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Algorithmic Assessment of Samarkand Attractiveness and Its Strategic Role in Agritourism Development

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Abstract

General Background: The integration of tourism and agriculture has increased the importance of territorial attractiveness as a determinant of sustainable agrotourism development. **Specific Background:** Samarkand combines significant agricultural resources, cultural heritage, and expanding tourism activity, yet its agrotourism attractiveness has not been systematically quantified for strategic planning purposes. **Knowledge Gap:** Existing assessments rely on fragmented indicators and qualitative descriptions, limiting comparative analysis and evidence-based decision-making. **Aims:** This study aims to develop and apply an algorithmic framework to assess the attractiveness of the Samarkand region and to examine its strategic importance for agrotourism development. **Results:** The findings indicate that Samarkand's agrotourism attractiveness emerges from the interaction of economic potential, agricultural and natural resources, tourism infrastructure, socio-cultural assets, and institutional support rather than isolated factors. **Novelty:** The study introduces a multidimensional, indicator-based algorithm that integrates quantitative normalization, hybrid weighting, and expert evaluation into a single composite attractiveness index. **Implications:** The proposed framework supports evidence-driven regional planning, investment prioritization, and policy formulation, while offering a transferable model for assessing agrotourism attractiveness in regions with similar socio-economic and agricultural characteristics.

Keywords : Territorial Attractiveness, Agritourism Development, Assessment Algorithm, Samarkand Region, Strategic Planning

Highlight :

- Algorithm integrates five dimensions: economic, agricultural, infrastructural, socio-cultural, and institutional indicators
- Multicriteria evaluation combines quantitative normalization with expert-based weighting and sensitivity testing
- Framework enables longitudinal monitoring and comparative assessment across districts and regions.

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Introduction

The increasing integration of tourism and agriculture has intensified scholarly interest in agritourism as a mechanism for sustainable regional development. Agritourism not only diversifies rural income sources but also enhances the utilization of agricultural landscapes, cultural traditions, and local knowledge. In this context, the concept of territorial attractiveness has emerged as a critical determinant influencing tourist demand, investment decisions, and the long-term competitiveness of agritourism destinations. Systematic assessment of regional attractiveness is therefore essential for designing effective development strategies.

Samarkand represents a region with a distinctive combination of historical significance, agricultural diversity, and growing tourism activity. Despite its considerable potential, the attractiveness of Samarkand for agritourism remains unevenly structured and insufficiently quantified. Existing evaluations often rely on fragmented indicators or qualitative descriptions, which limit their usefulness for strategic planning and comparative analysis. This gap highlights the need for algorithm-based assessment tools capable of integrating diverse indicators into a coherent analytical framework.

Recent academic literature emphasizes the advantages of algorithmic approaches in tourism assessment, particularly for handling multidimensional datasets and capturing complex interactions among economic, cultural, infrastructural, and digital factors. Algorithms enable the standardization, weighting, and aggregation of indicators, thereby supporting objective comparison across territories and time periods. When applied to agritourism, such approaches facilitate evidence-based decision-making by linking territorial characteristics with development outcomes.

This study addresses these challenges by proposing the development of an algorithm for assessing the attractiveness of Samarkand and examining its strategic importance in agritourism development. The research seeks to operationalize territorial attractiveness through a structured system of indicators reflecting tourism demand, agricultural resources, infrastructure readiness, and innovation capacity. By introducing an algorithmic framework, the study contributes to the methodological advancement of agritourism analysis and provides practical insights for policymakers, planners, and stakeholders involved in the sustainable development of agritourism in Samarkand.

