian regions using correlation and regression modeling to identify statistically significant gaps. The greatest influence is exerted by: the sectoral structure of the economy (β=0.32; p<0.01), the quality of the institutional environment (β=-0.38; p<0.01) and the level of production diversification (β=-0.45; p<0.001). The negative cumulative effect in monospecialized regions is highlighted. Scenario forecasting demonstrates that comprehensive programs combining economic diversification, human capital development, and institutional improvement can reduce strategic gaps by 25%-35% in the medium term (5-7 years). The results provide a foundation for the development of differentiated regional policy. The results of the study allow moving from unified approaches to differentiated regional development regulation and provide a scientific basis for making informed management decisions.

Keywords: Disproportions; GAP analysis; Regional development; Spatial development; Strategic gaps

1. Introduction

The increasing complexity of modern challenges fundamentally determines the relevance of developing a toolkit for determining optimal strategies for the sustainable development of regional economic systems. Today, regions operate in a volatile environment characterized by geopolitical shifts, technological disruptions, and heightened environmental constraints. These intensify strategic gaps—significant disparities between current developmental states and desired future goals, as outlined in strategic plans. Traditional planning methods often fail to account for the dynamic interplay between the economic, social, and environmental dimensions of sustainability, leading to inefficient resource allocation and stalled progress. Traditional economic metrics, often centered on gross domestic product (GDP) growth, have proven insufficient for capturing the multifaceted nature of sustainable development (Smith, 2020), which has led to a growing consensus on adopting multidimensional frameworks that integrate environmental, social, and institutional indicators alongside economic indicators to provide a holistic assessment of regional progress and disparities (Chung et al., 2018). Moreover, existing applications of GAP analysis in regional economics are often fragmented, focusing on singular dimensions (e.g., economic growth or social indicators) without integrating them into a holistic framework capable of diagnosing complex, interrelated imbalances (Johnson & Lee, 2019; Smith, 2020). This

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creates a significant research gap: the lack of a prescriptive, multicriteria toolkit that moves beyond descriptive diagnosis to identify the structural causes of gaps and model the efficacy of interventions. This study aims to bridge this methodological gap by developing and validating a comprehensive GAP–analysis toolkit that synthesizes six critical resource domains into a unified assessment system. The core scientific novelty and contribution of this research are threefold: 1) Integration of Spatial, Resource, and Institutional Aspects: The proposed model simultaneously quantifies disparities across six interdependent domains—informational, technical-technological, financial, personnel, organizational, and marketing—providing a nuanced structural diagnosis beyond one-dimensional metrics. 2) Transition from Diagnosis to Prescription: By integrating correlation/regression analysis and scenario forecasting, the methodology identifies key gaps (e.g., sectoral structure and institutional quality) and models the dynamic impact of policy measures, enabling data-driven strategy formulation. 3) Differentiated Policy Instrument: The methodology classifies gaps by severity and regional typology, allowing for tailored, rather than unified, policy recommendations that optimize resource allocation.

Accurately identifying these disparities forms the critical foundation for any subsequent strategic planning. GAP analysis emerges as a principal diagnostic tool in this context, providing a structured framework for comparing a regional economy's current state with its desired strategic goals (Brown & Miller, 2021), and as noted by (Wilson, 2017), the evolution of GAP-analysis from a simple diagnostic exercise to a prescriptive tool enables policymakers to not only identify "where we are" versus "where we want to be" but also illuminate the pathways to bridge that divide. The methodology involves a systematic process of identifying performance shortfalls, resource deficiencies, and spatial imbalances that hinder the achievement of sustainable development objectives. The selection and evaluation of relevant indicators are a critical component of this analysis. Effective strategies must move beyond conventional economic metrics to include indicators of innovation, human development, and environmental quality (Egorov et al., 2021; Hao, 2022). (Lundaeva & Gintciak, 2025) demonstrated that the impact of patent regulation features on the innovative activities of enterprises is a critical factor in fostering regional innovation ecosystems, which directly influences the informational and technological gaps identified in this study. The relationship between socio-economic indicators and broader development goals, such as public health and sanitation, further illustrates the interconnectedness of these factors (Li et al., 2022). The spatial distribution of resources and economic activity is a paramount concern for regional equilibrium. Imbalances in this distribution can intensify strategic gaps, leading to polarized development where certain territories advance while others stagnate (Zhogova et al., 2020). Addressing this requires sophisticated models for spatial resource allocation that can optimize distribution based on a set of multi-criteria decision-making (MCDM) parameters, ensuring that investments are directed to areas with the highest potential for sustainable impact and equitable growth (Davis et al., 2022). In the modern context, a region's digital and innovative potential is a decisive factor in overcoming developmental gaps. Assessment of a region's digital maturity and capacity for innovation is crucial for integrating into the global trends of Industry 5.0 and the circular economy (Narula et al., 2024; Rehman & Umar, 2024; Visvizi et al., 2024). (Sutriadi et al., 2025) examined the understanding of smart sustainable city themes through urban innovation performance, highlighting the importance of digital ecosystem maturity for regional competitiveness. (Shaposhnykov et al., 2023; Tashenova et al., 2020) demonstrated methods for evaluating the digital and innovative potential of industrial clusters, which can be leveraged to bridge strategic divides and foster smarter, more sustainable regional economic systems. The successful implementation of any strategy is inherently tied to effective governance and multilevel strategic planning. (Orel et al., 2025) emphasized that sustainable development in public administration requires a coherent approach that aligns national, regional, and local objectives. The role of human capital and scientific potential cannot be overstated. The interconnection between a region's scientometric indicators, such as university research output, and its economic performance is a key area of study (Rodionov & Velichenkova, 2020; Sandler & Gladyrev, 2020). (Voronkova et al., 2023) examined foreign experience in implementing digital education in the context of digital economy transformation, underscoring the importance of personnel development for closing strategic gaps in regional innovation systems. Building academic self-efficacy and innovation capacity within regional institutions is a fundamental step toward creating an ecosystem capable of generating endogenous growth and reducing dependency on external resources (Eroshkin et al., 2017; Habel, 2009).

