TO WHAT EXTENT CAN UZBEKISTAN REPLICATE ITS PREVIOUS SUCCESSES BY ESTABLISHING A FREE ECONOMIC ZONE (FEZ) IN KARAKALPAKSTAN?

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Annotation: the purpose of the work is to determine the possibility of creating a Free Economic Zone (FEZ) in the Republic of Karakalpakstan on the basis of previous experience of FEZ in Uzbekistan. The study investigates the socio-economic and environmental problems of the region, particularly the problems connected with the Aral-Syrdarya crisis, and considers which successful particular examples of FEZ implementation in Uzbekistan can be replicated in this case. Using a comparative analysis of the international experience in this sphere, it identifies the success factors of the FEZ implementation in a particular case. Based on the findings of the study, it concludes that sustainable success is impossible without investment incentives, proper governance, infrastructure development, environmental sustainability, and community involvement into the development process.

Keywords: Free Economic Zone (FEZ); Karakalpakstan; Uzbekistan; foreign direct investment (FDI); sustainable development; regional development; Aral Sea crisis; Central Asia

1. Introduction

FEZs and Uzbekistan's Development Context

Free Economic Zones (FEZs) play a critical role in economic development by attracting Foreign Direct Investment (FDI) and stimulating regional growth (Watanabe, 2003;). Uzbekistan occupies a central position within Central Asia, a region of growing geopolitical importance, and has pursued economic diversification through government-led initiatives such as FEZs. These initiatives aim to create local employment opportunities, reduce unemployment and forced migration, attract FDI, and improve infrastructure, trade, logistics, and tourism. FEZs are widely implemented to holistically stimulate FDI inflows and economic growth, particularly in developing countries (Barents, 1978; Lu, 2014).

FEZ Development in Uzbekistan

Uzbekistan has strategically established a network of free economic zones aimed at attracting FDI, promoting economic growth, and creating employment

opportunities (Investment Promotion Agency). The country's first FEZ, the Navoi Free Industrial Economic Zone, was established in 2008; subsequent zones followed, including the Angren Special Industrial Zone and the Jizzakh Free Economic Zone. As of the most recent data available, Uzbekistan operates 23 free economic zones across 13 regions.

Figure 1. Location of Free Economic Zones in Uzbekistan
Source: www.invest.go.uz

Figure 1. Distribution of free economic zones across Uzbekistan (www.invest.gove.uz).

Karakalpakstan's Unique Context and Research Focus

Karakalpakstan is a distinctive region within Uzbekistan in social, political, cultural, and environmental terms. The region has a population of approximately two million people, with Nukus as its capital (National Statistics Committee of the Republic of Uzbekistan, 2023). Although the Republic of Karakalpakstan holds constitutionally guaranteed autonomous status—including its own constitution and legislature—within Uzbekistan, the country itself remains a unitary republic rather than a federation (Constitution of the Republic of Uzbekistan, 1992/2023, arts. 70–75). This dual status—autonomy nested within a centralized state—makes Karakalpakstan a distinctive case internationally.

Given Karakalpakstan's severe economic challenges and environmental vulnerability stemming from the Aral Sea crisis (Micklin, 2007), the FEZ is positioned to play a strategic role in fostering sustainable economic growth in the region.

The FEZ offers preferential conditions for investors, including tax incentives, customs exemptions, streamlined administrative procedures, and access to state-supported infrastructure. These incentives are designed to attract both domestic and foreign enterprises and to minimize operational and entry barriers for businesses.

This study seeks to answer the following research question: **To what extent can Uzbekistan replicate its previous FEZ successes by establishing a Free Economic Zone in Karakalpakstan?**

This paper argues that although Uzbekistan can adapt the model of its former Free Economic Zones, the success of this adaptation for Karakalpakstan will depend on taking a 'whole system' view that considers economic incentives alongside social responsibility, environmental care, and a sound political environment, in order to create long-term, sustainable gains for investors and surrounding communities.

