

Possibilities of assessing cluster potential in regions: Evidence from Uzbekistan

Dilshod Hudaiberganov Tuxtabaevich^{1*}, *Sherzod* Saloxitdinov Farxodovich², *Firuz* Achilova Kurbanovna³, *Botir* Mukhtarov Abdusattarovich², *Sojida* Fayzullayeva Farhodovna², and *Sunajon* Yuldasheva Zokir kizi¹

¹Urgench state university, 14, Khamid Alimjan Street, Urgench city, 220100, Uzbekistan

²Jizzakh Branch of the Mirzo Ulugbek National University of Uzbekistan, 259, Sharof Rashidov street, Jizzakh city, 131113, Uzbekistan

³Karshi state technical university, 19, Khonobod Street, Karshi city, 180119, Uzbekistan

Abstract. This article examines the necessity of cluster formation, the implementation of cluster policies, the opportunities and key advantages they offer, and the importance of assessing cluster potential. It outlines directions and essential aspects of evaluating cluster potential in different regions. Moreover, it substantiates that, taking into account the specific conditions of various regions in Uzbekistan, clustering can be carried out based on defined ranges of assessment levels. The study proposes a comprehensive methodology for assessing regional cluster potential using a weighted indicator system encompassing economic, innovation, social, network, and governance dimensions. An empirical study was carried out to explore the potential of the agro-industrial cluster network in Uzbekistan's Khorezm region, testing the effectiveness of this methodology. The findings provided strong evidence for assessing regional agro-industrial development, confirming its value as a priority area of focus. Based on data from 2022–2024, a composite cluster potential index was calculated at 58.7 points on a 100-point scale. This score suggests that the region holds medium to good development potential. Based on the conclusions drawn, proposals and recommendations for effectively evaluating regional cluster potential have been developed. The findings demonstrate that systematic assessment of cluster potential can serve as a practical tool for regional development planning and investment decision-making in transitional economies.

Key words: cluster potential, regional development, assessment methodology, agro-industrial cluster, Uzbekistan, weighted indicators

* Corresponding author: dilshod.x@bk.ru

1 Introduction

Regional cluster development has become a central pillar of economic policy in both developed and developing countries (Porter, 2000; Ketels, 2013). Despite the widespread adoption of cluster-based strategies, significant methodological gaps persist in assessing regional cluster potential, particularly in transitional economies where data availability and institutional frameworks differ substantially from Western contexts.

Today, various problems are evident in assessing cluster potential in regions. In Uzbekistan and similar transitional economies, assessing cluster potential is associated with a number of methodological, informational and subjective problems. For example, in many regions there is no reliable, regularly updated data on enterprises, production capacities and resources. Outdated or inconsistent statistical data makes it difficult to accurately assess cluster potential. Also, monitoring the activities of some small and medium-sized enterprises is insufficient.

Cluster potential can be defined as the ability to create high added value, competitiveness and innovation as a result of mutual cooperation between enterprises, scientific institutions, infrastructure and management institutions operating in a particular territory or industry. Cluster potential assessment is a form of assessment through key indicators such as production capacity, innovative activity, human resources, logistics and infrastructure, financial stability and institutional environment.

The results of cluster potential assessment may not be fully consistent with regional development programs, investment strategies, and other economic policies. This situation limits the practical application of the assessment results. Therefore, the assessment process should use standardized indicators, an updated database, numerical and scientifically based methods, and an approach that takes into

account regional differences. This will increase the reliability and strategic importance of the assessment results.

In recent years, one of the key priorities in Uzbekistan has been the development of economic sectors. The Presidential Decree “On measures to accelerate the development of the national economy” (2022) highlights the importance of cluster-based strategies for promoting regional development. Implementing these strategies requires the establishment of clusters as a fundamental mechanism for economic organization.

Clusters are recognized as a contemporary model of economic growth and represent an advanced approach to structuring regional economies. They function through informal networks that connect sector-specific and cross-sectoral organizations, facilitating collaboration, resource sharing, and coordinated development efforts [1].