Methodological approaches now increasingly incorporate sophisticated modeling and data analysis techniques. These tools enhance the precision of GAP analysis by employing machine learning to improve the accuracy of development project cost estimates (Berawi et al., 2025) and using simulation models to calibrate complex socio-technical systems (Zubkova et al., 2022). Ultimately, the determination of an optimal strategy is an exercise in multicriteria optimization under uncertainty conditions. It involves balancing often competing objectives—economic growth vs. environmental conservation, equity vs. efficiency, and immediate gains vs. long-term resilience. Therefore, the methodology must integrate risk assessment models for digital transformation (Shang et al., 2023) and define threshold values for economic security indicators (Nazarychev et al., 2022) to ensure that the chosen development path is not only effective but also robust and sustainable. In conclusion, a modern methodology for crafting optimal sustainable development strategies must be an integrative, data-driven, and multidimensional process. It builds upon the foundational principles of GAP-analysis and enriches it with advanced analytical techniques, a broad set of innovative and socio-environmental indicators, and a keen understanding of spatial dynamics and digital transformation. This comprehensive approach enables policymakers to accurately diagnose strategic gaps, design targeted interventions for balanced spatial development, and navigate the complex trade-offs inherent in the pursuit of sustainable regional economic development.

2. Methods

This study's methodological framework is designed to diagnose strategic gaps in regional development and develop targeted policy recommendations. It is based on a comprehensive application of GAP analysis, augmented by multivariate statistics and scenario forecasting methods. The core of the approach involves a structured, multi-stage process to quantitatively assess the disparities between a regional economic system's current and target states across six critical resource dimensions: informational, technical-technological, financial, personnel, organizational, and marketing.

2.1 Formation of the indicator system and domain justification

The system is structured around six key resource domains, selected based on their theoretical and empirical significance in regional economics and sustainable development literature: Informational: Reflects digital maturity and data integration capacity, critical for modern governance and innovation (Narula et al., 2024). (Tubis, 2023) developed a digital maturity assessment model for organizational and process dimensions, which informed the selection of indicators for the informational domain in our methodology. Technical-Technological: Captures the level of technological adoption and infrastructure adaptability, determining the productive capacity (Visvizi et al., 2024). (Zaytsev et al., 2021) developed a methodology for assessing the innovative potential of alternative energy in the context of the transition to the circular economy, which informed the selection of environmental and technological indicators in our framework. Financial: represents investment accessibility and budgetary resilience, which are fundamental for development financing. Personnel: Encompasses the quality and skills of human capital, a primary driver of long-term growth (Hao, 2022). (Zaitseva et al., 2021) proposed a model for the distribution of labor resources among regions to improve their economic indicators, which aligns with our approach to assessing personnel gaps and their impact on regional development. Organizational: Assesses governance efficiency and institutional quality, which underpin any strategy's implementation (Orel et al., 2025). Marketing: Evaluates place branding and export potential, key for economic diversification and competitiveness. Indicators for each domain were selected based on relevance, measurability (using Rosstat and official reports), reliability, and sensitivity to policy change. The instrumental apparatus for auditing the innovative potential of enterprises, as demonstrated by (Dmitriev et al., 2022), provides a complementary framework for selecting indicators that reflect the capacity for project-based innovation and technological renewal.

2.2 Normalization, weighting, and aggregation of data

Raw indicator data were normalized to a [0,1] scale using Min–Max linear scaling (Formula 1). This method is sensitive to extreme outliers; therefore, the data set was cleaned before analysis. (Lemeshko & Lemeshko, 2005) demonstrated robust methods for rejecting anomalous measurements using Grubbs-type tests, which informed our approach to outlier detection and data cleaning prior to normalization. The inclusion of new regions in future applications would require renormalization.

$$\mathrm{GAP}_{\mathrm{norm}} = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \tag{1}$$

where X_i is the value of the indicator of the region, $X_{\min}$ is the minimum value for all regions, and $X_{\max}$ is the maximum value for all regions.

Expert weighting was applied to reflect the relative importance of indicators within each domain. A panel of 15 experts (academics and regional policy practitioners) was convened. The Analytic Hierarchy Process (AHP) was used to derive consistent pairwise comparison matrices, yielding the final weight sets. The relationship between non-cash payment systems and various economic indicators, as explored by (Kredina et al., 2022), further validates the inclusion of financial and digital indicators in the assessment framework. To test robustness, a sensitivity analysis was performed by varying weights by ±15%; the resulting changes in regional rankings were found to be less than 5%, confirming stability. The weighted normalized values were aggregated into integral indices for each domain and then averaged for an overall GAP score.

2.3 Classification and visualization of the GAP results

The overall GAP values were classified by severity: insignificant (0.00–0.10), moderate (0.11–0.20), substantial (0.21–0.30), and critical (>0.30). Radar diagrams were constructed for each region to visualize the disparity profile.