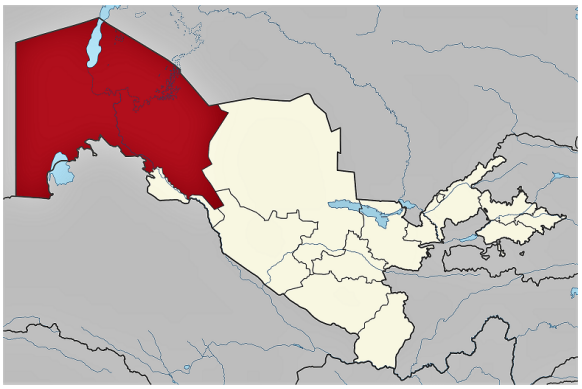

Figure 2 Geographic placement of Karakalpakstan in Uzbekistan

2. FEZ in the Context of Karakalpakstan

Environmental and Socio-Economic Challenges in Karakalpakstan

The region faces long-standing problems with both ecological and socio-economic roots. Most significant is the impact of the Aral Sea disaster on ecological and human systems in Karakalpakstan: what was once among the largest inland seas in the world has shrunk dramatically since the 1960s, largely as a result of large-scale Soviet-era irrigation projects and the mismanagement of the Amu Darya and Syr Darya river systems (Micklin, 2007). This has resulted in severe environmental degradation, including declining water availability, land desertification, soil salinization, and dust storms that carry salt and residual agrochemical pollutants into the air (Bartrem et al., 2025; Micklin, 2007). These ecological issues have severely affected the economic livelihoods, health, and well-being of the local population (Anchita et al., 2021; Bartrem et al., 2025).

The socio-economic consequences of the Aral Sea disaster include a rapid decline in agricultural production, driven by salt-affected soils and water scarcity, undermining the primary source of income for many households in the region (Anchita et al., 2021). Local communities face high unemployment and limited industrial development and infrastructure. Furthermore, residents have experienced deteriorating public health, reflected in elevated rates of respiratory illness, chronic disease, and other conditions linked to environmental pollution

and poor living conditions (Anchita et al., 2021; Bartrem et al., 2025). These challenges have driven substantial labor migration, as many residents leave the region in search of better economic and social opportunities elsewhere in Uzbekistan or abroad (Anchita et al., 2021).

Governance, Culture, and Development Constraints

Karakalpakstan has a separate identity and culture; it speaks its own language, which is closely related to Kazakh, and has developed distinct traditions and community structures (Schlyter, 2012). To achieve sustainable outcomes with community participation, policymakers must account for the region's unique culture. The region holds constitutionally guaranteed autonomy, including its own constitution and legislature, granting it authority to establish localized policies; however, these policies must remain within the framework of the centralized Republic, and the laws of Uzbekistan remain binding throughout Karakalpakstan's territory (Constitution of the Republic of Uzbekistan, 1992/2023, arts. 70–75). This interplay between autonomous and centralized governance presents both opportunities and constraints for development planners.

FEZs as a Policy Tool in Karakalpakstan

To address the challenge of developing the region in a way that respects both its physical location and its cultural identity, the Uzbek government established a Free Economic Zone in Karakalpakstan in 2017. The FEZ was designed to encourage economic growth by fostering local and foreign investment, creating jobs, and facilitating industrialization and export-oriented development. Priority sectors include manufacturing, agro-processing, logistics, renewable energy, and environmentally friendly technologies. The FEZ offers tax preferences, exemptions from customs duties, and simplified administrative procedures to encourage investment.

The Special Economic Zone (SEZ) model is one policy mechanism used globally to respond to regional economic challenges while pursuing sustainable growth through environmental, social, and cultural considerations (Aggarwal, 2012). For an SEZ to succeed, public and private investment must be aligned with strategic public policy that improves local health and well-being, reduces unemployment, and mitigates environmental degradation (Aggarwal, 2012). The unique combination of Karakalpakstan's autonomous status, environmental pressures, and socio-economic weaknesses creates an opportunity for innovative development strategies in the region.