The cluster model has been recognized globally, in both developed and developing countries, as one of the most effective ways to foster socio-economic and innovative growth. In this regard, industrial clusters also have untapped potential for promoting energy transition and climate neutrality. However, it remains unclear how and when this potential can be achieved, and whether the benefits can be scaled up and replicated [2]. Furthermore, recent studies highlight that accurately forecasting current demand is essential for the efficient management of various transport platforms, such as micromobility services. While existing research has primarily focused on developing better demand forecasting algorithms, the relatively neglected process of creating regions is of great importance [3].

As global economic competition intensifies, investigating cluster potential has become increasingly significant. Governments and businesses are focusing on developing clusters to stimulate economic growth, create employment opportunities, and strengthen global competitiveness. Furthermore, clusters

contribute to sustainable development by promoting the development and use of environmentally friendly technologies.

Clusters play a vital role in driving economic growth. They encourage innovation, boost efficiency, and strengthen competitiveness. At the same time, they attract investment, improve infrastructure, and raise the standard of living for local communities.

Yet, despite the extensive literature on cluster theory and policy, challenges remain when it comes to creating practical assessment methods that fit transitional economies. Most existing frameworks (such as those by Andersson et al., 2004; Sölvell, 2008) were designed for advanced industrial nations and don't fully capture the institutional and structural realities of Uzbekistan.

This study seeks to fill that gap through three main steps: first, by introducing a comprehensive system of weighted indicators to measure cluster potential; second, by testing the methodology in the agro-industrial sector of the Khorezm region; and third, by offering practical recommendations for policymakers working in similar economic contexts.

Regional competence clusters are a strategic tool for shaping economic regions. Their effectiveness depends on how well local resources are used, the strength of inter-sectoral cooperation, the innovation environment, and labor market opportunities. Assessing cluster competence therefore requires more than just economic indicators—it calls for a detailed look at social, scientific, technological, and infrastructural development.

Unlike traditional cluster assessment systems, this study adapts classification and normalization methods to Uzbekistan's realities, where fragmented information and informal cooperation are common. In doing so, it provides a framework that is both context-sensitive and practically applicable.

2 Literature Review

Cluster policy has become a fundamental concept in the development strategies of many modern nations [4]. In cluster policy, different approaches are used to evaluate how effectively clusters are formed. These methods are applied not only by policymakers but also by researchers and the academic community. However, in most cases, analyses of cluster performance pay limited attention to defining and assessing their actual effectiveness, and the conceptual framework is rarely applied [5]. Improving systems for assessing the potential of regional clusters is essential for enhancing their effectiveness, supporting their development, and increasing their contribution to regional economic growth. The development of clusters can lead to increased labor productivity, the creation of new enterprises and jobs, the growth of regional innovation capacity, competitive advantages, and the formation of a positive investment image for the region [6].

Effective implementation of cluster policy requires relevant tools and data. In this regard, methodological and analytical tools at the regional level can serve as a foundation for informed decision-making in the development of cluster strategies [7]. This policy is based on a cluster-specific approach - that is, the cluster-network approach appears to be an effective method for studying the activities of regions with priority cluster structures and for identifying optimal governance decisions [8].

The practical implementation of clusters must be carried out using appropriate methods. For example, if real-world data are unavailable during training, supervised classifiers become ineffective for crop mapping. In such cases, unsupervised clustering methods are used as an alternative for mapping crop types [9]. Developing a comprehensive clustering methodology is also crucial for implementing effective cluster policy. In Spain, for instance, a clustering-based methodology was developed to address supply chain challenges. The main objective was to design an optimal network

for the efficient allocation of resources and utilization of waste in the shortest possible time, and to ensure effective integration of biomass into energy conversion processes [10]. Conceptual research on clustering policy has also been carried out, particularly with a focus on the theoretical discussion surrounding digital industrial clusters. These clusters represent a new model of digital agglomeration based on the evolution of traditional industrial clusters [11].

Various indicators are used to assess the potential of clusters in different regions, reflecting multiple aspects of cluster performance. The results of these assessments should be utilized by regional authorities in shaping development strategies. This, in turn, enhances the effectiveness of using clusters to drive the innovative development of regions [12]. Accordingly, researchers and practitioners have conducted studies aimed at addressing the challenges of developing clustering processes within regional production and economic systems. Most of these studies focus on evaluating cluster potential or analyzing the effectiveness of existing clusters.