2.4 Causal and predictive analysis

A multivariate ordinary least squares (OLS) regression model was employed to identify the drivers of gaps. The dependent variable was overall GAP. The independent variables included: share of the extractive industry in GRP (%), the economic diversification index (Herfindahl-type), the institutional quality index (aggregated from World Bank governance indicators and regional data), the human capital index, and a dummy variable for spatial peripherality. The model assumptions (normality of residuals, homoscedasticity, and absence of severe multicollinearity with VIF <5) were satisfied.

Scenario forecasting was conducted using expert-based trend extrapolation and simulation modeling. A system of linear equations was defined for each regional type, linking changes in key driver variables (e.g., diversification index) to projected changes in domain-specific GAPs based on the regression coefficients. Monte Carlo simulation (1000 iterations) was used to incorporate uncertainty (±10%) in parameter estimates, generating the expected ranges of values. This created a unified metric space, preserving relative distances between values and allowing for a statistically valid comparison and aggregation of data across all regions. Optimization models for resource allocation, such as those applied by (Saroji et al., 2022) in the context of power generation development, provide a methodological parallel to our approach for balancing regional resource distribution. (Rusanov et al., 2022) proposed an approach to forecasting socio-economic development indicators based on indirect indicators, which complements our methodology by providing a robust framework for predictive analysis in conditions of data limitations. This created a unified metric space, preserving relative distances between values and allowing for a statistically valid comparison and aggregation of data across all regions.

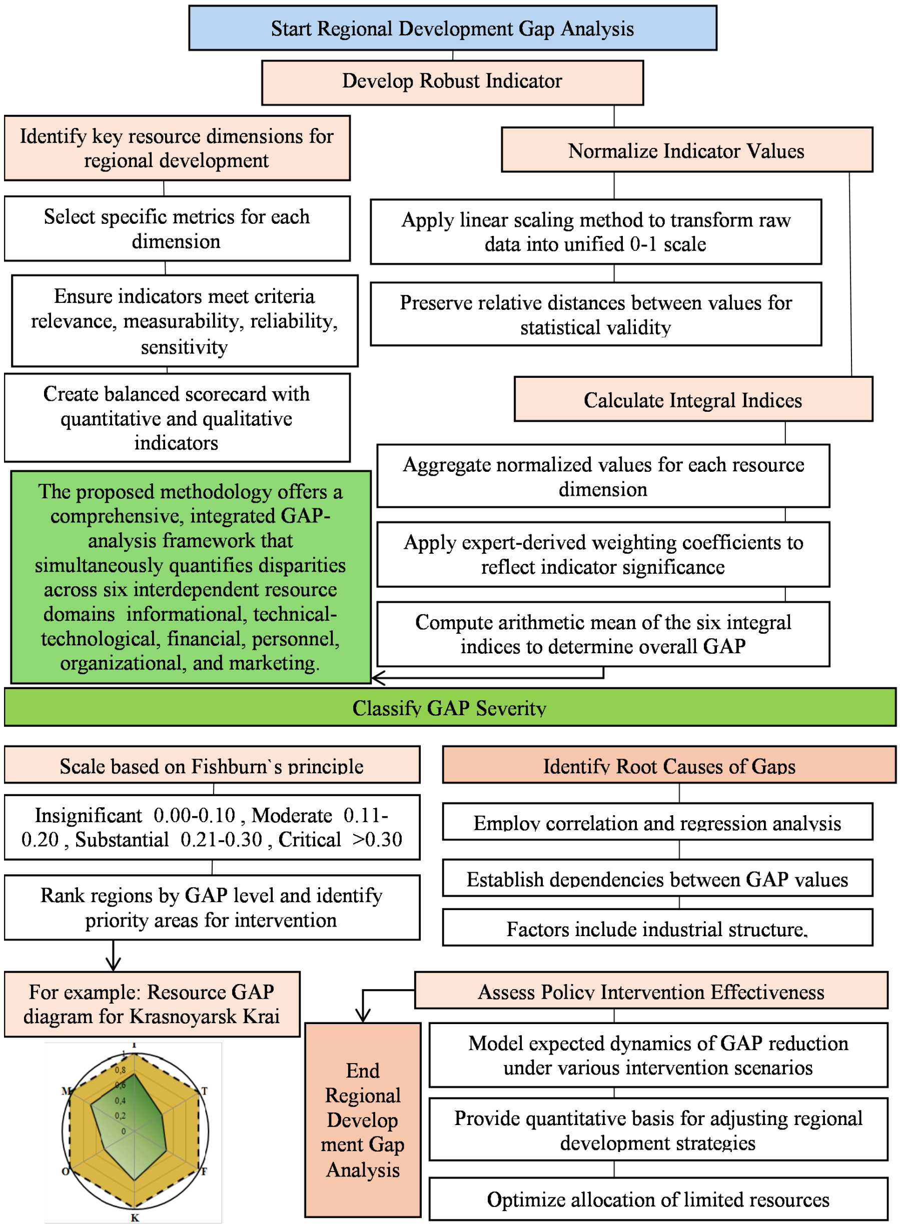

Figure 1 Multi-stage methodological process for determining the optimal strategy for sustainable development of regional economic systems in the context of overcoming the strategic gap and balancing the spatial distribution of resources based on GAP analysis

The normalized values were then aggregated into integral indices for each of the six directions. Expert-derived weighting coefficients were incorporated into this aggregation to reflect the relative significance of each indicator within its respective dimensions. The arithmetic mean of these six integral indices was then calculated to determine the overall (average) GAP of the region. The resulting values were classified by severity using a scale based on Fishburn's principle: insignificant (0.00–0.10), moderate (0.11–0.20), substantial (0.21–0.30), and critical (>0.30). This classification allows regions to be ranked by their level of disparity and to identify priority areas for policy intervention.