Karakalpakstan's Free Economic Zones

The earliest verifiable instrument is the 3 May 2017 presidential decree establishing the "Nukus-Pharm" pharmaceutical free economic zone, one of several sector-specific zones created that year (Cabinet of Ministers records, cited in Free Economic Zones in the Republic of Uzbekistan and Ways to Attract Investment in Them, 2022). In September 2019, President Shavkat Mirziyoyev signed a decree transforming Nukus-Pharm into the broader Nukus Free Economic Zone, granted a 30-year special tax and customs regime, with existing Nukus-Pharm participants automatically carried over as Nukus FEZ residents (Times of Central Asia, 2019). A second, agriculture-focused zone, "Karakalpak-agro," was created by presidential decree on 11 November 2020 to support seed-to-market agricultural production, hydroponic greenhouses, and export-oriented logistics (UNCTAD Investment Policy Hub, 2021). Accordingly, the verifiable establishment sequence for the region's FEZs is 2017 (sectoral origin) → 2019 (Nukus FEZ) → 2020 (Karakalpak-agro FEZ), roughly a decade after — not before — the 2008 launch of the Navoi Free Industrial Economic Zone discussed in Section 4.

Quantitative Socio-Economic Profile of Karakalpakstan

To move beyond descriptive claims of hardship, Table 3 assembles the most recent officially reported and internationally verified indicators for Karakalpakstan. Two poverty metrics are reported because Uzbekistan's Ministry of Employment and Poverty Reduction uses a monetary poverty line, whereas the United Nations Development Programme (UNDP) uses a 34-indicator multidimensional poverty index that also captures education, health, and living-standard deprivation; the gap between the two figures (10.8% vs. 29.9%) is itself analytically significant, indicating that monetary poverty substantially understates the region's deprivation relative to a multidimensional standard.

Table 3. Socioeconomic Indicators of the Republic of Karakalpakstan

Indicator	Value	Year / Period	Source
Population	~2.0 million (region); ~752,000 ethnic Karakalpaks	2021–2023	National Statistics Committee of Uzbekistan (2023); Wikipedia: Karakalpaks (2025 est.)
Share of national territory	37% of Uzbekistan's land area	–	Minority Rights Group (2024)

Indicator	Value	Year / Period	Source
Monetary poverty rate	13.6% → 10.8% (declining)	2023 → 2024	Ministry of Employment and Poverty Reduction, cited in Kun.uz (2025)
Multidimensional poverty rate	29.9% (highest of all Uzbek regions)	2023	UNDP, cited in Times of Central Asia (2024)
National poverty rate (comparator)	11.0% → 8.9%	2023 → 2024	Eurasianet (2025); Kun.uz (2025)
Aral Sea seabed exposed	~90% shrinkage of former sea area	cumulative to 2020s	Minority Rights Group (2024); Micklin (2007)
Historical extreme-poverty benchmark (Aral zone)	44% poverty rate reported in earlier UN programming	UN baseline period	UN Human Security Unit, Uzbekistan Programme Summary (n.d.)
Karakalpakstan FEZ investment target	US$2.1 billion in planned foreign investment for the region (2024)	2024	SpecialEurasia (2024)

Table 3. Compiled by the authors from national and international secondary sources.

3. International and Regional Comparisons

Eurasian and International FEZ Models

Uzbekistan's approach to FEZs parallels several countries in Eurasia. Kazakhstan has implemented Special Economic Zones (SEZs) featuring tax breaks and streamlined regulations, focusing on manufacturing, logistics, and technology (Yifan, 2015). Azerbaijan has established diverse FEZs to diversify its economy, offering tax holidays and infrastructure access in tourism, technology, and agriculture (Alizada, 2021). Similarly, Georgia's Free Industrial Zones (FIZs) provide tax breaks, streamlined customs procedures, and infrastructure support, concentrating on manufacturing, logistics, and technology (Gogishvili & Harris-Brandts, 2020). While Uzbekistan's model shares these features, it is important to recognize the distinct economic and political context shaping each country's strategy.