García et al. (2025) aimed to formulate a supply chain problem involving a clustering methodology to propose a reorganization of geographical units based on the collected data [12]. Fernandez-Escobedo and Cuevas-Vargas (2023) aimed to help policymakers and cluster organizations visualize the effective organization and development of service provision [10]. Eynan and Mantin (2025) focused on vertically differentiated product design decisions requiring prediction by incorporating future target plans [13].

In the context of Central Asian economies, limited research has been conducted on cluster potential assessment. Islamov and Shadmanov (2021) examined industrial clustering in Uzbekistan but focused primarily on textile sector without developing a comprehensive assessment framework. Ruziev and Midmore (2015) examined regional economic development

in transitional economies; however, their analysis did not specifically focus on cluster-based assessment methodologies. Our research is designed to tackle existing challenges by introducing a methodology that fits the institutional and structural realities of Uzbekistan. This alignment ensures that the results can be applied effectively and put to practical use.

While earlier studies have examined different aspects of regional development—such as economic growth or innovation—they have often overlooked governance structures and informal cooperation mechanisms. These elements are especially important in transitional economies, where diverse institutional frameworks and networks of collaboration shape outcomes. They play a decisive role in determining efficiency levels that are appropriate for regional development.

3 Methodology

This section explores how to assess the composition and potential of regional clusters and explains the methodology behind it. The process unfolds in several stages. First, cluster potential is defined by identifying its key dimensions and relevant indicators. Second, different measurement methods are applied to determine how strongly each indicator influences the overall potential. Third, the collected data are brought together into a single dataset, allowing for qualitative comparison and normalization of results. Finally, the findings are used to analyze the overall composition and strength of regional cluster potential.

3.1 Indicator Selection

The selection of indicators was guided by several key criteria. Most importantly, their relevance to cluster development theory was considered. In Uzbekistan's context, attention was given to how measurable their impact is and whether they are supported by reliable data. To ensure accuracy, existing literature was carefully reviewed, and consultations were held with specialists from regional development agencies,

universities, and business associations. As a result, twenty-five indicators were identified and grouped into distinct measurement categories (see Table 1).

To determine the significance of the composite index, the variation coefficient was calculated. This step made it possible to assess both the reliability and the importance of the chosen indicators.

3.2 Weight Determination

The weights of the indicators were determined using the Analytic Hierarchy Process (AHP), introduced by Saaty in 1980. In this method, each indicator's relative importance was compared in pairs, with a panel of twelve experts providing assessments. For all comparisons, the consistency ratio was below 0.10, confirming an acceptable level of consistency. The final weights of the indicators are presented in Table 2.

To evaluate the impact of the weights derived from the AHP method, calculations were carried out using five selected indicators. A sensitivity analysis was then performed with a $\pm 10\%$ adjustment. The results showed that the composite index remained stable, fluctuating only within about ± 2.3 points. This demonstrates the reliability and robustness of the weighting scheme.

3.3 Data Collection

Beyond general cluster assessment models, our study introduced a tailored selection of indicators. This approach reflects Uzbekistan's institutional framework and statistical realities, ensuring that the assessment is both accurate and context-specific. It provides a clear basis for planning local policies and guiding development. With this foundation, the applied results can be effectively analyzed and put into practice.

Primary data were collected from: Statistics Agency of the Republic of Uzbekistan (2022-2024); Khorezm Regional Statistics Department; Ministry of

Agriculture of Uzbekistan; Chamber of Commerce and Industry of Khorezm region; Survey of 47 enterprises in the agro-industrial sector (conducted in March-April 2024).

Secondary data sources included regional development reports, investment project documentation, and published academic studies.

3.4 Normalization and Aggregation

All indicators were normalized to a 0-100 scale using min-max normalization:

$$X_{norm} = \frac{X - X_{min}}{X_{max} - X_{min}} \times 100 \quad (1)$$

The composite Cluster Potential Index (CPI) was calculated as:

$$CPI = \sum_{i=1}^n W_i \times X_{i(norm)} \quad (2)$$

Where W_i is the weight of indicator i , and $X_{i(norm)}$ is the normalized value.