Methods of correlation and regression analysis were employed to identify the root causes of the diagnosed gaps. These statistical techniques were used to establish dependencies between the magnitude of GAP values and various regional factors, such as industrial structure, institutional quality, and spatial location. Finally, scenario forecasting was used to assess the potential effectiveness of different policy measures. This involved modeling the expected dynamics of GAP reduction under various intervention scenarios, providing a quantitative basis for adjusting regional development strategies and optimizing limited resource allocation.

The scientific novelty of this research lies in the development of an integrated GAP-analysis methodology that synthesizes spatial, resource, and institutional aspects into a unified assessment system.While GAP analysis is an established strategic management tool, its application in regional economics has often been fragmented, focusing on singular dimensions such as economic growth or social indicators (Chung et al., 2018; Smith, 2020), and many current applications of regional analysis are predominantly retrospective, cataloging existing disparities but offering limited mitigation guidance (Johnson & Lee, 2019) ; consequently, the primary distinction of this research is its provision of a differentiated, rather than a unified, regional policy instrument, since existing models often propose generalized solutions without sufficient consideration of the specific resource imbalance profile of individual regions (Brown & Miller, 2021). Unlike these existing approaches, the proposed toolkit provides a holistic framework that simultaneously quantifies disparities across six interdependent resource domains: informational, technical-technological, financial, personnel, organizational, and marketing. This multicriteria structure moves beyond traditional one-dimensional metrics, offering a comprehensive and nuanced diagnosis of a region's developmental imbalances and structural composition. A further distinct contribution is the capacity of the methodology to move from descriptive diagnosis to prescriptive strategy formulation. Many current applications of regional analysis are predominantly retrospective, cataloging existing disparities but offering limited mitigation guidance (Johnson & Lee, 2019). Consequently, the primary distinction of this research is its provision of a differentiated, rather than a unified, regional policy instrument. Existing models often propose generalized solutions without sufficient consideration of the specific resource imbalance profile of individual regions (Brown & Miller, 2021). Through its structured classification of gap severity and typology, the developed methodology enables the formulation of tailored policy recommendations.

3. Results and Discussion

The GAP analysis methodology for identifying strategic disparities in regional economic development constitutes a structured, multistage process aimed at quantifying imbalances between a region's current and target economic states.

The initial stage of GAP analysis—the formation of a system of indicators—serves as the foundational basis for the entire study, as the correct selection of metrics fundamentally depends on the accuracy of strategic gap diagnostics. The indicator system is structured around six key aspects of regional development: informational (access to digital technologies, level of cross-departmental integration), technical and technological (adoption of Industry 4.0, infrastructure adaptability), financial (investment accessibility, budgetary capacity), personnel (labor force qualifications, education level), organizational (governance efficiency, quality of institutions) and marketing (place branding, export potential). Each dimension reflects a critical resource segment where an imbalance can hinder the region's sustainable development. The selection of specific indicators is based on rigorous criteria to ensure the validity and practical applicability of the methodology. The relevance criterion ensures that the indicators align with the analysis objectives and the regional economy's specifics. The measurability criterion requires reliable data sources (e.g., Rosstat, ministries, and analytical reports). The reliability criterion excludes indicators with a high degree of subjectivity or manipulative potential. The sensitivity criterion guarantees that an indicator responds to changes in managerial interventions, thereby enabling the assessment of gap dynamics over time. The combination of these requirements minimizes the risk of methodological errors. The outcome of this stage is a balanced scorecard that provides comprehensive coverage of all aspects of regional development and establishes an objective basis for the quantitative assessment of disparities.

The linear scaling method (min-max normalization) employed for this transformation overcomes the problem of heterogeneous measurement units by converting all raw values into a unified, dimensionless scale from 0 to 1, where 0 corresponds to the minimum observed value for an indicator across the sample of regions, and 1 corresponds to the maximum. This approach not only eliminates the issue of heterogeneous measurement units but also contextualizes the position of each region relative to the entire sample, illustrating how its performance deviates from the minimum and maximum levels achieved by other constituent entities. The normalization procedure creates a unified metric space where all indicators are statistically comparable and ready for subsequent weighting and aggregation. This establishes the methodological foundation for calculating integral indices for each of the six analytical dimensions (informational, technological, etc.) and determining the overall strategic gap. Notably, the chosen method preserves the relative distances between the original values, enabling an accurate reflection of real developmental disparities among regions and ensuring the objectivity of all subsequent analyses. The methodology for calculating the informational GAP using the Moscow Oblast as an example confirmed its practical applicability and diagnostic value for assessing regional digital development (Table 1).

The calculations demonstrate that the methodology allows not only a quantitative assessment of the overall development level but also the identification of the internal structure of disparities through the analysis of weighted contributions of individual indicators. The calculations revealed significant differentiation in the development of various components of the region's information environment. The indicators of high-speed Internet accessibility (0.123) and digital literacy of the population (0.115) made the greatest contributions to the integral index, indicating effective policy in these areas. Simultaneously, problem zones were identified, such as the low level of cross-departmental integration (0.0275) and IT infrastructure adaptability (0.045), requiring targeted attention from governing bodies. Comparison with a reference value for the Russian Federation (e.g., 0.65) showed that Moscow Oblast has the potential to further reduce its gap despite its leading positions in absolute terms. This is because the methodology assesses the relative position of the region rather than the absolute level of development compared with the maximum values achieved nationally. This approach ensures an objective assessment and identifies development reserves even in highly developed regions.

