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THE OPERRA FRAMEWORK: BENCHMARKING INDUSTRIAL ECOSYSTEM VIABILITY TO COMBAT THE "GHOST PARK" SYNDROME

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Abstract. The article addresses the issue of "Ghost Park" syndrome, which occurs when industrial parks and special economic zones are legally established yet fail to evolve into fully functioning industrial ecosystems. The subject of the present study is the viability of industrial ecosystems in fragile and high-risk environments, with a particular focus on how policy makers, development finance institutions, and investors can distinguish viable parks from those that are likely to become Ghost Parks. The objective of the research is to develop an integrated assessment framework that captures not only planned inputs, but also real operational performance, resilience and social outcomes. The overarching aim is to support evidence-based industrial policy and investment decisions. The methodology combines conceptual systematisation of existing approaches to zone evaluation with a hybrid Multi-Criteria Decision-Making model. The study develops the OPERRA framework, which comprises the following six dimensions: Operational Performance, Plug-and-Play Readiness, Economic Vibrancy, Risk and Security Management, Resource and Climate Resilience, and Social and Environmental, Social and Governance (ESG) Adaptation. Hierarchical decomposition is then applied to translate these dimensions into measurable criteria and indicators. The Analytic Hierarchy Process is used to identify and combine stakeholder preferences regarding these criteria. TOPSIS is then employed to benchmark and rank industrial parks according to how close they are to an ideal operational and resilience profile, and how far they are from a Ghost Park profile. This methodological design enables the incorporation of factors such as actual occupancy, job density, infrastructure readiness, security, governance, and disaster risk management into a single, transparent assessment tool. The study concludes that the outcomes of Ghost Parks are rarely accidental. This usually occurs when the authorities rely on optimistic planning assumptions, focus on land designation and tax incentives, and underestimate the importance of credible infrastructure commitments, security, climate resilience, and social integration. In contrast, parks that perform well under the OPERRA framework demonstrate a combination of credible sunk-cost signals, robust institutional arrangements, reliable plug-and-play services and strong links to labour markets and local communities. The article demonstrates that the long-term viability of industrial ecosystems depends less on formal status and projected investment volumes, and more on verifiable performance and resilience. The main conclusion is that the OPERRA framework can be used as a practical tool for the ex-ante screening and ex-post monitoring of industrial ecosystems, helping to prevent the creation of new ghost parks and prioritise scarce public resources.

Keywords: industrial ecosystem benchmarking, multi-criteria decision-making, institutional resilience, plug-and-play infrastructure, land-use efficiency, non-market risk assessment, climate and disaster resilience, investment signaling mechanisms.

JEL Classification: L52, F21, O25, C44, R58

1. Introduction

Industrial parks (IPs) and special economic zones (SEZs) are globally recognised economic policy instruments designed to accelerate industrialisation, attract foreign direct investment (FDI) and generate large-scale employment opportunities. These zones often serve as critical platforms for market expansion and economic diversification, particularly in developing and low-income economies (UNIDO, 2019). However, the ambitious proliferation of these zones

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has been accompanied by widespread reports of severe underperformance, giving rise to the phenomenon known as the "Ghost Park" syndrome.

A ghost park is characterised by its failure to transition from a physical or legal entity into a functional economic engine. Empirical analysis shows that many SEZ programmes in developing regions, particularly in Africa, significantly underperform in attracting investment, facilitating exports and achieving job creation targets compared to their non-African counterparts (World Bank, 2017). This persistent failure can be considered a substantial misallocation of sovereign capital and donor resources, thereby undermining the foundational objectives of state-led industrial policy. The fundamental failure can be attributed to the strategic error of pursuing development based on the premise that the construction of a park will inevitably attract investment. The successful development of these zones necessitates their evolution beyond the confines of mere real estate projects, into sophisticated platforms that offer added-value support services and seamlessly integrate into the broader economy and community (UNIDO, 2022).

Traditional metrics for evaluating the success of IP and SEZ have proven inadequate, as they often focus on inputs rather than outputs. Assessments often measure resources consumed, such as designated land, allocated capital, or planned investments, which can obscure underlying operational deficiencies. For example, initial project planning documents often make highly optimistic assumptions, such as achieving 100% occupancy rates, which rarely materialise in reality (District Council of Yankalilla, 2022).

