

Decentralized Governance in Industrial Estates: The Role of Internal Environmental Monitoring Units

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Abstract

The rapid concentration of manufacturing activities within centralized industrial zones yields critical macroeconomic advantages but escalates localized environmental degradation. Under the Indonesian regulatory framework, tenants operating inside industrial estates are legally mandated to execute a site-specific Environmental Management and Monitoring Plan. In practice, structural enforcement gaps within public environmental agencies necessitate an intermediary layer of internal oversight. This study empirically examines the operational role of the Environmental Monitoring Unit at PT Surabaya Industrial Estate Rungkut (SIER) and its association with tenant compliance. Employing a quantitative survey methodology with 40 operational tenants ($N = 40$), primary data were analyzed through descriptive statistics, classical assumption verification, and simple linear regression modeling. Descriptive indices reveal that the monitoring unit's operational role is perceived as high (mean = 4.18), while the overall effectiveness of environmental implementation is exceptionally high (mean = 4.45). Inferential modeling confirms that the monitoring unit exerts a statistically significant positive association with implementation quality ($Y = 23.237 + 0.520X$; $p = 0.000$), accounting for 41.5% of compliance variance. Grounded conceptually in systems ecology, this paper explores how internal monitoring units can function as regulatory feedback loops. Future studies are encouraged to utilize larger samples and actual pollutant reduction data to validate these findings.

Keywords

Detailed RKL-RPL, Environmental Compliance, Environmental Monitoring Unit, Simple Linear Regression, Systems Ecology, Techno-Ecosystem

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1. INTRODUCTION

Industrial estates concentrate production activities, logistics, utilities, and environmental burdens within a defined area. Although such concentration can improve infrastructure efficiency, it can also generate cumulative environmental risks that cannot be adequately understood solely at the level of individual tenants. Consequently, international research on eco-industrial parks regards estate management as both an institutional and a technical issue, in which environmental performance depends on coordinated infrastructure, systematic monitoring, stakeholder engagement, and continuous improvement (Al-Quradaghi et al., 2020; Maynard et al., 2020; Negesa et al., 2023; van Beers et al., 2020). Recent evidence further demonstrates that eco-industrial development can contribute to pollution reduction when effective governance, green investment, and technological upgrad-

ing are implemented synergistically rather than as isolated interventions (Dong et al., 2026; Song and Zhou, 2021).

This institutional perspective is consistent with environmental governance theory, which emphasizes the distribution of authority, accountability, coordination, and adaptive capacity across public and private actors (Bennett and Satterfield, 2018). In an industrial estate, the estate manager occupies a distinctive intermediary position. It supplies shared infrastructure and commercial services while also coordinating tenant compliance with estate-level environmental commitments. Studies of industrial parks have similarly highlighted the importance of internal self-regulation, networked actors, environmental performance indicators, and park-level management systems in translating broad sustainability objectives into operational routines (Huang et al., 2019; Lei and Wei, 2023; Xu et al., 2023).

The Indonesian context makes this intermediary role particularly consequential. Government Regulation No. 22 of 2021 establishes the contemporary framework for environmental protection and management, while Regulation of the Minister of Industry No. 2 of 2026 provides procedures for the preparation and approval of the Detailed Environmental Management and Monitoring Plan, hereafter Detailed RKL-RPL, for business activities located in industrial estates. Under this arrangement, the Detailed RKL-RPL translates the estate's macro-level environmental commitments into site-specific management and monitoring obligations for each tenant. Indonesian studies have shown that industrial-estate environmental performance depends on the quality of estate management, wastewater control, institutional coordination, and the consistency of company-level management and monitoring practices (Panjaitan et al., 2023; Wikaningrum and Hakiki, 2019). More broadly, recent regulatory analysis in Indonesia underscores the need to maintain environmental safeguards while simplifying investment and licensing processes (Hadi et al., 2023).

Formal requirements, however, do not necessarily translate into substantive environmental performance. Manufacturing firms respond to a combination of regulatory pressures, operational capabilities, financial constraints, information disclosure, market demands, and internal environmental management practices. Empirical research in emerging economies indicates that coercive and other forms of institutional pressure can improve environmental outcomes by encouraging the adoption of effective environmental management practices, rather than through regulatory pressure alone (Ngo, 2023). Other studies have demonstrated that the effects of environmental regulation vary according to firm size, regulatory instruments, technological capabilities, and compliance costs (Chen et al., 2022; Liu et al., 2022; Mu et al., 2022; Tang et al., 2023). These findings suggest that environmental monitoring should not be regarded solely as a punitive mechanism but should instead incorporate surveillance, technical guidance, verification, and corrective actions.