Approbation of the third stage of the GAP-analysis methodology, which involves calculating partial gaps for the six key dimensions, confirmed its high diagnostic value for identifying structural disproportion in regional development. The analysis of structural resource GAPs in the studied set of regions revealed significant differences in the levels and nature of socio-economic development disparities (Table 2).

The most problematic spheres for most regions were the financial and personnel GAPs, indicating systemic challenges in attracting investment, developing human capital, and ensuring sustainable development financing. Critical values of the financial GAP (0.28–0.32) are observed in Perm Krai, Irkutsk Oblast, and Kemerovo Oblast, indicating the need to develop targeted measures to improve the investment climate and optimize budgetary planning. The assessment of state support to industry and its impact on economic development indicators, as examined by (Kushnarev et al., 2022; Zainy et al., 2023), confirms that targeted government interventions can significantly mitigate financial gaps in regions with pronounced industrial specialization. High values of the personnel GAP (0.25–0.28) in these regions underscore problems with labor resource quality and out-migration. Regions with moderate and elevated gap levels (0.18–0.22) demonstrate specific structural imbalances requiring differentiated regional policy approaches. For example, Leningrad Oblast has elevated financial (0.22) and organizational (0.20) GAPs, whereas Samara Oblast has a combination of high financial (0.25) and organizational (0.25) gaps. Such a disparity structure indicates the need to improve governance mechanisms and enhance the efficiency of financial resource use.

Table 1 Calculation of the Informational GAP for Moscow Oblast

Indicator	Raw Value (MO)	Min	Max	Normalized Value (Calculation)*	Weight	Weighted Contribution
Share of enterprises using Industry 4.0 (%)	68%	20%	100%	(68-20)/(100-20)=0.60	0.20	0.120
Access to high-speed internet (% of households)	87%	50%	95%	(87-50)/(95-50)=0.82	0.15	0.123
Transport network throughput (scores 1-10)	7.1	3.0	9.0	(7.1-3)/(9-3)=0.68	0.10	0.068
Adaptability of IT infrastructure (index 0-1)	0.52	0.4	0.8	(0.52-0.4)/(0.8-0.4)=0.3	0.15	0.045
Digital literacy of the population (scores 1-100)	73	50	90	(73-50)/(90-50)=0.575	0.20	0.115
Accessibility of digital services for SMEs (index 0-1)	0.48	0.2	0.8	(0.48-0.2)/(0.8-0.2)=0.47	0.10	0.047
Cross-departmental integration (index 0-1)	0.41	0.3	0.7	(0.41-0.3)/(0.7-0.3)=0.275	0.10	0.0275
Integral Informational GAP					Sum:	0.5455

Table 2 Values of Structural Resource GAPs in the Studied Set of Regions

Region	Inform. GAP	Tech.-Techn. GAP	Fin. GAP	Pers. GAP	Org. GAP	Mark. GAP	Average GAP
Moscow Oblast	0.12	0.15	0.18	0.22	0.10	0.14	0.15
Republic of Tatarstan	0.15	0.12	0.20	0.25	0.15	0.13	0.17
Leningrad Oblast	0.18	0.10	0.22	0.18	0.20	0.17	0.18
Samara Oblast	0.22	0.13	0.25	0.20	0.25	0.12	0.20
Sverdlovsk Oblast	0.20	0.08	0.23	0.15	0.22	0.10	0.16
Khanty-Mansiysk AO	0.25	0.20	0.30	0.28	0.28	0.08	0.23
Chelyabinsk Oblast	0.19	0.11	0.19	0.17	0.19	0.07	0.15
Nizhny Novgorod Oblast	0.25	0.22	0.28	0.20	0.23	0.15	0.22
Perm Krai	0.30	0.28	0.32	0.25	0.30	0.18	0.27
Krasnoyarsk Krai	0.28	0.20	0.25	0.22	0.28	0.20	0.24
Irkutsk Oblast	0.32	0.25	0.30	0.28	0.32	0.17	0.27
Yamalo-Nenets AO	0.27	0.18	0.28	0.25	0.30	0.15	0.24
Lipetsk Oblast	0.22	0.25	0.25	0.20	0.25	0.10	0.21
Republic of Bashkortostan	0.25	0.22	0.27	0.18	0.22	0.13	0.21
Kemerovo Oblast	0.30	0.20	0.32	0.25	0.20	0.18	0.24

The fourth stage involves calculating the overall (average) GAP for a region as the arithmetic mean of all six GAPs. This indicator serves as a generalized characteristic of the strategic gap level of the region and enables interregional comparisons. Simultaneously, an analysis of the gap structure was conducted to identify the most problematic areas requiring priority attention (Table 3).