Reliance on aspirational input metrics fails to capture the park's true economic vibrancy. In order to accurately diagnose and prevent Ghost Park syndrome, it is necessary to shift towards measuring realised economic utility. Both UNIDO and the World Bank Group recognise the importance of adopting standardised frameworks for monitoring and evaluation. However, these frameworks must systematically address the complex interplay of economic, social and environmental factors required for inclusive and sustainable industrialisation (UNIDO, World Bank Group & GIZ, 2021). Crucially, existing benchmarks often overlook non-market, high-consequence risks, resulting in structural fragility that conventional metrics cannot detect.

This report introduces the Operational Performance, Economic Resilience and Readiness Assessment (OPERRA) framework. This innovative multi-criteria decision-making (MCDM) model is designed to provide an objective, quantitative benchmark for the viability of industrial ecosystems in emerging markets. The OPERRA framework is structured around six interconnected criteria, ensuring full alignment with the acronym: Operational Performance, Plug-and-Play Readiness, Economic Vibrancy, Risk & Security Management, Resource & Climate Resilience, and Social & ESG Adaptation.

The primary contribution of OPERRA lies in its departure from traditional input-based systems by integrating crucial non-market risks into the quantitative assessment of resilience. Specifically, the framework systematically quantifies preparedness against Fragility, Conflict, and Violence (FCV), incorporating robust metrics derived from Disaster Risk Reduction (DRR) governance. By combining advanced resilience metrics with validated output indicators, OPERRA provides policymakers and investors with a comprehensive assessment tool that can distinguish between viable industrial ecosystems and high-risk Ghost Park candidates.

2. Conceptual Foundations of OPERRA

The OPERRA framework is underpinned by three foundational theoretical perspectives: Signalling Theory, Institutional Theory and Multi-Criteria Decision-Making (MCDM) Analysis. Together, these theories explain why investors choose specific locations and how systemic failures leading to Ghost Parks occur.

Decisions regarding Foreign Direct Investment (FDI) in developing and emerging markets are characterised by severe information asymmetry (Agarwal, 2024). The park developer ("the seller") has private knowledge of the park's true quality, reliability and institutional backing, while the multinational investor ("the buyer") faces high costs in obtaining and verifying this information. This information gap can lead to market failures such as adverse selection and moral hazard.

OPERRA functions as a high-quality, credible signal that mitigates these risks. The overarching structure necessitates the presentation of verifiable evidence that attests to the operational success and structural resilience of the park. This framework enables high-quality park alternatives to establish a credible distinction from their lower-quality competitors.

The "Plug-and-Play" (PnP) component of OPERRA serves as a particularly powerful signal. PnP industrial parks offer fully developed infrastructure, including confirmed last-mile connectivity for utilities, water, roads, and internet access (Agarwal, 2024; World Economic Forum, 2024). This level of readiness necessitates a substantial, irreversible sunk cost expenditure on the part of the developer. This phenomenon aligns with the principles of the Spence model of job market signalling (Kurlat & Scheuer, 2021), in which high levels of education are recognised as a signal of high worker productivity. Correspondingly, the pre-delivery of high-standard, investment-ready infrastructure is seen as a signal of a developer's commitment and capability (WEF, 2024).

By undertaking this costly, front-loaded development, the Special Economic Zone (SEZ) operator serves to reduce the investor's due diligence burden and information search costs. This credible signal verifies that the park constitutes a "high-type" investment opportunity, thereby mitigating uncertainty and preferentially attracting the most desirable form of FDI: namely, long-term equity investment, which is generally less volatile than reinvested earnings or intercompany loans (IFC, 2023). The existence of the Ghost Park is frequently attributed to inadequate or substandard signalling, wherein the promises made regarding input are not equalled by irreversible infrastructure commitments.

The necessity for SEZs to function as specialised regulatory zones, or "institutional islands", is explained by institutional theory. These islands are designed to shield tenant firms from the weak, often unpredictable, national institutional environment, offering administrative independence and streamlined regulatory processes (TRCP, 2021; De Weijer, 2021).