Comparative Lessons from South Korea and Central Asia

Uzbekistan and South Korea both use FEZs to attract foreign investment, yet key differences exist. Uzbekistan's zones emphasize manufacturing, logistics, and technology, whereas South Korea prioritizes high-tech sectors such as IT, biotechnology, and nanotechnology. Government involvement also differs: Uzbekistan relies on state-owned enterprises, while South Korea's FEZs are primarily privately operated with government support (Clément, 2019). Regulatory environments differ as well; Uzbekistan's framework remains under development and faces implementation challenges, whereas South Korea benefits from long-established regulations (Ikramov et al., 2008). FEZs across Uzbekistan, Kazakhstan, Kyrgyzstan, and Tajikistan share commonalities but also reflect distinct national priorities. Kazakhstan targets high-tech industries under a specific legal framework (Turgel et al., 2019). Kyrgyzstan focuses on manufacturing, agro-industry, and tourism under its own legal framework (Vokhidova et al., 2019). Tajikistan emphasizes manufacturing, tourism, and agro-industry, governed by distinct laws (Saidmurodova & Amirkulov, 2019). Uzbekistan's FEZs, such as Navoi and Angren, have distinct economic focuses and operate under unique legal frameworks (Spechler, 2008). These variations illustrate the diverse approaches to FEZ development across Central Asia.

Comparative Quantitative Analysis

Table 2. International Comparison of FEZ Models

Country	Flagship zone(s)	Legal basis	Sector focus	Reported scale / performance
Uzbekistan	Navoi FIEZ; Angren SIZ; Nukus & Karakalpak-agro FEZs	Law No. ZRU-604 "On Special Economic Zones" (2020)	High-tech manufacturing, logistics, agro-processing, pharma	20–24 SEZs nationally (2024); 771 resident enterprises; US$3.2bn cumulative investment incl. US$896.9mn FDI; ~55,000 jobs since 2008 (Daryo News, 2025)
Kazakhstan	TURAN SEZ and 13 others	Law on Special Economic and Industrial Zones	Processing industry (35 priority activities), petrochemicals, logistics	129 projects worth 530.1bn tenge in TURAN SEZ alone; national unemployment 4.6–4.8% (Invest in

Country	Flagship zone(s)	Legal basis	Sector focus	Reported scale / performance
				Kazakhstan, 2024; World Bank, 2026)
Azerbaijan	Aghdam & Araz Valley industrial parks; Sumgayit Chemical Industrial Park	Presidential decrees (2021 onward)	Non-oil industry, chemicals, reconstruction zones	Continued expansion of industrial-zone investment reported through 2026 (Azerbaijan Economic Zones Agency, 2026)
Georgia	Poti FIZ; Kutaisi (Hualing) FIZ; Tbilisi Free Zone	Law on Free Industrial Zones (2007)	Trade, light manufacturing, logistics (Black Sea port access)	4 operating FIZs; Poti FIZ hosts 100+ companies; GDP per capita US$9,610 (ADB, 2026)
South Korea	Incheon, Busan–Jinhae Free Economic Zones	Free Economic Zone Act (2003)	IT, biotechnology, nanotechnology, advanced logistics	Predominantly privately operated with state co-investment; long-established regulatory regime (Clément, 2019)

Table 2. Compiled by the authors; figures are the most recent publicly reported values and are not fully time-aligned across countries.

4. Evidence from Uzbekistan's Previous FEZ Successes

Navoi and Angren FEZs

The government has made substantial investments in infrastructure within these zones—including roads, railways, and utilities—to enhance their attractiveness to investors (Tursunov, 2020; Peremkulov, 2016). The Navoi Free Industrial Economic Zone, located in central Uzbekistan, is the largest and most well-established of the country's FEZs, focused on export development and high-tech industry growth. Within this zone, a diverse range of businesses—including pharmaceuticals, textiles, and electronics—has emerged, attracting substantial investment from major companies such as Samsung, LG, and Total (Tursunov, 2020).

Located near the capital, Tashkent, the Angren Special Industrial Zone, which contains the Angren FEZ, aims to strengthen the country's manufacturing sector, particularly in machinery, electronics, and construction materials. The zone offers incentives to investors, including tax holidays, customs duty exemptions, and simplified permitting and licensing procedures (Peremkulov, 2016).

National FEZ Performance Indicators

Table 1 situates Navoi and Angren within the national FEZ system, drawing on the most recent aggregated reporting available. It also records the presidential decree of 16 May 2019 that extended free-economic-zone status to the entire Navoi region — a milestone additional to, and consistent with, the original 2008 establishment date cited by the authors.