Table 3 GAP Breakdown with Interpretation

Region	Average GAP	Problem Severity Level	Key Problems (Largest GAPs)
Moscow Oblast	0.15	Low	Personnel (0.22), Financial (0.18)
Republic of Tatarstan	0.17	Moderate	Personnel (0.25), Financial (0.20)
Leningrad Oblast	0.18	Moderate	Financial (0.22), Organizational (0.20)
Samara Oblast	0.20	Elevated	Financial (0.25), Organizational (0.25)
Sverdlovsk Oblast	0.16	Low	Financial (0.23), Informational (0.20)
Khanty-Mansiysk AO	0.23	High	Financial (0.30), Personnel (0.28)
Chelyabinsk Oblast	0.15	Low	Financial (0.19), Informational (0.19)
Nizhny Novgorod Oblast	0.22	High	Financial (0.28), Informational (0.25)
Perm Krai	0.27	Critical	Financial (0.32), Informational (0.30)
Krasnoyarsk Krai	0.24	High	Informational (0.28), Organizational (0.28)
Irkutsk Oblast	0.27	Critical	Informational (0.32), Organizational (0.32)
Yamalo-Nenets AO	0.24	High	Organizational (0.30), Financial (0.28)
Lipetsk Oblast	0.21	Elevated	Technical-Technological (0.25), Financial (0.25)
Republic of Bashkortostan	0.21	Elevated	Financial (0.27), Informational (0.25)
Kemerovo Oblast	0.24	High	Financial (0.32), Informational (0.30)

The calculation of weighted averages for each dimension based on normalized indicators enabled a transition from fragmented data to integral assessments characterizing the level of regional development in informational, technical-technological, financial, personnel, organizational, and marketing spheres. The application of expert-defined weighting coefficients ensured an adequate reflection of each indicator's relative significance within its respective dimensions. The results demonstrate a pronounced differentiation in the GAP structure between regions, indicating the methodology's sensitivity to their socio-economic specificity. Analysis of 15 regions revealed significant structural disparities.

The fifth stage involves classifying the identified gaps based on their severity. GAPs are subdivided into four types using the proposed scale, which employs principles similar to the Fishburn formula: negligible (0.00–0.10), moderate (0.11–0.20), substantial (0.21–0.30), and critical (>0.30). This classification allows for ranking regions according to problem severity and determining regional policy priorities (Table 4).

Table 4 Map of Structural GAPs with Significance Levels

Region	Informational GAP	Technical-Technological GAP	Financial GAP	Personnel GAP	Organizational GAP	Marketing GAP	Average GAP
Moscow Oblast	0.12 (Mod.)	0.15 (Mod.)	0.18 (Mod.)	0.22 (Sub.)	0.10 (Negl.)	0.14 (Mod.)	0.15 (Mod.)
Republic of Tatarstan	0.15 (Mod.)	0.12 (Mod.)	0.20 (Mod.)	0.25 (Sub.)	0.15 (Mod.)	0.13 (Mod.)	0.17 (Mod.)
Leningrad Oblast	0.18 (Mod.)	0.10 (Negl.)	0.22 (Sub.)	0.18 (Mod.)	0.20 (Mod.)	0.17 (Mod.)	0.18 (Mod.)
Samara Oblast	0.22 (Sub.)	0.13 (Mod.)	0.25 (Sub.)	0.20 (Mod.)	0.25 (Sub.)	0.12 (Mod.)	0.20 (Mod.)
Sverdlovsk Oblast	0.20 (Mod.)	0.08 (Negl.)	0.23 (Sub.)	0.15 (Mod.)	0.22 (Sub.)	0.10 (Negl.)	0.16 (Mod.)
Khanty-Mansiysk AO	0.25 (Sub.)	0.20 (Mod.)	0.30 (Crit.)	0.28 (Sub.)	0.28 (Sub.)	0.08 (Negl.)	0.23 (Sub.)
Chelyabinsk Oblast	0.19 (Mod.)	0.11 (Mod.)	0.19 (Mod.)	0.17 (Mod.)	0.19 (Mod.)	0.07 (Negl.)	0.15 (Mod.)
Nizhny Novgorod Oblast	0.25 (Sub.)	0.22 (Sub.)	0.28 (Sub.)	0.20 (Mod.)	0.23 (Sub.)	0.15 (Mod.)	0.22 (Sub.)
Perm Krai	0.30 (Crit.)	0.28 (Sub.)	0.32 (Crit.)	0.25 (Sub.)	0.30 (Crit.)	0.18 (Mod.)	0.27 (Sub.)
Krasnoyarsk Krai	0.28 (Sub.)	0.20 (Mod.)	0.25 (Sub.)	0.22 (Sub.)	0.28 (Sub.)	0.20 (Mod.)	0.24 (Sub.)
Irkutsk Oblast	0.32 (Crit.)	0.25 (Sub.)	0.30 (Crit.)	0.28 (Sub.)	0.32 (Crit.)	0.17 (Mod.)	0.27 (Sub.)
Yamalo-Nenets AO	0.27 (Sub.)	0.18 (Mod.)	0.28 (Sub.)	0.25 (Sub.)	0.30 (Crit.)	0.15 (Mod.)	0.24 (Sub.)
Lipetsk Oblast	0.22 (Sub.)	0.25 (Sub.)	0.25 (Sub.)	0.20 (Mod.)	0.25 (Sub.)	0.10 (Negl.)	0.21 (Sub.)
Republic of Bashkortostan	0.25 (Sub.)	0.22 (Sub.)	0.27 (Sub.)	0.18 (Mod.)	0.22 (Sub.)	0.13 (Mod.)	0.21 (Sub.)
Kemerovo Oblast	0.30 (Crit.)	0.20 (Mod.)	0.32 (Crit.)	0.25 (Sub.)	0.20 (Mod.)	0.18 (Mod.)	0.24 (Sub.)