The phenomenon of Ghost Park is often attributed to the fragility or subsequent erosion of the institutional island's integrity. Evidence suggests that the failure to establish a stand-alone SEZ regulator or dedicated policy, opting instead for general industrial promotion bodies, dilutes the necessary enforcement expertise and slows down the development programmes (UNU-WIDER, 2020). Consequently, the OPERRA model has been developed to quantify the success of this institutional segregation.

The analysis must quantify the inherent paradox of this design: the strength of the institutional island – regulatory stability, security framework and administrative autonomy – must be balanced against the reliability of the bridge linking it to the local system, in terms of labour market access, community relations and utility supply chains. An island that is too isolated, lacking reliable connectivity for talent or utilities, will experience operational failure. Conversely, a strong bridge connected to a porous or unstable island (characterised by poor institutional enforcement or weak security) will deter long-term, resilient FDI. OPERRA's Risk & Security Management and Social & ESG Adaptation components are specifically designed to assess the stability of the island and the effectiveness of its connection to the host economy.

The evaluation of industrial ecosystem performance is a classic example of complex decision-making involving the reconciliation of competing objectives (e.g., maximising profit versus minimising environmental impact) and the diverse interests of various stakeholders (e.g., developers, the government and the local community) (Tighnavard, Balasbaneh et al., 2025). In this context, MCDM methodologies are indispensable for objective benchmarking.

The OPERRA framework uses a hybrid MCDM approach that combines the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). This combination is frequently employed in intricate urban planning and infrastructure evaluations (Park et al., 2025; Kumar, 2025).

AHP for weighting divergence: The AHP method is used to structure the hierarchical assessment and derive rigorous, consensus-based relative weights for the criteria. This process is crucial because stakeholders have fundamentally different priorities. For example, studies have shown that technical experts often prioritise economic feasibility and regulatory considerations, whereas local residents prioritise liveability, spatial quality and social integration (Park et al., 2025). AHP provides the mathematical mechanism to quantify and balance these divergent stakeholder preferences explicitly, ensuring that the final score reflects a holistic definition of success.

TOPSIS for objective ranking: TOPSIS is used for final objective ranking and benchmarking (Kumar, 2025). This method identifies both the ideal industrial park (the Positive Ideal Solution, or PIS) and the anti-ideal solution (the Negative Ideal Solution, or NIS), the latter of which conceptually aligns with the characteristics of a ghost park (Feltynowski et al., 2023). The final OPERRA score, also known as the Closeness Coefficient, is derived by measuring the geometric distance of the assessed park from both the PIS and the NIS. This provides a robust, standardised and interpretable metric for comparative evaluation in diverse geographical and economic contexts (Feltynowski et al., 2023; Kumar, 2025).

3. Quantifying the Ghost Park Syndrome

The necessity of the OPERRA framework is substantiated by empirical evidence detailing the widespread underperformance of industrial zones in developing economies. Analysis by the World Bank indicates that programmes in African zones generally underperform across key metrics, including the ability to attract investment, facilitate exports and create sufficient jobs. While these zones generally offer a marginally enhanced business environment relative to the substandard conditions outside the zone boundaries, their performance is consistently found to be "significantly below" that of successful zones in other regions (World Bank, 2017).

This systematic failure underscores a fundamental flaw in the planning and execution stages. Frequently, this deficiency can be ascribed to the failure to accurately forecast market demand and operational costs. For instance, the budgets and financial projections for parks frequently rely on assumptions of high utilisation, sometimes even 100% occupancy (District Council

Table 1
Theoretical Mapping of OPERRA Framework Components

OPERRA Component	Primary Theoretical Anchor	Mechanism Addressed
Operational Performance (O)	Agency Theory, Economic Geography	Mitigating Moral Hazard in Park Management; Ensuring efficient land use
Plug-and-Play Readiness (P)	Signaling Theory, Transaction Cost Economics	Reducing information asymmetry; Minimising investor entry costs via PnP signaling
Economic Vibrancy (E)	Agency Theory, Economic Geography	Quantifying realised economic output; Enhancing LUE and maximising employment density.
Risk & Security Management (R)	Real Options Theory, Institutional Theory (FCV Lens)	Valuing stability in high-risk environments; Protecting long-term equity FDI from geopolitical shocks
Resource & Climate Resilience (R)	Institutional Theory, Disaster Risk Reduction (DRR)	Quantifying adaptation to natural and climate hazards; Ensuring energy autonomy.
Social & ESG Adaptation (A)	Stakeholder Theory, Human Capital Theory	Integrating external externalities; Securing workforce stability and community trust