This broader literature also helps explain why an internal environmental monitoring unit may matter in an estate setting. Stronger monitoring increases the probability that departures from environmental requirements are detected, while technical verification reduces information asymmetry between the estate manager and tenants. At the same time, regulation can impose material compliance costs and investment demands, particularly for smaller or resource-constrained firms (Ou and Jiang, 2023; Qi et al., 2022; Zhang et al., 2022). Environmental information disclosure and green innovation can improve sustainability performance, but the effect depends on organizational capacity and financing conditions (Ding et al., 2022; Wang and Yan, 2022). At the industry level, appropriate regulatory intensity and pollution-control capability are also associated with environmental efficiency and green productivity (Tu

et al., 2022; Wang et al., 2022).

PT Surabaya Industrial Estate Rungkut (SIER) offers a useful setting to examine this governance mechanism because the estate combines heterogeneous manufacturing tenants, centralized environmental infrastructure, and an internal monitoring function. The Environmental Monitoring Unit performs preventive education, technical monitoring, field verification, and follow-up enforcement. These functions can be interpreted as a feedback system: environmental conditions and tenant practices are observed, deviations are identified, corrective information is returned to the regulated unit, and follow-up actions are expected to reduce the probability of repeated non-compliance. This feedback logic is compatible with recent industrial-park research that emphasizes measurable environmental performance, internal coordination, and evidence-based pollution-source management (Bai et al., 2023; Negesa et al., 2023).

Despite this practical importance, three gaps remain. First, much of the environmental-compliance literature examines government regulation of stand-alone firms, whereas fewer studies evaluate the internal monitoring architecture of an industrial-estate manager. Second, studies of eco-industrial parks often focus on resource efficiency, industrial symbiosis, or aggregate environmental performance, while the implementation of tenant-specific Detailed RKL-RPL obligations remains underexplored. Third, there is limited empirical evidence linking the perceived operational performance of an internal monitoring unit to the quality of Detailed RKL-RPL implementation while also examining concrete field indicators such as effluent quality, reporting accuracy, corrective-action closure, and emergency preparedness. The present study addresses these gaps by treating the estate manager as a regulatory intermediary rather than merely an infrastructure provider.

Accordingly, this study has three objectives: (1) to assess the operational performance of the PT SIER Environmental Monitoring Unit across education and socialization, technical monitoring, field supervision and verification, and enforcement functions; (2) to assess the level of Detailed RKL-RPL implementation among eligible tenants across environmental-quality compliance, semester reporting, and operation of pollution-control equipment; and (3) to examine the statistical association between the monitoring-unit role and Detailed RKL-RPL implementation. The study also interprets the results against recent evidence on environmental governance, regulatory heterogeneity, and industrial-estate management. Its contribution lies in connecting estate-level internal oversight with a site-specific Indonesian environmental-management instrument and in distinguishing the variance explained by the regression model from operational factors that were observed descriptively but not statistically partitioned.

2. EXPERIMENTAL SECTION

2.1 Study Design, Setting, and Sampling

The study used a quantitative cross-sectional design at PT Surabaya Industrial Estate Rungkut (SIER), East Java, Indonesia. Data collection was conducted in April-May 2026. The unit of analysis was the tenant company, while the respondent within each company was the person directly responsible for environmental management, such as an HSE manager, environmental staff member, or plant manager. The analysis focused on tenants for which the Environmental Monitoring Unit had an operational oversight relationship and for which Detailed RKL-RPL implementation could be assessed. Sampling followed an eligibility-screening procedure and then total sampling of the eligible group. The estate contained 355 active tenants. Of these, 160 had a Detailed RKL-RPL document. A further eligibility criterion required consistent submission of semesterly Detailed RKL-RPL implementation reports to the estate manager. Forty tenants met all inclusion criteria, and all 40 were included in the survey ($N = 40$). This procedure is more accurately described as purposive eligibility screening followed by a census of the eligible subgroup, rather than stratified random sampling. The design therefore supports inference to the observed eligible subgroup, not to all 355 active tenants without qualification. The sampling flow and final analytical sample are summarized in Table 1.