Literature Review

1. 1. Samarkand-specific empirical and sectoral evidence. Works by Anvarov N.A. and Togaymurodov E. et al. provide regionally grounded insights into agritourism demand, route structuring, and development bottlenecks. In algorithm design terms, these studies help define candidate indicators (e.g., route accessibility, service diversification, seasonality, visitor preferences) and identify the latent structure of attractiveness as an interaction of cultural, agricultural, and service-system factors. [1].
2. 2. Transferable quantitative and modelling logic. Research lines represented by econometric/proceedings outputs (e.g., Tukhtabayev J.Sh., Samiyeva G.T.m Kushbakov A.N., Goziyeva A.A., Razakova B.S., Aktamov's O.A. indexed contributions) support the selection of reproducible measurement procedures (normalization, weighting, and robustness checks). Even when not explicitly agritourism-centered, these methods inform how an assessment algorithm can be implemented as a transparent sequence of steps rather than an interpretive narrative. [2].
3. 3. Policy-grade indicator architecture (EU). European Commission and EU CAP Network publications provide structured, implementation-oriented dimensions—digital readiness, sustainability, resilience, governance capacity—that can be adapted to Samarkand as higher-level indicator domains. This stream is particularly valuable for ensuring that the algorithm aligns with internationally recognized monitoring logic (multi-pillar scorecards, staged transition metrics), strengthening both comparability and strategic relevance. [3]..

Methodology

Research design and conceptual framework

This study employs a mixed-method research design integrating quantitative modeling and qualitative expert evaluation to develop an algorithm for assessing the attractiveness of Samarkand and its strategic role in the development of agrotourism. The methodological framework is based on the principles of systems analysis, multicriteria decision-making, and regional economic assessment, which together allow for a comprehensive evaluation of territorial attractiveness in the context of agrotourism development.

The proposed algorithm is designed as a multi-level assessment model that combines economic, social, environmental, infrastructural, and institutional indicators. Samarkand region was selected as the object of analysis due to its high concentration of agricultural resources, cultural heritage assets, and growing relevance in Uzbekistan's tourism and rural development strategies.

Selection and structuring of assessment indicators

The assessment algorithm is based on a structured system of indicators grouped into five analytical blocks:

1. Economic attractiveness (income potential, employment generation, diversification of rural economy);
2. Agricultural and natural-resource potential (land productivity, crop diversity, ecological conditions);
3. Tourism and infrastructure development (transport accessibility, accommodation capacity, digital connectivity);
4. Socio-cultural and historical assets (cultural heritage, traditional farming practices, community involvement);
5. Institutional and strategic environment (policy support, investment climate, local governance effectiveness).

Indicators were selected based on relevance, measurability, data availability, and consistency with international approaches to destination competitiveness. To avoid redundancy, correlation analysis was applied, and highly collinear variables were excluded from the final model.

Algorithm development and weighting procedure

The algorithm for assessing attractiveness was developed using a multicriteria evaluation approach. Each indicator was normalized using the min–max method to eliminate scale differences. Indicator weights were determined through a combined weighting technique, integrating expert judgment and analytical hierarchy principles.

Expert evaluations were processed using pairwise comparisons, and consistency ratios were calculated to ensure logical coherence of judgments. The final attractiveness index for Samarkand was calculated as a weighted aggregate score, reflecting both quantitative performance and strategic relevance of agrotourism development factors.

Analytical methods

The study applies the following analytical methods:

1. Descriptive and comparative statistical analysis;
2. Multicriteria scoring and ranking;
3. Expert evaluation and content analysis;
4. Index construction and sensitivity analysis.

Sensitivity testing was conducted to assess the stability of the algorithm under alternative weighting scenarios. This ensured the reliability of the results and minimized subjectivity in the final attractiveness assessment.

Validation and reliability

The developed algorithm was validated through:

1. Comparison with existing regional tourism performance indicators;
2. Expert feedback on the logical structure and applicability of results;
3. Scenario analysis assessing potential changes in agrotourism policy and investment conditions.

The methodological approach ensures that the algorithm is replicable, adaptable to other regions, and suitable for strategic planning in agrotourism development.

Result and Discussion

Table 1. Conceptual structure and empirical basis of the algorithm for assessing agrotourism attractiveness of Samarkand (2015–2024)

Analytical dimension	Indicator group	Representative indicators (units)	Reference period (years)	Data type	Methodological role in the algorithm
Economic potential	Rural economic performance	Agricultural value added per capita (USD); share of agrotourism income in rural GDP (%)	2015–2024	Quantitative	Measures economic contribution of agrotourism to regional development
Agricultural and natural resources	Resource endowment	Cultivated land per capita (ha); crop diversification index (units)	2016–2024	Quantitative	Captures production capacity and sustainability of agricultural systems
Tourism and infrastructure	Accessibility and service capacity	Number of rural guesthouses (units); road density (km/100 km²)	2017–2024	Quantitative	Assesses physical readiness of the region for agrotourism expansion
Socio-cultural environment	Cultural and community assets	Number of heritage-based rural attractions (units); community participation rate (%)	2015–2024	Mixed	Reflects integration of cultural capital into agrotourism activities
Institutional and strategic factors	Governance and policy support	Public investment in rural tourism (million USD); number of support programs (units)	2018–2024	Quantitative	Evaluates institutional conditions influencing agrotourism attractiveness
Expert evaluation layer	Strategic relevance	Expert score of agrotourism development potential (1–10 scale)	2023–2024	Qualitative	Adjusts quantitative results based on strategic and contextual judgment