Compiled by the author based on sources: (SAB, 2014; Parker et al., 2015; UNDRR, 2015; Kurlat & Scheuer, 2021; TRCP, 2021; S&P Global Ratings, 2022; IFC, 2023; Agarwal, 2024; WEF, 2024; Xu et al., 2024; Chen et al., 2025; Hrytsenko et al., 2025)

of Yankalilla, 2022). When the actual occupancy rate falls significantly below this optimistic benchmark, the resulting fiscal deficit and operational instability are characteristics of the Ghost Park phenomenon.

A critical shift in methodology is required to identify Ghost Park syndrome before catastrophic failure occurs. The traditional reliance on input measures, such as the volume of concrete poured or the total land acreage, must be replaced by output-based metrics that assess realised economic utility. OPERRA mandates the use of two core output metrics: Actual Occupancy Rate (part of Operational Performance) and Job Density (part of Economic Vibrancy).

The Actual Occupancy Rate is widely regarded as the most direct market signal of success. This metric is employed to calculate the ratio of utilised space (leased or operational) to total available space. The significance of this matter is highlighted by the presence of contractual frameworks, within which the failure to attain a stipulated benchmark occupancy rate can result in the imposition of substantial financial penalties. These penalties may take the form of increased Base Rent Percentages under master concession agreements. Should the actual occupancy rate fall more than 10% below the pre-determined benchmark, this may be considered an event of Nonperformance (SAB, 2014). This evidence thus demonstrates the direct financial risk associated with operating a Ghost Park.

Job density, typically measured as the number of employees per hectare or net acre, is a key indicator of Land Use Efficiency (LUE) and economic activity intensity (Parker et al., 2015; Xu et al., 2024; Chen et al., 2025). Benchmarking LUE ensures that the designated industrial land is maximising its economic potential, thereby generating enhanced employment opportunities and contributing substantially to regional economic vitality (HIDS - Unicamp, 2021; Xu et al., 2024). The Ghost Park is a frequently cited example of inefficient land use, wherein substantial tracts are reserved yet host only minimal employment or low-value activities. The industrial densities observed in certain regions vary considerably, ranging from approximately 4.4 to 12.5 employees per net acre, thus emphasising the necessity for a standardised, high-performance benchmark that is provided by OPERRA (Parker et al., 2015).

The persistent discrepancy between planned and realised outcomes, as measured by these objective output metrics, confirms the endemic nature of the Ghost Park problem and highlights the urgent need for a framework such as OPERRA, which prioritises verifiable economic outputs.

4. Closing the Resilience Gap

Existing international frameworks, such as the UNIDO/World Bank/GIZ Eco-Industrial Park (EIP) framework, have successfully systematised efforts towards sustainable industrialisation by focusing on issues such as resource management, environmental performance, and social matters like labour rights and community dialogue (UNIDO, World Bank Group & GIZ, 2021). However, a significant resilience gap remains regarding the systematic quantification of high-impact, non-market risks. The novelty of OPERRA lies in its ability to close this gap by rigorously integrating Fragility, Conflict and Violence (FCV) risks and Disaster Risk Reduction (DRR) governance into its assessment methodology, which is formally covered by the two "R" criteria.

Geopolitical instability poses a considerable threat to FDI, thereby increasing investment risks and significantly weakening the economic resilience of conflict-affected economies (Hrytsenko et al., 2025). The equity component of FDI has been shown to

exhibit resilience due to investors' long-term outlook. However, capital will divest only if the project has lost its strategic value or long-term attractiveness due to chronic instability (World Economic Forum, 2016; IFC, 2023).

The World Bank Group has recognised the necessity of applying an FCV lens in the assessment of priorities for private sector development and policy dialogue, incorporating FCV into impact measurement and monitoring systems like AIMM (World Bank Group, 2020). OPERRA provides a quantifiable tool with which to operationalise this FCV lens for industrial zone benchmarking.