Table 1. Uzbekistan Free Economic Zone Performance (National and Flagship-Zone Level)

Metric	Navoi FIEZ	Angren SIZ / national comparator	National (all SEZs)
Year established	2008 (region-wide status extended 2019)	2012 (Tashkent-region SEZ comparator)	First zone 2008; 20–24 zones by 2024
Resident enterprises / projects	~90 projects (~73 operational, 2026)	119 enterprises (Tashkent-region SEZ)	771 resident enterprises (April 2024)
Investment	≈€2.2 billion in active projects	≈€1.3 billion (Tashkent-region SEZ)	US$3.2 billion cumulative since 2008
FDI component	Included above; Samsung, LG, Total among investors	Chinese investors lead (31 of 71 foreign projects)	US$896.9 million cumulative FDI
Jobs created	8,000+ (with ~2,000 more planned 2026–2029)	n/a in source	~55,000 jobs since 2008
Exports	≈€132 million (2025), projected	n/a in source	n/a in source

Metric	Navoi FIEZ	Angren SIZ / national comparator	National (all SEZs)
	>€141 million (2026)		

Table 1. Compiled by the authors from Euronews (2026), Daryo News (2025), and Eurasian Research Institute (n.d.); figures reflect different reference years and are indicative of scale, not directly additive.

SWOT Analysis of FEZ Replication in Karakalpakstan

Building on Sections 2–4, Table 4 synthesizes the evidence into a SWOT structure that directly feeds into the Evaluation Framework and the readiness assessment presented later in the paper.

Table 4. SWOT Analysis — FEZ Replication in Karakalpakstan

Strengths	Weaknesses
Constitutionally guaranteed autonomy enabling localized policy experimentation; existing Nukus and Karakalpak-agro FEZ legal infrastructure; proximity to Amu Darya transport corridor; strong central-government investment commitment (~US$2.1bn target, 2024)	Highest multidimensional poverty rate of any Uzbek region (29.9%); severe environmental degradation limiting agro-industrial land; nascent zones (2017/2019/2020) with far less track record than Navoi (2008); labor out-migration eroding the local skills base

Opportunities	Threats
Renewable-energy and climate-adaptation sectors aligned with	Continued Aral Sea desiccation eroding the resource base

Opportunities	Threats
global green-finance flows; agro-processing linked to Karakalpak-agro's greenhouse/hydroponics program; growing donor interest (UNDP, World Bank, ADB) in Aral Sea recovery financing	faster than FEZ gains can offset it; risk of investment concentrating in the capital region and bypassing Karakalpakstan; social tension evidenced by the 2022 constitutional-status protests (Nukus, Wikipedia, 2025), which underscores the political sensitivity of centrally directed development

Table 4. Compiled by the authors.

An Original Conceptual Model: The Five-Dimensional Sustainable FEZ Development Model (5D-SFDM)

This section introduces the paper's original scientific contribution, developed directly from the evidence assembled in Sections 2–4 and formalized in the Methodology section above.

Rationale

Existing FEZ frameworks (e.g., Aggarwal, 2012; UNCTAD, 2019) typically evaluate zones along parallel economic, institutional, social, and infrastructural dimensions, treating environmental factors as one dimension among several. That approach is defensible in most contexts, but it does not fit a region where the resource base itself — water, arable land, air quality — has already been degraded to the point of driving out-migration (Anchita et al., 2021; Bartrem et al., 2025). The 5D-SFDM therefore proposes a structural departure from prior models: environmental resilience is modeled not as a fifth parallel dimension but as a moderating precondition that constrains the achievable ceiling of the other four dimensions in ecologically fragile regions.

Figure 3. The Five-Dimensional Sustainable FEZ Development Model (5D-SFDM)

Figure 3. The Five-Dimensional Sustainable FEZ Development Model (5D-SFDM). Source: developed by the authors.

Dimensions, Variables, and Relationships

Economic Dimension. FDI inflows, resident-enterprise formation, export diversification, employment generation, and the effective (not nominal) fiscal cost of tax incentives. This dimension directly reflects the incentive package described in Section 2 (tax preferences, customs exemptions, simplified administration).