3.5 Assessment Formulas

The following formulas are used to assess cluster efficiency:

1) Cluster gross economic efficiency:

$$E_{econ} = \frac{Y_k}{X_k} \quad (3)$$

Where: Y_k = gross value added (GVA) created by the cluster; X_k = total resources (capital, labor, raw materials) attracted to the cluster.

2) Average profitability of cluster members:

$$R_a = \frac{\sum_{i=1}^n R_i}{n} \quad (4)$$

Where: R_i = the income of the i -enterprise; n = the number of enterprises in the cluster.

3) Cooperation efficiency (synergy coefficient):

$$S = \frac{Y_{kl}}{\sum_{i=1}^n Y_i} \quad (5)$$

Where: Y_{kl} = the total production volume of the cluster; $\sum Y_i$ = the production volume that would be achieved if the enterprises worked separately. If $S > 1$, there is cluster synergy.

4) Innovative activity coefficient:

$$K_{in} = \frac{N_{in}}{N_{tot}} \quad (6)$$

Where: N_{in} = number of innovatively active enterprises; N_{tot} = total number of enterprises in the cluster.

5) Share of innovative value added:

$$IQV = \frac{Y_{in}}{Y_k} \quad (7)$$

Where: Y_{in} = the added value obtained from the innovative product; Y_k = the total added value of the cluster.

4 Empirical Analysis: Case Study of Khorezm Region

This section presents the empirical application of the proposed methodology to assess the agro-industrial cluster potential of Khorezm region, Uzbekistan.

Khorezm region is located in central Uzbekistan with a population of approximately 1.4 million (2024). The regional economy is predominantly agricultural, with cotton, wheat, fruits, and vegetables as main products. The region has 12 districts and hosts several food processing enterprises, logistics centers, and agricultural service providers. According to the regional development strategy (2022-2026), the formation of an agro-industrial cluster is identified as a priority direction.

4.2 Data and Sample

The analysis covers the period 2022-2024. Our sample includes: 47 agricultural enterprises (farms, agro-firms, cooperatives); 18 food processing companies; 8 logistics and storage facilities; 5 agricultural input suppliers; 3 research and educational institutions; Total: 81 potential cluster participants.

4.3 Results

Table 1. Assessment of Khorezm Region Agro-Industrial Cluster Potential

Dimension	Indicator	Weight	Raw Value	Normalized Score (0-100)	Weighted Score
Economic (40 %)	Number of enterprises	0.08	81	65	5.2
	Employment in sector	0.08	12,400	58	4.6
	GVA (billion UZS)	0.10	847	62	6.2
	Export volume (million USD)	0.08	28.5	45	3.6
	Investment volume (million USD)	0.06	15.2	52	3.1
Innovation (20 %)	R&D expenditure (% of revenue)	0.06	1.2%	40	2.4
	New products introduced	0.05	7	58	2.9
	Patents registered	0.04	3	50	2.0
	Cooperation with institution	0.05	3	60	3.0

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	Cooperation with institution	0.05	3	60	3.0

Dimension	Indicator	Weight	Raw Value	Normalized Score (0-100)	Weighted Score
Infrast ructur e (15 %)	universities		5		
	Transport accessibility	0.05	Good	70	3.5
	Storage capacity (thousands)	0.05	45	55	2.75
Social (10%)	Digital infrastructure	0.05	Moderate	50	2.5
	Skilled labor availability	0.05	68%	68	3.4
	Training programs	0.05	5 programs	55	2.75
Netwo rk (10 %)	Inter-firm cooperation level	0.05	Moderate	52	2.6
	External linkages	0.05	Limited	45	2.25
	Strategic	0.05	Basic	55	1.375

Dimension	Indicator	Weight	Raw Value	Normalized Score (0-100)	Weighted Score
TOTAL	planning				
	Institutional support	0.025	Moderate	60	1.5
TOTAL		1.00			58.7

The stability of the composite index was further supported by sensitivity analysis, which showed limited variation in CPI values under alternative weighting scenarios.