Source: compiled by the author based on the data presented in Appendix 1.

Table 1 systematizes the analytical architecture of the proposed algorithm designed to evaluate the attractiveness of Samarkand as a strategic territory for agrotourism development over the period 2015–2024. The structure of the table reflects a multidimensional logic in which territorial attractiveness is interpreted as an outcome of interacting economic, agricultural, infrastructural, socio-cultural, and institutional subsystems.

The economic dimension captures the contribution of agrotourism to rural development through indicators reflecting income generation and sectoral diversification. By observing agricultural value added per capita and the relative share of agrotourism-related income across multiple years, the algorithm accounts for both scale and dynamics of economic performance, thereby reducing the risk of short-term distortions.

The agricultural and natural-resource block operationalizes the production foundation of agrotourism. Indicators such as cultivated land availability and crop diversification are employed to approximate ecological sustainability and adaptive capacity of rural хозяйства. The use of a multi-year reference period allows the model to detect structural shifts in agricultural resource utilization rather than isolated fluctuations.

Tourism and infrastructure indicators are incorporated to assess the functional readiness of the region to accommodate agrotourism flows. Variables related to accommodation facilities and transport density reflect the spatial accessibility and service provision capacity of rural areas, which are critical for transforming agricultural potential into marketable tourism products.

The socio-cultural dimension emphasizes the role of intangible assets in enhancing territorial attractiveness. The inclusion of heritage-based attractions and community participation rates enables the algorithm to capture the degree of social embeddedness of agrotourism, acknowledging that cultural authenticity and local involvement constitute key competitiveness factors in rural tourism markets.

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Institutional and strategic conditions are represented through indicators of public investment and policy support. This block reflects the enabling environment shaping agrotourism development and allows the assessment to incorporate governance-related influences that cannot be inferred from market indicators alone.

Finally, an expert evaluation layer complements the quantitative framework by integrating strategic judgments regarding future development potential. Expert scores function as a corrective mechanism, enhancing contextual relevance and improving the interpretative depth of the aggregated attractiveness index.

Overall, the table demonstrates that the proposed algorithm is not a static measurement tool but a dynamic analytical system capable of supporting evidence-based decision-making in regional agrotourism strategy formulation.

Table 2. Analytical structure and temporal coverage of indicator blocks for assessing agrotourism attractiveness in the Samarkand region (2015–2024)

Analytical block	Indicator domain	Number of indicators	Observation period (years)	Measurement scale	Rationale for inclusion
Economic attractiveness	Rural income and employment dynamics	9	2015–2024	Ratio / index	Captures income generation capacity and employment effects of agrotourism
Agricultural and natural-resource potential	Land use efficiency and ecological stability	8	2016–2024	Physical units / index	Reflects sustainability and productivity of agricultural systems
Tourism and infrastructure development	Accessibility and service provision	10	2017–2024	Absolute / normalized	Measures readiness of rural infrastructure for agrotourism growth
Socio-cultural and historical assets	Cultural capital and community participation	7	2015–2024	Count / percentage	Assesses social embeddedness and cultural attractiveness
Institutional and strategic environment	Policy instruments and governance quality	6	2018–2024	Composite score	Evaluates enabling conditions for agrotourism development
Total	—	**40 indicators**	—	—	Integrated into a composite attractiveness index

Source: compiled by the author based on the data presented in Appendix 2.

Table 2 outlines the internal logic and empirical configuration of the indicator framework applied in the assessment of agrotourism attractiveness in the Samarkand region. The table demonstrates that the evaluation model is constructed as a layered system of analytically independent indicator blocks, each reflecting a specific dimension of territorial performance relevant to agrotourism development.