Institutional & Governance Dimension. Legal-framework clarity (e.g., Law No. ZRU-604), one-stop-shop administrative capacity, and — specific to this case — the coordination mechanism between Karakalpakstan's autonomous legislature (Jokargy Kenes) and the centralized Republic-level legal framework described in Section 2. Weak coordination in this dimension is identified in the SWOT analysis (Table 4) as a structural weakness distinct from, but related to, generic bureaucratic inefficiency.

Environmental Resilience Dimension (moderating precondition). Water-use efficiency, land-rehabilitation investment, climate-adaptation infrastructure, and pollution mitigation (dust suppression, salinity management). Because this dimension moderates the other four, the model predicts that even strong scores on Economic or Infrastructure dimensions will fail to translate into

sustainable outcomes if Environmental Resilience remains low — a hypothesis directly testable against the readiness assessment below.

Social Inclusion Dimension. Monetary and multidimensional poverty reduction, education and skills investment, healthcare access, migration retention, and — reflecting Karakalpakstan's distinct linguistic and cultural identity (Schlyter, 2012) — the extent to which FEZ governance and employment practices accommodate Karakalpak language and cultural norms rather than importing a uniform national template.

Infrastructure & Connectivity Dimension. Transport corridor integration (notably the Amu Darya logistics corridor and rail links used by existing zones), utility reliability, and digital infrastructure, mirroring the airport-logistics advantage identified as central to Navoi's success (Section 4).

Theoretical and Practical Contribution

Theoretically, the 5D-SFDM extends the SEZ-success-factor literature (Aggarwal, 2012) by re-specifying environmental sustainability from a parallel factor to a moderating precondition in ecologically fragile regions, a distinction with implications beyond this case (e.g., other Aral-basin, Sahelian, or delta regions considering SEZ-style instruments). Practically, the model supplies the variable structure used in the Evaluation Framework below, giving policymakers a replicable diagnostic instrument rather than a purely narrative assessment.

Evaluation Framework and Comparative Assessment

Applying the scoring logic set out in the Methodology section, Table 5 scores each case on the 5D-SFDM's four active dimensions (Economic, Institutional, Social, Infrastructure), with the Environmental Resilience precondition scored separately in the final column because of its moderating role.

Table 5. Evaluation Matrix (1 = nascent … 5 = mature)

Case	Economic	Institutional	Social Inclusion	Infrastructure	Environmental Resilience (precondition)
Navoi FIEZ (UZ)	4	4	3	4	3
Angren SIZ (UZ)	3	3	3	3	3
Nukus / Karakalpak-agro FEZ (Karakalpakstan)	2	2	2	2	1
Kazakhstan SEZs (e.g., TURAN)	4	3	3	4	3

Case	Economic	Institutional	Social Inclusion	Infrastructure	Environmental Resilience (precondition)
Azerbaijan industrial parks/zones	3	3	2	3	3
Georgia FIZs (Poti, Kutaisi, Tbilisi)	3	3	3	4	4
South Korea FEZs (Incheon, Busan-Jinhae)	5	5	4	5	4

Table 5. Author-constructed composite scoring per the ordinal rubric defined in the Methodology section; not an official index.

Table 6. Original FEZ Readiness Assessment — Karakalpakstan

Readiness criterion	Current status	Score (1–5)	Priority for policy action
Legal/institutional foundation	Two active FEZs (Nukus, Karakalpak-agro) under national law; limited track record since 2019/2020	2	Medium
Autonomy–centre coordination	Constitutional autonomy exists but a dedicated FEZ coordination mechanism between Jokargy Kenes and national FEZ authorities is not evident in public sources	2	High
Environmental resilience baseline	Active desertification and salinization continuing to erode the resource base	1	Highest

Readiness criterion	Current status	Score (1–5)	Priority for policy action
	(Micklin, 2007; Bartrem et al., 2025)		
Social inclusion / poverty	Multidimensional poverty 29.9%, the highest of any region; monetary poverty declining (10.8%)	2	High
Infrastructure/connectivity	Amu Darya corridor and rail access exist but lag Navoi's airport-logistics hub	2	Medium
Investment momentum	US$2.1bn regional investment target announced (2024); Karakalpak-agro greenhouse/hydroponics program underway	3	Maintain

Table 6. Compiled by the authors using the 5D-SFDM criteria.