Higher cluster potential is associated with improved conditions for competitiveness, although direct causal effects require further longitudinal analysis.

4.4 Interpretation of Results

The composite Cluster Potential Index (CPI) of 58.7 points indicates moderate-to-good development potential for the agro-industrial cluster in Khorezm region. Based on the assessment ranges developed in this study (Table 2), this score falls within the "Medium-High" category.

Table 2. Cluster Potential Assessment Ranges

Range	Score	Interpretation	Recommended Actions
Low	0-30	Limited potential	Focus on basic infrastructure development
Medium-Low	31-45	Emerging potential	Strengthen enterprise base and cooperation
Medium	46-60	Moderate potential	Develop innovation and export capacity
Medium-High	61-75	Good potential	Accelerate cluster formalization
High	76-100	Strong potential	Focus on international

Range	Score	Interpretation	Recommended Actions
			competitiveness

The justification for these ranges is based on: Statistical distribution of scores across 14 Uzbekistan regions (using mean \pm standard deviation); Benchmarking against; international cluster assessment frameworks (European Cluster Observatory); Expert consensus from the AHP panel.

The proposed assessment ranges were validated through a triangulation strategy that combined several complementary approaches. These included an analysis of statistical distribution based on the mean and standard deviation calculated across fourteen regions, international benchmarking practices, and the consensus of subject-matter experts. The integration of these methods enhanced the credibility and reliability of the proposed evaluation thresholds.

To minimize subjectivity in qualitative assessment, descriptive categories such as “good,” “moderate,” and “limited” were converted into corresponding numerical scores of 70, 50, and 30. These values were assigned according to predefined criteria agreed upon by experts, ensuring greater consistency and transparency in the evaluation process.

It should be noted that this framework is exploratory in nature and is primarily designed for regions with comparable economic structures. Therefore, its direct application may require adaptation when used in substantially different economic contexts.

4.5 Strengths and Weaknesses Analysis

The assessment results made it possible to identify a number of key strengths and weaknesses related to cluster development potential.

Among the main strengths is the presence of an established enterprise base, comprising eighty-one potential participants that provide a solid foundation for cluster

formation. The region also benefits from favorable transport infrastructure, particularly its proximity to the Tashkent–Samarkand corridor, which enhances connectivity and market access. In addition, the availability of relatively skilled labor, estimated at 68 percent, contributes positively to production capacity and innovation potential. Institutional support from regional authorities further strengthens the enabling environment for cluster development.

At the same time, several weaknesses were identified. Expenditure on research and development remains relatively low at 1.2 percent, compared to the international benchmark of three percent or higher. Export orientation is also limited, with export volumes amounting to 28.5 million US dollars. Furthermore, cooperation networks among firms are underdeveloped, which constrains knowledge sharing and joint innovation efforts. The region also faces challenges related to insufficient storage facilities and cold chain infrastructure, limiting the efficiency and competitiveness of agro-industrial activities.

5 Discussion

The methodology developed for assessing regional cluster potential encompasses several interrelated components. These include the dynamics of regional economic development, the investment climate, the degree of integration into international economic relations, the development of small and medium-sized enterprises, the quality of regional infrastructure, the effectiveness of continuous education systems, and the overall structure of the regional economy. Together, these elements provide a multidimensional perspective on cluster readiness and development capacity. The empirical findings from the Khorezm region offer important implications for cluster policy design. The moderate Composite Potential Index (CPI) score of 58.7 indicates that the foundational conditions for cluster formation are present;

however, substantial investment is still required, particularly in innovation infrastructure and the strengthening of inter-firm networks. The set of economic indicators is largely based on enterprise numbers and employment levels—factors that tend to be weaker when it comes to measuring innovation. This reflects broader trends in economies with structural imbalances, where true progress depends on the quality of growth and the role of innovation.

The methodology we propose goes beyond simple measurement. It includes analytical tools that assess how cluster associations influence regional socio-economic systems. These tools combine economic-statistical analysis, regional economic evaluation, sociological methods, graphical modeling, and other complementary approaches. Taken together, they provide a comprehensive assessment of regional cluster potential, capturing not only business performance but also technological progress, innovation capacity, and social outcomes.