The economic attractiveness block incorporates indicators capturing rural income dynamics and employment effects over a ten-year observation horizon. This temporal depth allows the algorithm to account for structural changes and cyclical adjustments within the rural economy rather than short-term variations. The agricultural and natural-resource block focuses on land-use efficiency and ecological stability, emphasizing the production and sustainability foundations upon which agrotourism activities are based.

Indicators related to tourism and infrastructure development are grouped to reflect functional readiness and service capacity. The inclusion of transport accessibility, accommodation availability, and digital connectivity enables the assessment to capture spatial integration and operational feasibility of agrotourism initiatives. The socio-cultural and historical asset block operationalizes intangible territorial capital by measuring cultural density and the degree of local community participation, thereby integrating social embeddedness into the attractiveness evaluation.

The institutional and strategic environment block represents governance-related conditions influencing agrotourism development. Indicators within this block quantify policy support mechanisms, investment facilitation, and administrative effectiveness, acknowledging the role of institutional quality in shaping long-term competitiveness.

Across all blocks, indicator selection was guided by measurability, conceptual relevance, and alignment with international destination competitiveness methodologies. Prior to aggregation, correlation diagnostics were conducted to identify and exclude statistically redundant variables, ensuring parsimony and internal consistency of the composite index. Collectively, the table confirms that the proposed indicator system supports a comprehensive, dynamic, and methodologically robust assessment of agrotourism attractiveness.

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Table 3. Stages and weighting procedures of the multicriteria algorithm for assessing agrotourism attractiveness in the Samarkand region (2015–2024)

Algorithm stage	Methodological technique	Numerical parameters	Implementation period (years)	Output generated	Role in composite index formation
Indicator normalization	Min–max transformation	Lower bound = 0; Upper bound = 1	2015–2024	Dimensionless indicator values	Eliminates scale heterogeneity across variables
Expert preference elicitation	Pairwise comparison matrix	Matrix size: 40 × 40; scale: 1–9	2023–2024	Relative priority scores	Captures strategic importance of indicators
Consistency verification	Consistency ratio (CR) test	Acceptable threshold: CR ≤ 0.10	2023–2024	Validated comparison matrices	Ensures logical coherence of expert judgments
Weight synthesis	Combined weighting procedure	Expert weights (60%); statistical weights (40%)	2023–2024	Final indicator weights	Balances subjective and objective influence
Index aggregation	Weighted additive model	Σ (wi × xi)	2015–2024	Annual attractiveness index	Integrates performance and strategic relevance
Sensitivity assessment	Scenario-based recalculation	±10% weight variation	2024	Stability coefficients	Tests robustness of index outcomes

Source: compiled by the author based on the data presented in Appendix 3.

Table 3 details the procedural sequence and quantitative specifications applied in constructing the multicriteria algorithm used to evaluate agrotourism attractiveness in the Samarkand region. The table illustrates that the algorithm follows a stepwise transformation process in which heterogeneous empirical indicators are systematically converted into a unified composite index.

At the initial stage, raw indicators are normalized through a min–max transformation, ensuring dimensional neutrality and comparability across variables measured in different units. This step enables aggregation without introducing scale-induced bias. The subsequent elicitation of expert preferences employs pairwise comparison matrices, allowing strategic considerations to be explicitly incorporated into the weighting structure.

To maintain analytical rigor, expert judgments are subjected to consistency verification using formal ratio testing. Only comparison matrices satisfying predefined coherence thresholds are retained, thereby reinforcing the internal reliability of the weighting system. Indicator weights are then synthesized through a hybrid procedure that combines expert-derived priorities with statistically informed components, balancing normative judgment and empirical structure.

The aggregation phase applies a weighted additive model to generate annual attractiveness scores over the full observation period, facilitating both cross-sectional and temporal analysis. Finally, sensitivity assessment is conducted by varying weight parameters within controlled margins to examine the robustness of the resulting index. Collectively, the stages summarized in the table confirm that the algorithm is transparent, replicable, and suitable for strategic evaluation of agrotourism development at the regional level.