The composite pattern in Tables 5 and 6 supports the model's central prediction: Karakalpakstan's Environmental Resilience score (1) is the lowest of any case in the sample, and its Economic, Institutional, and Social scores cluster at the next lowest band (2), consistent with the 5D-SFDM's claim that a weak environmental precondition caps achievable performance in the other dimensions rather than operating independently of them.

5. Conditions Required for Successful Replication

Key Success Factors

Despite the notable benefits FEZs can provide, investors must overcome existing obstacles to fully capitalize on their advantages for national and regional development. For FEZs to realize their potential as effective vehicles for economic development, governments should focus on building infrastructure, reducing bureaucratic red tape, and improving access to capital and financing, in addition

to expanding market access and pursuing the following priorities (Aggarwal, 2012):

- Environmental mitigation and sustainability, and health and social services programs;
- Education and skills development programs;
- Research and development opportunities;
- Community engagement; and
- Cultural competency within the international community.

6. Conclusion

Answer to the Research Question

The factors discussed above combine to create new opportunities for a more comprehensive and effective use of FEZs for economic development in Karakalpakstan. Through the integration of new investment opportunities focused on employment and training for skilled labor, alongside a greater presence of national organizations in the international market, FEZs can support the creation of resilient societies, improved living standards, and progress toward long-term national development goals.

Final Proposal

Thus, while adaptation is possible, the success of the FEZ in Karakalpakstan will depend on a holistic strategy that combines economic incentives with social, environmental, and political considerations to ensure long-term benefits for both investors and local communities.

The Proposed 5D Sustainable FEZ Development Model

This paper's central scientific contribution is the 5D-SFDM, which re-specifies environmental resilience as a moderating precondition rather than a parallel success factor in ecologically fragile FEZ contexts. The evaluation framework built on this model (Tables 5–6) provides the first — to the authors' knowledge — systematic, criterion-based readiness assessment of Karakalpakstan's FEZs against both domestic (Navoi, Angren) and international (Kazakhstan, Azerbaijan, Georgia, South Korea) comparators.

Policy Implications

For Uzbekistan nationally, the analysis suggests that Karakalpakstan should not be evaluated by the same investment-attraction metrics used for Navoi, since it is at a structurally earlier institutional stage (2017/2019/2020 vs. 2008); premature benchmarking risks discouraging continued investment in a zone that needs a longer runway. **For Karakalpakstan specifically,** the readiness assessment (Table 6) indicates that environmental-resilience

investment (water efficiency, land rehabilitation) should precede or accompany, rather than follow, further economic incentive expansion, and that a formal autonomy–centre coordination mechanism for FEZ governance would address the institutional gap identified in Table 6.

Theoretical Contribution to the FEZ Literature

By treating environmental resilience as a moderator rather than a parallel factor, this paper offers a testable refinement to existing SEZ success-factor frameworks (Aggarwal, 2012; UNCTAD, 2019) that is potentially transferable to other ecologically stressed regions pursuing SEZ-based development (e.g., other Aral-basin districts, or delta and drought-prone regions elsewhere).

Limitations

As set out in the Methodology section, the evaluation scores in Tables 5–6 are a structured qualitative synthesis rather than an externally audited index; cross-country source data are not fully time-aligned; and Karakalpakstan's FEZs are too young to support retrospective performance comparison with Navoi. These limitations should be read as boundaries on the scope of the paper's claims, not as weaknesses that undermine the core argument.

Future Research Directions

- Longitudinal tracking of Nukus and Karakalpak-agro FEZ performance indicators once a multi-year time series becomes available (post-2025).
- Primary data collection (investor and household surveys) to validate the ordinal 5D-SFDM scores against firm-level and community-level evidence.
- Application of the 5D-SFDM to other ecologically fragile SEZ contexts to test the generalizability of the environmental-precondition hypothesis.

Formal econometric modeling of the relationship between environmental-resilience investment and FEZ economic performance, once sufficient panel data exist.

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