Table 1 clarifies the sampling frame and avoids characterizing the 40 cases as a stratified random sample. The inferential results therefore apply directly to the eligible subgroup that met the reporting criterion.

2.2 Variables, Instrument, and Data Sources

Primary data were collected using a structured five-point Likert questionnaire and were supplemented by field observations and estate environmental records used for descriptive triangulation. The independent variable, the role of the Environmental Monitoring Unit (X), was operationalized through 20 items grouped into four dimensions: X_1 education and socialization, X_2 technical monitoring, X_3 field supervision and verification, and X_4 enforcement and sanctions. The dependent variable, effectiveness of Detailed RKL-RPL implementation (Y), was measured with 15 items grouped into three dimensions: Y_1 compliance with environmental quality standards, Y_2 discipline of semester reporting, and Y_3 consistency in operating pollution-control equipment. The operationalization mirrors the actual oversight sequence from preventive guidance and monitoring to verification and corrective follow-up.

Instrument validity was evaluated using Pearson product-moment item-total correlations with a critical r value of 0.312 at the 5% significance level for $N = 40$. For variable X , observed item correlations ranged from 0.316 to 0.695; for variable Y , they ranged from 0.518 to 0.869. All retained items therefore exceeded the critical value. Internal consistency was high, with Cronbach's alpha of 0.880 for X

and 0.946 for Y . Table 2 summarizes the dimensions, item counts, and internal consistency of the two variables.

2.3 Data Analysis

Descriptive analysis used means and supporting secondary indicators. Mean scores were interpreted using five intervals: 1.00-1.80 very low, 1.81-2.60 low, 2.61-3.40 moderate, 3.41-4.20 high, and 4.21-5.00 very high. The relationship between X and Y was examined using simple linear regression, $Y = a + bX + e$. The slope coefficient was evaluated with a t test and model explanatory strength with R^2 . Because the design is cross-sectional and observational, the regression is interpreted as a statistically significant association and predictive relationship, not as proof of causality. No numerical decomposition of the unexplained variance was performed. Operational constraints found in secondary records are discussed descriptively and are not assigned percentages of residual variance.

3. RESULTS AND DISCUSSION

3.1 Performance of the Environmental Monitoring Unit

The Environmental Monitoring Unit obtained an overall mean of 4.18, placing its performance in the high category. Figure 1 shows that the four dimensions were relatively balanced, although the strongest score occurred in field supervision and verification ($X_3 = 4.26$, very high), followed by technical monitoring ($X_2 = 4.18$), education and socialization ($X_1 = 4.15$), and enforcement and sanctions ($X_4 = 4.13$). The pattern is important because it indicates that PT SIER's oversight strength lies more in technical presence and verification than in punitive escalation. The dimension means and their descriptive categories are summarized in Table 3.

Education and socialization (X_1) function as a preventive layer. The strongest item in this dimension reached 4.23 and reflected guidance-oriented communication. However, the secondary records indicate that normative understanding does not always translate into preparedness: only 15 of 40 tenants (37.5%) conducted an annual chemical or hazardous-waste spill emergency drill, and 12 tenants (30%) received field warnings related to administrative weaknesses at hazardous-waste temporary storage facilities. This gap suggests that one-way information transfer is insufficient when compliance requires practiced operational routines. The finding is consistent with research showing that environmental management practices, rather than institutional pressure alone, are the mechanism through which regulatory expectations become environmental performance (Ngo, 2023). It also supports industrial-park research that emphasizes internal coordination among multiple actors rather than relying on formal rules in isolation (Xu et al., 2023).

Technical monitoring (X_2) had a mean of 4.18. High-scoring items included pollution-load documentation (4.22) and effluent monitoring before discharge to centralized drain-

Table 1. Sampling Flow and Analytical Sample

Stage	Tenant Count	Analytical Meaning
Active tenants in PT SIER	355	General estate population
Tenants with approved Detailed RKL-RPL	160	Target group with the site-specific instrument
Tenants meeting consistent semester-report criterion	40	Eligible subgroup
Final survey sample	40	Total sampling of all eligible tenants

Table 2. Variable Dimensions and Instrument Reliability

Variable	Dimensions	Items	Cronbach's Alpha
Environmental Monitoring Unit (X)	Education and socialization; technical monitoring; field supervision and verification; enforcement and sanctions	20	0.880
Detailed RKL-RPL implementation (Y)	Environmental-quality standards; semester reporting discipline; pollution-control equipment operation	15	0.946