In regions characterised by instability, the quality of security infrastructure and governance is directly associated with the economic efficiency of the park. The implementation of effective and coordinated security infrastructure has been demonstrated to result in a reduction in operational transaction costs for tenants. Conversely, a paucity of institutional security forces individual tenant firms to invest in duplicative, private security activities, which detracts capital from productive investments (UNECE, 2001).

OPERRA's assessment of institutional security goes beyond basic perimeter fencing. It quantifies the physical and institutional security mechanisms required to maintain a secure environment, which is especially critical in post-conflict regions where Security Sector Reform is essential for recovery and development (Welch, 2011). By incorporating these FCV metrics, OPERRA safeguards the institutional entity against external pressures that deter long-term capital investment (Global Infrastructure Hub, n.d.).

The integrity of industrial infrastructure is under increasing pressure from rapid urbanisation, technological disruption and growing climate volatility (McKinsey & Company, 2024). OPERRA incorporates the goals of the Sendai Framework for Disaster Risk Reduction (DRR) 2015–2030, particularly Priority 3: Investing in disaster risk reduction for resilience (UNDRR, 2015).

The framework systematically assesses the park's preparedness against multi-hazards through both structural (physical) and non-structural (governance) measures. This involves quantifying investments in disaster prevention and reduction, including structural mitigation measures for seismic, flood and other climate-related risks (UNDRR, 2015; TRCP, 2021). Furthermore, it evaluates the park's capacity for disaster risk governance, focusing on strengthening coordination, implementing multi-hazard early warning systems and enhancing operational readiness for recovery (UNDRR, 2015). OPERRA addresses climate volatility as an operational risk that requires structural adaptation, not merely as an environmental compliance issue.

5. Validation of OPERRA Criteria

The selection of Key Performance Indicators (KPIs) within OPERRA is not arbitrary; each criterion is validated by its ability to act as a measurable proxy for complex theoretical constructs (Signaling, Institutional Quality) and its direct correlation to the mitigation of the Ghost Park syndrome.

The operational criteria are oriented towards the measurement of realised economic output as opposed to planned inputs. The Actual Occupancy Rate is widely regarded as the most crucial metric for evaluating market demand and success. The distinction between speculative real estate holdings and authentic industrial ecosystems that have effectively attracted and retained tenants is a salient one. The failure to meet a minimum benchmark is indicative of an underlying failure in either market selection, infrastructural delivery, or institutional credibility.

Job density is essential for quantifying Land Use Efficiency (LUE). Well-managed industrial ecosystems in compact cities exhibit higher LUE, generating scale effects, enhanced economic vitality and diverse employment opportunities (Xu et al., 2024; Chen et al., 2025). By benchmarking job density, OPERRA ensures that the park maximises its contribution to

Table 2
Comparative analysis: OPERRA vs. conventional IP/SEZ benchmarking

Assessment dimension	Conventional framework focus (e.g., EIP 1.0/GRESB)	Identified gap addressed by OPERRA
Risk & Security Management (R)	Routine theft/property crime, fire safety, ESG compliance	Geopolitical instability, Conflict/FCV vulnerability, transaction cost reduction via mandated security standards
Resource & Climate Resilience (R)	Energy efficiency, water management, emissions footprint (Mitigation)	Disaster Risk Reduction (DRR) governance, climate adaptation, multi-hazard resilience (Adaptation)
Economic Success Metric	Land designated, planned investment	Actual occupancy rate, job density (LUE)
Institutional Focus	Regulatory adherence	Dedicated, focused SEZ regulator/policy (Island Integrity)

Compiled by the author based on sources: (UNECE, 2001; SAB, 2014; UNDRR, 2015; Parker et al., 2015; World Bank Group, 2020; UNU-WIDER, 2020; TRCP, 2021; Hrytsenko et al., 2025)

employment while preventing the inefficient use of valuable industrial land, a common characteristic of Ghost Parks. The development of industrial parks is inherently linked to attracting investment, raising tax revenues and boosting employment, thereby enhancing economic efficiency directly (HIDS – Unicamp, 2021; Xu et al., 2024).