Classification key: Negl. (Negligible): 0.00–0.10; Mod. (Moderate): 0.11–0.20; Sub. (Substantial): 0.21–0.30; Crit. (Critical): >0.30

The sixth stage involves visualizing the results of the analysis by constructing hexagonal (radar) diagrams, which display the values of all six partial gaps. The area of the resulting hexagon is calculated and normalized, allowing for a quantitative assessment of the disparities in the region's resource provision. The area values are interpreted similarly to the GAP values. The relationship between safety indicators and urban environment infrastructure parameters, as explored by (Sargsyan et al., 2022; Talipova et al., 2025) demonstrates the interconnectedness of organizational, technical, and social factors that contribute to regional development gaps. Figure 2 showcases diagrams, visually contrasting a critical, multifaceted gap profile with a more balanced, moderate gap profile.

The regression model yielded a statistically significant explanation of the GAP variance (Adjusted $R^2 = 0.78$). Table 5 presents the full results, including the coefficients, standard errors, and diagnostics.

The results confirm that a low level of economic diversification is the strongest predictor of a large strategic gap (β = -0.45, p<0.001). This aligns with regional resilience theories, suggesting that monospecialized economies are more vulnerable to shocks and possess less adaptive capacity. Similarly, institutional quality has a broad, negative impact on gaps (β = -0.38, p<0.01). A concerning cumulative effect is observed: regions with high extractive industry shares and low institutional quality (e.g., Perm Krai, Irkutsk Oblast) exhibit synergistically amplified gaps across multiple domains.

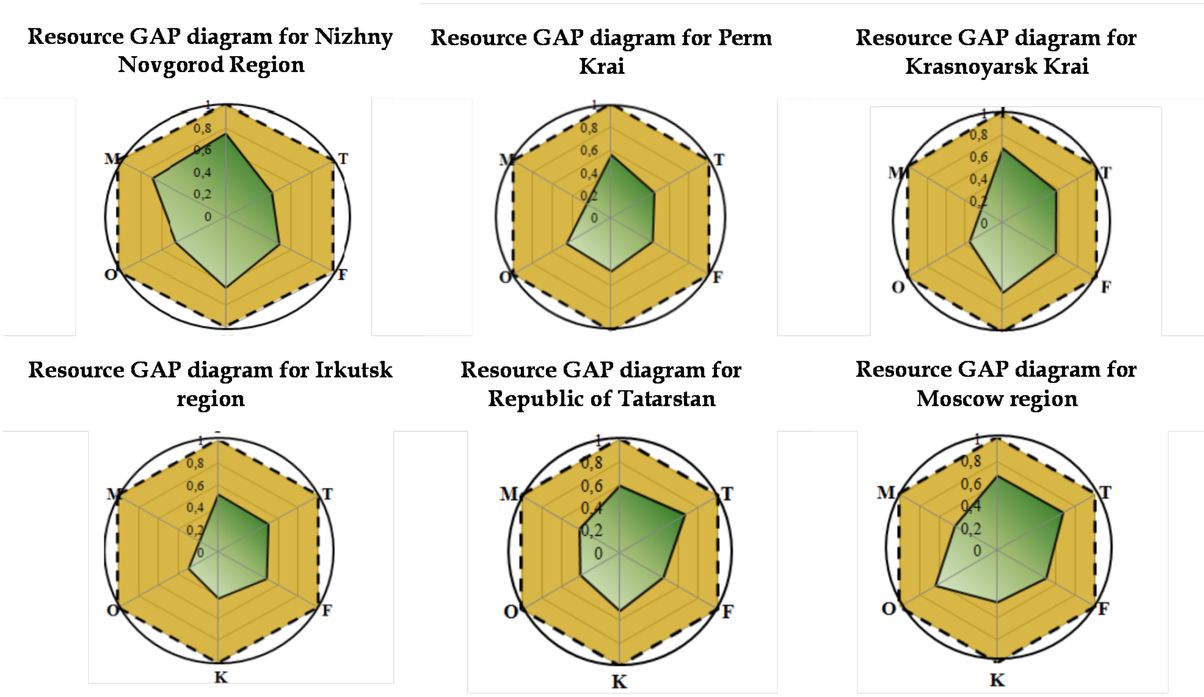

Figure 2 Resource deficit diagram in Russian regions

Table 5 Multivariate Regression Results for Strategic GAP Drivers

Influencing Factor	β-coefficient	Std. Error	t-statistic	p-value	VIF
(Constant)	0.12	0.04	3.00	<0.01	–
Level of Economic Diversification	**-0.45**	0.08	-5.63	<**0.001**	2.1
Quality of Institutional Environment	**-0.38**	0.10	-3.80	<**0.01**	2.8
Share of Extractive Industry	**0.32**	0.09	3.56	<**0.01**	3.0
Level of Human Capital	-0.29	0.12	-2.42	<0.05	1.9
Spatial Peripherality (Dummy)	0.21	0.09	2.33	<0.05	1.5

Model Summary: R=0.89, R^2=0.80, Adjusted R^2=0.78, F-stat=18.45 (p<0.0001), Durbin–Watson=2.1.

The seventh stage aims to identify the cause-and-effect relationships underlying the emergence and persistence of strategic gaps (Table 6). This study employs correlation and regression analysis to establish dependencies between the GAP magnitude and various factors: economic sectoral structure, institutional conditions, spatial position, and other regional characteristics.

Regression modeling confirmed that sectoral specialization is a critical factor. Resource-oriented regions show elevated financial GAPs (β=0.32), whereas industrially developed regions show a strong dependence of organizational GAP on diversification levels (β=-0.45). Institutional quality significantly impacts all GAP types, and spatial position moderately influences marketing GAP (β=0.21). A cumulative effect was identified: regions combining monospecialization and weak institutions exhibit synergistic increases in GAP.