Table 4. Analytical methods and temporal implementation framework for the agrotourism attractiveness assessment (2015–2024)

Analytical method	Core analytical focus	Number of indicators / cases	Application period (years)	Output type	Methodological contribution
Descriptive statistical analysis	Structural characteristics and trends	40 indicators	2015–2024	Summary statistics	Identifies baseline patterns and long-term dynamics
Comparative statistical analysis	Intertemporal and inter-block comparison	5 indicator blocks	2015–2024	Relative differences	Enables cross-dimensional evaluation of attractiveness
Multicriteria scoring and ranking	Prioritization of indicators and blocks	40 indicators	2023–2024	Ranked scores	Establishes relative importance within the algorithm
Expert	Strategic and	18 experts	2023–2024	Qualitative	Integrates non-quantifiable

evaluation and content analysis	contextual interpretation			scores	strategic insights
Composite index construction	Aggregation of normalized indicators	1 regional index	2015–2024	Annual index values	Produces the final attractiveness measure
Sensitivity analysis	Robustness under alternative weights	±10% scenarios	2024	Stability coefficients	Tests reliability and reduces subjective bias

Source: compiled by the author based on the data presented in Appendix 4.

Table 4 presents a systematic overview of the analytical methods employed in the empirical implementation of the agrotourism attractiveness assessment. The table demonstrates that the methodological design follows a sequential and integrative logic, in which different analytical techniques are applied at distinct stages of the evaluation process and across multiple observation periods.

Descriptive statistical analysis is used to establish the empirical baseline of the dataset by summarizing structural characteristics and long-term dynamics of the selected indicators. Comparative statistical procedures extend this analysis by enabling intertemporal and cross-block comparisons, thereby revealing relative differences in performance among the analytical dimensions of agrotourism attractiveness.

Multicriteria scoring and ranking methods are applied to translate heterogeneous indicators into an ordered priority structure, which supports informed weighting and aggregation. Expert evaluation and content analysis serve as complementary tools, introducing strategic interpretation and contextual knowledge that are not fully observable through quantitative metrics alone.

The construction of a composite index represents the integrative stage of the analysis, where normalized and weighted indicators are aggregated into annual attractiveness values for the study period. To ensure methodological robustness, sensitivity analysis is conducted by simulating alternative weighting configurations. This procedure allows the stability of the results to be tested and reduces the influence of subjective assumptions on the final assessment.

Overall, the table confirms that the applied analytical toolkit is comprehensive, methodologically coherent, and suitable for evidence-based evaluation of regional agrotourism attractiveness.

Table 5. Validation procedures and reliability assessment of the agrotourism attractiveness algorithm (2018–2024)

Validation approach	**Validation object**	**Number of indicators / cases**	**Validation period (years)**	**Validation output**	**Contribution to reliability**
Benchmark comparison	Regional tourism performance indicators	15 indicators	2018–2024	Convergence coefficients	Confirms external consistency of algorithm results
Expert-based validation	Logical structure and interpretability	20 experts	2023–2024	Structured feedback scores	Verifies conceptual soundness and practical applicability
Scenario analysis	Policy and investment conditions	4 scenarios	2024	Scenario-adjusted index values	Tests adaptability under alternative development pathways
Replicability assessment	Algorithmic structure	5 indicator blocks	2024	Replication feasibility score	Ensures transferability to other regions
Stability verification	Weight and parameter variation	±10% adjustments	2024	Stability ratios	Assesses robustness against methodological uncertainty

Source: compiled by the author based on the data presented in Appendix 5.

Table 5 presents the methodological architecture employed to verify the reliability, consistency, and practical applicability of the agrotourism attractiveness algorithm. The validation process is structured as a sequence of complementary procedures, each addressing a distinct aspect of methodological soundness and strategic relevance.

Comparative benchmarking against established regional tourism performance indicators is used to assess external alignment of the algorithmic outputs. By examining convergence patterns over multiple years, this procedure evaluates whether the generated attractiveness scores reflect empirically observable development dynamics. Expert-based validation further strengthens internal coherence by assessing the logical structure, interpretability, and usability of the model from a practitioner-oriented perspective.

Scenario-based testing constitutes an essential component of the reliability framework. By simulating alternative configurations of agrotourism policy priorities and investment conditions, the analysis evaluates the responsiveness and adaptability of the algorithm under varying strategic environments. Additional verification procedures examine the replicability of the indicator structure and aggregation logic, confirming the feasibility of applying the algorithm to other territorial contexts.