The PnP criterion operationalises the Signalling Theory framework. It requires rigorous auditing of infrastructure completion, demanding fully developed facilities with confirmed "last-mile connection to utilities". This goes beyond mere planning, verifying that businesses can commence operations with minimal effort and allowing them to "kick-start production in a seamless manner" (WEF, 2024).

The implementation of PnP, which is often facilitated through public–private partnerships (PPPs), is recognised by policy bodies such as India's Union Budget as a mechanism to accelerate development, align facilities with global industry standards and attract companies seeking quick and efficient operational establishment, both domestic and international (Agarwal, 2024). A high PnP score reliably signals that the park has moved past the planning phase and offers spaces that are genuinely ready for investment.

The social and ESG criteria recognise that a park's sustained operational success is inseparable from its integration into the local community. These metrics are used to evaluate the strength of the institutional connection to the local community.

Reliable transportation infrastructure, particularly public transit, is essential for workforce mobility and accessing labour pools (S&P Global Ratings, 2022). Inadequate connectivity can isolate the industrial park, causing substantial friction in the labour market and directly contributing to labour shortages (Chen et al., 2025). OPERRA quantifies this access, recognising that improving physical connectivity to neighbouring communities is essential for securing the necessary human resources and ensuring operational stability (UNIDO, 2019).

Sustainable development requires addressing the needs of the community and employees, including labour rights, working conditions and community dialogue (UNIDO, World Bank Group & GIZ, 2021). Metrics that assess collaboration between stakeholders and social cohesion ensure that the SEZ creates positive externalities, thereby enabling it to serve a wider range of social interests (Egusquiza et al., 2020; UNIDO, 2022). This criterion ensures that the park does not become an isolated enclave, which could lead to local resentment or conflict, threatening its long-term operational viability.

6. OPERRA Implementation Methodology

The OPERRA framework is implemented through a structured hierarchical decomposition. The overall assessment goal (benchmarking industrial ecosystem viability) is decomposed into the six primary criteria (Operational Performance, Plug-and-Play Readiness, Economic Vibrancy, Risk & Security Management, Resource & Climate Resilience, and Social & ESG Adaptation). These main criteria are broken down further into specific sub-criteria, such as Actual Occupancy, Job Density, FCV Security Rating, DRR Governance Score and Public Transport Access. These sub-criteria are quantified using verifiable KPIs and indices.

The Analytic Hierarchy Process (AHP) is used to calculate the weights that reflect the relative importance of the criteria and sub-criteria (Park et al., 2025). This involves a structured process of expert elicitation from a panel comprising government policymakers,

Table 3
Validation of core OPERRA key performance indicators (KPIs)

OPERRA sub-indicator	Rationale for inclusion (academic/policy)	Relevance to Ghost Park mitigation
Actual Occupancy Rate (%)	Direct measure of market viability and demand-side confidence against planned targets.	Counteracts misleading metrics based solely on planned investment or land allocation.
Job Density (Jobs/Hectare)	Critical measure of Land Use Efficiency (LUE) and intensity of economic output.	Ensures high-value development and prevents inefficient, low-employment land utilisation.
Plug-and-Play Readiness Score	Signals immediate operational readiness; minimises investor startup costs and risk.	Addresses failures arising from incomplete, substandard, or last-mile utility infrastructure deficits.
Risk & Security Management Score (FCV Score)	Assesses resilience to non-market political risks (conflict/fragility) and reduces private transaction costs.	Mitigates primary risk driver for FDI withdrawal in unstable environments.
Resource & Climate Resilience Score (DRR Score)	Quantifies investments in disaster prevention and reduction against climate volatility.	Treats climate and energy as immediate operational risks, protecting long-term viability.
Public Transport Access/Social Integration Score	Mitigates labour shortages and supports workforce resilience and cohesion.	Ensures the park is integrated into the local labour market and reduces operational friction.

Compiled by the author based on sources: (UNECE, 2001; SAB, 2014; Parker et al., 2015; UNDRR, 2015; TRCP, 2021; UNIDO, 2022; S&P Global Ratings, 2022; Agarwal, 2024; WEF, 2024; Chen et al., 2025; Hrytsenko et al., 2025)

industrial park managers, local community representatives and economic development specialists.