5.1 Economic Indicators

The socio-economic contribution and performance of regional clusters are measured through several key quantitative indicators. One of the most important is the number of jobs created, which highlights the cluster's potential and its role in strengthening the labor market. From the perspective of added value, the cluster's share in gross domestic product (GDP) is used to assess its impact on the regional economy.

The total revenue of cluster enterprises reflects the scale and intensity of their activities, while export volumes show how competitive their products and services are in international markets. Strong export performance, in turn, attracts investment, shaping the cluster's long-term development prospects.

Wage levels within cluster enterprises are also examined, as they provide insight into employees' living standards and income

conditions. Taxes paid by clusters contribute directly to the regional budget. Finally, production volumes are assessed to capture the cluster's overall capacity and operational scale.

5.2 Innovation Indicators

To evaluate the innovation potential of regional clusters, several indicators were taken into account. One key measure is the number of technologies or products developed, which reflects the cluster's innovative output. Another important indicator is the number of registered patents, showing how well intellectual property is protected and signaling the maturity of the innovation process.

Research and development (R&D) spending is a key indicator of the scientific and technological strength of cluster enterprises. The share of employees engaged in innovative activities shows how deeply innovation is embedded in the organizational structure and daily operations of cluster members.

Equally important is the extent to which participants adopt new technologies, as this reveals the speed and efficiency of technological diffusion. Finally, collaboration with universities and research centers highlights the strength of ties between cluster enterprises and scientific institutions—an essential factor for sustaining long-term innovation and effective knowledge transfer.

5.3 Social Indicators

In addition to economic and innovation indicators, several social and environmental factors were considered to capture the broader impact of cluster development. Rising household incomes serve as a key measure of how cluster activities improve living standards in the region. Creating jobs for underprivileged or vulnerable groups reflects the inclusiveness and social responsibility of cluster initiatives.

The development of social infrastructure within cluster areas highlights their contribution to regional progress, while positive environmental outcomes demonstrate support for ecological sustainability and responsible resource use. Clusters also play a role in preserving and promoting local culture, strengthening community identity. Finally, participation in vocational training and retraining programs shows their commitment to enhancing workforce skills and supporting continuous professional development.

5.4 Network Indicators

To evaluate the structural and network capabilities of regional clusters, several organizational and collaboration indicators were considered. The degree of cooperation among cluster members reflects the strength of internal networks, which are essential for knowledge sharing and coordinated development. The total number of participants shows the cluster's scale, diversity, and overall potential.

Connections with external organizations—such as universities, research centers, and government agencies—demonstrate the scope of collaboration and institutional integration. The use of information technologies in cluster operations serves as a marker of digital transformation and modernization.

Participation in international networks highlights opportunities for global cooperation and integration into wider economic systems. Finally, collaboration with other clusters indicates the level of inter-cluster interaction, fostering synergies, shared innovation, and expanded market opportunities.

5.5 Governance Indicators

The effectiveness of a cluster's management system is a key indicator of how well it is structured, coordinated, and governed. A strong management system ensures strategic alignment among

members and supports sustainable development.

Member participation in management processes reflects the inclusiveness and democratic nature of cluster governance. Active involvement in decision-making fosters transparency, shared responsibility, and internal cohesion.

Equally important is the presence of a clearly defined strategic development plan, which demonstrates the cluster's commitment to its long-term vision and goals.

Such a plan provides direction for coordinated growth and enhances the cluster's capacity to respond to changing economic conditions.

Financial sustainability of the cluster: Shows the cluster's access to and management of financial resources.

Effectiveness of marketing strategies: Assesses how successfully cluster products are promoted in the market.

However, when selecting these indicators, the following principles must be taken into account:

Clarity: Indicators must be clear and measurable.

Relevance: Indicators should align with the goals and objectives of clusters.

Reliability: Indicators must be based on credible data.

Comparability: Indicators should allow comparisons across clusters or regions.

Significance: Indicators must reflect the most critical factors influencing cluster development.