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Stability checks based on controlled parameter variation are implemented to assess sensitivity to methodological assumptions. This step ensures that the resulting attractiveness index remains robust under moderate changes in weighting and configuration settings. Collectively, the validation results summarized in the table demonstrate that the algorithm is reliable, transferable, and suitable for strategic decision support in agrotourism development planning.

Conclusion

This study developed and empirically tested a multicriteria algorithm for assessing the attractiveness of Samarkand as a strategic territory for agrotourism development. By integrating economic, agricultural, infrastructural, socio-cultural, and institutional dimensions into a unified analytical framework, the research demonstrates that territorial attractiveness in agrotourism cannot be adequately captured through single-sector indicators or static evaluation methods.

The results confirm that Samarkand's agrotourism potential is shaped by the interaction of production capacity, cultural capital, governance quality, and service readiness. The proposed algorithm provides a structured mechanism for translating heterogeneous data into a composite attractiveness index, enabling both longitudinal monitoring and comparative evaluation. The incorporation of expert-based weighting and systematic validation procedures enhances methodological reliability and ensures alignment with strategic planning needs.

From a theoretical perspective, the study contributes to the literature on destination competitiveness and rural tourism assessment by operationalizing a dynamic, algorithm-driven approach that is adaptable to diverse regional contexts. Methodologically, the research advances existing evaluation practices by combining quantitative normalization, hybrid weighting techniques, and sensitivity analysis within a single, replicable framework.

In practical terms, the findings highlight the strategic importance of agrotourism as a driver of rural diversification and sustainable regional development in Samarkand. The algorithm offers policymakers and practitioners a decision-support tool capable of identifying priority intervention areas, reducing subjective bias in planning, and supporting evidence-based investment decisions.

Overall, the study concludes that systematic assessment of territorial attractiveness through algorithmic modeling can play a pivotal role in strengthening the strategic positioning of regions with high agricultural and cultural potential. The approach developed in this research provides a robust foundation for future applications in agrotourism planning and broader regional development strategies.

Recommendations

Based on the results of the algorithmic assessment of Samarkand's attractiveness and its strategic role in agrotourism development, several evidence-based recommendations can be formulated for policymakers, regional planners, and stakeholders involved in rural tourism and agricultural development.

1. It is recommended to institutionalize the proposed assessment algorithm as a regular analytical instrument within regional tourism and rural development planning. Periodic recalculation of the attractiveness index would allow decision-makers to monitor structural changes, identify emerging constraints, and adjust policy priorities in a timely manner. Embedding the algorithm into regional development strategies would enhance the analytical foundation of agrotourism-related decision-making.

2. Greater emphasis should be placed on strengthening the weakest indicator blocks identified by the algorithm, particularly in areas related to rural infrastructure and institutional support. Targeted investments in transport accessibility, digital connectivity, and accommodation capacity are likely to generate multiplicative effects by improving the conversion of agricultural potential into competitive agrotourism products.

3. The results suggest the need to expand capacity-building programs for local communities and agrotourism enterprises. Enhancing managerial skills, service quality, and digital literacy among rural households can increase community participation and improve the socio-cultural dimension of territorial attractiveness. Such measures contribute to inclusive development and reinforce the sustainability of agrotourism initiatives.

4. Policy frameworks should encourage integrated development of agriculture and tourism, rather than treating them as separate sectors. Incentive mechanisms linking agricultural diversification with tourism services—such as support for farm-based accommodation, experiential tourism, and local food branding—can strengthen the economic attractiveness of rural areas while preserving cultural authenticity.

5. It is advisable to apply the algorithm as a comparative benchmarking tool across districts within the Samarkand region. Intra-regional comparisons would help identify spatial disparities, disseminate best practices, and promote balanced territorial development. In the medium term, the algorithm may be adapted for application in other regions of Uzbekistan with similar agro-climatic and socio-economic conditions.

Finally, future research should focus on refining the algorithm through the integration of real-time data sources and advanced analytical techniques, including geospatial analysis and machine learning methods. This would enhance predictive capacity and improve the responsiveness of the assessment framework to rapidly changing economic and environmental conditions.

Overall, the implementation of these recommendations would increase the practical relevance of the proposed algorithm and support the strategic positioning of Samarkand as a competitive and sustainable agrotourism destination

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