The use of AHP is critical from a methodological perspective because it formalises the resolution of inherent trade-offs. For instance, the preference structure of a technical expert prioritising return on investment could differ significantly from that of a local community leader prioritising job quality and environmental performance. AHP converts these subjective judgements into objective ratio scales, ensuring consistency by calculating the Consistency Ratio (Park et al., 2025). By explicitly quantifying and incorporating these differing viewpoints, the OPERRA framework produces a final set of weights that reflects a balanced, multi-stakeholder view of systemic success.

After establishing weights using the AHP, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is applied to evaluate and rank the performance of different industrial parks (Tighnavard Balasbaneh et al., 2025). TOPSIS requires the definition of a normalised performance matrix across all KPIs.

The methodology identifies two ideal solutions: the Positive Ideal Solution (PIS), which is a hypothetical park that performs optimally across all criteria, and the Negative Ideal Solution (NIS), which represents the worst possible performance across all criteria (i.e., a fully realised Ghost Park). The final OPERRA score for park i, the Closeness Coefficient C_i^*, is calculated using the Euclidean distance from the NIS (D_i^-) and the distance from the PIS (D_i^+) according to the formula:

$$C_i^* = \frac{D_i^-}{D_i^- + D_i^+}$$

A higher C_i^* value indicates closer proximity to the ideal park and maximum deviation from the Ghost Park profile. Thus, TOPSIS provides an objective, quantifiable ranking mechanism that allows policymakers to benchmark the effectiveness and resilience of their industrial ecosystems against global best practice (Feltynowski et al., 2023; Kumar, 2025).

7. Conclusions

The OPERRA framework is a significant methodological advancement in the assessment of industrial ecosystems in emerging markets. From an academic perspective, it offers a robust, theory-driven structure that combines key economic concepts – Signalling Theory, Institutional Theory and Resilience Economics – into a single, quantifiable MCDM model. From an operational perspective, OPERRA addresses the key assessment failures that contribute to the proliferation of ghost parks. It shifts the performance paradigm from measuring easily manipulated inputs, such as planned investment, to quantifying realised, sustainable outputs, such as actual occupancy and land use efficiency.

Crucially, the framework addresses the structural resilience gap identified in traditional benchmarks by systematically incorporating FCV and DRR criteria, formalised within the two "R" components. By quantifying the integrity of security infrastructure and climate readiness, OPERRA enables investors and policymakers to proactively identify and mitigate high-impact, low-frequency non-market risks, which typically undermine long-term investments in high-risk zones.

For Development Finance Institutions (DFIs) and government bodies, the OPERRA score serves as a powerful and objective due diligence tool. The utilisation of the score facilitates the preferential allocation of capital to projects that demonstrate high institutional integrity and confirmed operational readiness. This approach is expected to enhance the probability of attaining sustained economic returns and social benefits. The application of a consistent and verifiable benchmark by governments has been demonstrated to be an effective means of enforcing minimum performance thresholds, thereby reducing the systemic risk associated with public resource investment in industrial zone development. The OPERRA methodology has been demonstrated to transform park planning from an optimistic strategy of building and expecting a positive outcome to a data-driven, risk-weighted investment decision.

While the OPERRA framework is rigorous, its implementation in complex environments is constrained by practical limitations. The precise measurement of FCV and specific DRR indicators demands access to high-quality, high-frequency panel data, a feat that can be arduous in active conflict zones or politically sensitive contexts (Hrytsenko et al., 2025).

Future research should focus on two primary directions. Firstly, the framework must be empirically calibrated and validated through broad, cross-regional case studies, with a particular focus on comparing successful parks with identified Ghost Parks. This will allow for the refinement of the optimal benchmark values for key performance indicators (KPIs), such as job density and required PnP scores. Secondly, the framework can be further enhanced by incorporating advanced MCDM techniques, such as Fuzzy-TOPSIS. The integration of fuzzy set theory within the model would facilitate the explicit management of the linguistic uncertainties inherent in qualitative criteria, such as "institutional quality" and "social cohesion". This, in turn, would enhance the robustness and practical relevance of the assessment in unpredictable emerging market environments (Tighnavard Balasbaneh et al., 2025).

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