5.6 Policy Implications

Based on the Khorezm case study, the following policy recommendations are proposed:

1. Innovation Enhancement: Establish a regional agricultural innovation center with government co-funding to increase R&D expenditure from 1.2% to at least 2.5% within three years.

2. Network Development: Create a formal cluster coordination body (Cluster

Development Agency) to facilitate inter-firm cooperation and knowledge exchange.

3. Export Promotion: Develop export-oriented production programs with a target of doubling export volume within five years.

4. Infrastructure Investment: Prioritize cold storage and logistics infrastructure development through public-private partnerships.

5. Human Capital: Expand vocational training programs in agricultural technologies and food processing in partnership with Khorezm State University and technical colleges.

6. Policy recommendations are prioritized based on feasibility, fiscal capacity, and short-term impact.

6 Conclusion

Based on the results of our research, strengthening the cluster potential assessment system in the regions will accelerate the development of clusters and increase their contribution to economic growth. The formation of cluster organizations based on regional potential is necessary to strengthen competitiveness and access to international markets.

This study makes three main contributions to the literature on cluster development. First, we proposed a comprehensive methodology for assessing regional cluster potential that integrates economic, innovation, social, network, and governance dimensions with empirically derived weights. Second, we provided the first systematic empirical assessment of agro-industrial cluster potential in Uzbekistan, specifically in Khorezm region, generating a composite index score of 58.7 points. Third, we developed context-sensitive assessment ranges validated through statistical analysis and expert consultation.

The empirical findings demonstrate that Khorezm region possesses moderate-to-good potential for agro-industrial cluster development, with strengths in enterprise base and infrastructure but weaknesses in

innovation capacity and inter-firm networks. These results can inform regional development strategies and investment priorities.

In this regard, cluster potential varies across regions, and is determined by factors such as the level of development of network connections, human capital, knowledge and technologies, infrastructure, and the institutional environment. A comprehensive analysis of these factors and their interdependence is used to develop strategies aimed at strengthening the strengths of clusters, reducing weaknesses, effectively using existing opportunities, and eliminating risks.

Cooperation between regional authorities, business entities, scientific institutions and civil society is of particular importance in the development of clusters. It is through multilateral cooperation that clusters will realize their full economic, social and innovative potential.

6.1 Limitations

This research is subject to several limitations that should be taken into consideration when interpreting the findings.

First, the availability and quality of data affected the overall scope of certain indicators. In Uzbekistan, official statistical information is not always regularly updated or sufficiently detailed at the district level. As a result, it was necessary to complement official sources with survey-based data, which may introduce additional variability.

Second, although the Analytic Hierarchy Process (AHP) offers a systematic way to identify gaps in indicators, it relies heavily on expert judgment. Even with efforts to ensure consistency and objectivity, the composition and orientation of the expert group in a short-term system can influence the results.

Third, while the proposed rating ranges are grounded in empirical observations and contextual recommendations, they are tailored to Uzbekistan's unique institutional

and economic conditions. Applying them in other national contexts would therefore require methodological adjustments.

Finally, the empirical system is integrated, targeted, and closely aligned with the core sector. This strengthens its reliability and enhances the broader applicability of methodologies designed to improve supply chain development within interregional and intersectoral support frameworks.

6.2 Future Research Directions

Future research offers a strong foundation for expanding this study in several directions.

First, the methodology can be applied to a detailed investigation of Uzbekistan's regions. This would allow for internal analysis of indicators by region and the development of evaluation ranges tailored to specific local conditions.

Second, future studies may build on assessment models that capture the effective development of cluster potential. Analytically, this makes it possible to identify new development trends through structural changes and to better understand the long-term impact of policies.

Third, the framework can be strengthened by incorporating artificial intelligence and machine learning techniques. These tools help reduce subjectivity in assigning weights and provide clearer insights into the influence of the assessment model.

Fourth, interactive digital platforms can be used to monitor and evaluate cluster potential. Presenting analytical results in a user-friendly format makes them more accessible to policymakers and practitioners.

Finally, conducting comparative research in collaboration with other Central Asian economies would open new opportunities for cross-regional analysis and shared learning.

Such cross-country analysis would help identify common development patterns,

shared challenges, and best practices in cluster policy implementation.

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