Table 6 Identification of Causal Relationships Underlying Strategic Gaps

Influencing Factor	Impact on GAPs	Strength of Link (β)	Stat. Significance (p-value)	Example of Regional Dependency
Share of Extractive Industry	Positive link with Financial & Personnel GAP	β=0.32	p<0.01	A 1% increase in extractive sectors raises Financial GAP by 0.32 points in Khanty-Mansiysk AO
Level of Economic Diversification	Inverse link with Organizational & Technological GAP	β=-0.45	p<0.001	A 10% increase in diversification index reduces Organizational GAP by 4.5 points in Samara Oblast
Quality of Institutional Environment	Inverse link with all GAP types	β=-0.38	p<0.01	A 1-point improvement in governance index reduces Organizational GAP by 0.38 points in Tatarstan
Level of Human Capital	Inverse link with Personnel & Informational GAP	β=-0.29	p<0.05	A 5% increase in education index reduces Personnel GAP by 1.45 points in Moscow Oblast
Spatial Position	Moderate influence on Marketing & Infrastructural GAP	β=0.21	p<0.05	Peripheral regions have an elevated Marketing GAP by 0.21 points (Krasnoyarsk Krai)
Innovation Activity	Inverse link with Technological & Informational GAP	β=-0.35	p<0.01	A 1% increase in innovation spending reduces Technological GAP by 0.35 points in Tatarstan
Investment Attractiveness	Inverse link with Financial & Organizational GAP	β=-0.27	p<0.05	A 10% increase in investment per capita reduces Financial GAP by 2.7 points in Leningrad Oblast

The eighth stage entails developing recommendations for overcoming identified strategic gaps (Table 7). Based on the analysis of the structure and magnitude of the gaps, proposals are formed to adjust regional policy to eliminate the most acute disparities. The recommendations are differentiated and consider each region's specifics.

Table 7 Recommendations for Overcoming Strategic Gaps

Region Type	Key Identified Problems	Priority Regulatory Directions	Specific Measures	Expected Effect
Resource-Oriented	Critical Financial & Personnel GAP	Economic diversification, human capital development	Creating reinvestment funds for resource revenues, workforce retraining programs	Reduce Financial GAP by 15–20%, Personnel by 10–15%
Industrially Developed	Elevated Organizational & Technological GAP	Management modernization, technological renewal	Implementing agile methodologies, state programs for technological upgrading	Reduce Organizational GAP by 20–25%, Technological by 15–20%
Innovation-Oriented	Substantial Personnel & Financial GAP	Talent attraction/retention, financial flow optimization	Creating R&D clusters, developing venture financing	Reduce Personnel GAP by 25–30%, Financial by 15–20%
Crisis Industrial	Systemic gaps across all directions	Comprehensive modernization, institutional reforms	Developing reindustrialization programs, improving business climate	Reduce average GAP by 30–35% over 5–7 years
Agro-Industrial	Moderate but persistent gaps	Balanced development, targeted support	Developing agrotech, import substitution programs	Reduce average GAP by 10–15%

The ninth stage involves assessing the effectiveness of the proposed measures based on modeling the expected changes in GAP indicators (Table 8). Policy scenarios were simulated based on the causal model, showing the expected GAP reductions under baseline and optimistic scenarios as median values with the interquartile range (IQR).

Table 8 Simulated Effectiveness of Policy Measures (Median GAP Reduction, IQR in Parentheses)

Region Type	Scenario	Key Measures	Expected Avg. GAP Reduction	Time Horizon
Crisis Industrial	Optimistic	Comprehensive reindustrialization, institutional reform	32.5% (28.0–36.0%)	7–10 years
Resource-Oriented	Optimistic	Revenue reinvestment funds, diversification programs	17.5% (15.0–20.0%)	5–7 years
Industrially Developed	Optimistic	Technological upgrading, agile governance	22.5% (19.0–25.0%)	4–6 years

The forecasting underscores that the most profound effects require complex, long-term interventions targeting the core drivers identified by the regression analysis—diversification and institutional quality. Piecemeal approaches yield significantly lower returns.

This study has several limitations. The Min–Max normalization is sensitive to the sample composition. Although robust in sensitivity tests, expert weighting introduces an element of subjectivity. The regression model, while robust, is cross-sectional; future work should employ panel data to capture dynamics. Furthermore, although the scenario forecasts are based on causal relationships, they remain projections subject to external shocks. Future research directions include applying cluster analysis (e.g., k-means) to group regions by gap typology and integrating spatial econometric models to account for interregional spillover effects.

4. Conclusions

This study makes a distinct scientific contribution by developing and empirically validating an integrated six-dimensional GAP-analysis methodology for regional development. It advances beyond descriptive frameworks by: (1) providing a holistic, structurally detailed diagnosis of resource imbalances; (2) statistically identifying the key drivers of these gaps, with economic diversification and institutional quality being the most influential; and (3) enabling prescriptive, data-driven strategy formulation through causal modeling and scenario simulation. The practical significance lies in providing policymakers with a differentiated instrument for regional regulation. The methodology identifies not only the most disadvantaged regions but also the specific resource domains requiring priority intervention, enabling optimized resource allocation. The findings strongly argue against uniform regional policies, instead advocating for strategies tailored to a region's unique gap profile and its underlying structural causes, such as breaking the negative cycle of mono-specialization and weak institutions.

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Author Contributions

The authors declare no conflicts of interest.

Supplementary Materials

No supplementary materials are associated with this article.

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