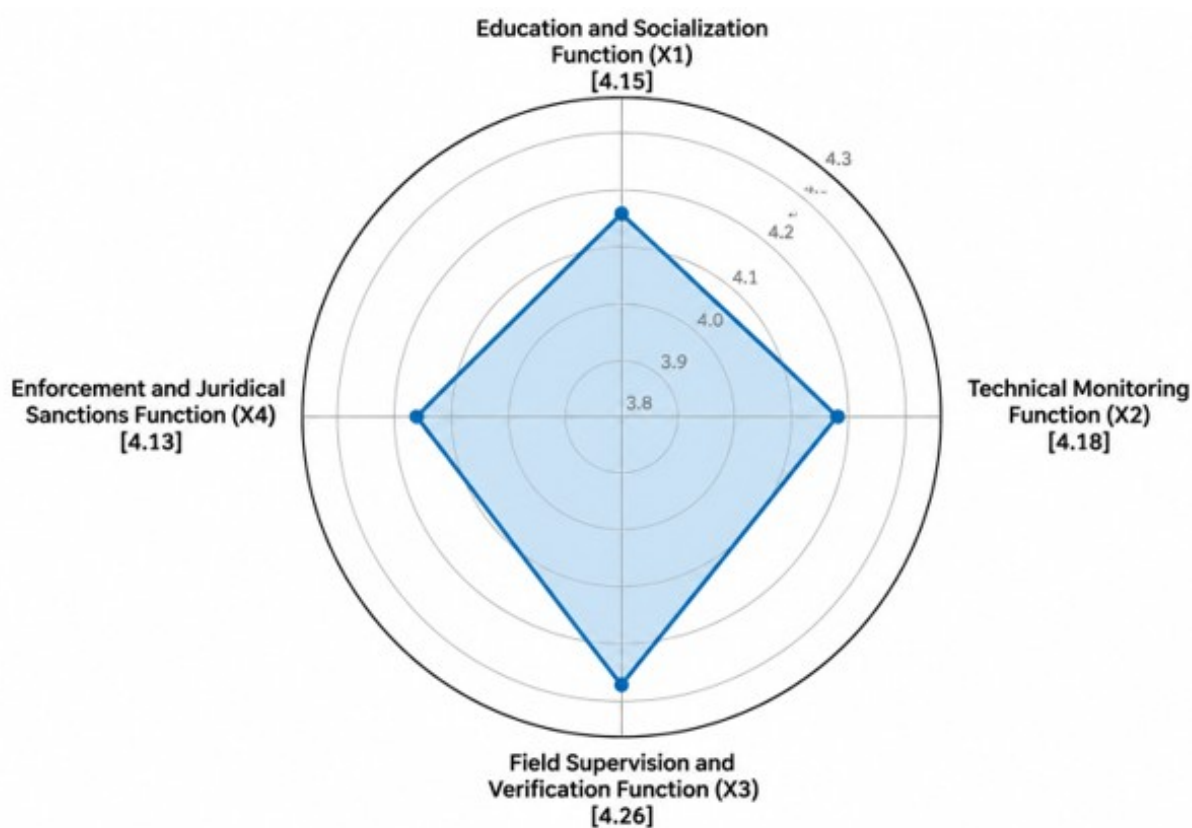
**Figure 1.** Performance of the Environmental Monitoring Unit by Dimension

Table 3. Environmental Monitoring Unit performance by Dimension

Dimension	Mean	Category
X_1 Education and socialization	4.15	High
X_2 Technical monitoring	4.18	High
X_3 Field supervision and verification	4.26	Very High
X_4 Enforcement and sanctions	4.13	High
Overall X	4.18	High

nage (4.20). Secondary environmental records supported the survey perception: average tenant effluent concentrations were BOD 35 mg/L and COD 80 mg/L for the observed sample, within the estate’s pre-treatment requirements. The substantive meaning of this dimension is that monitoring creates an evidence base for corrective action. Environmental regulation studies repeatedly show that implementation quality depends on the ability to observe environmental performance and to differentiate regulation by actual conditions rather than by formal status alone (Tang et al., 2023; Wang and Yan, 2022). In industrial parks, measurable performance indicators are likewise central to benchmarking and continuous improvement (Lei and Wei, 2023; van Beers et al., 2020).

Field supervision and verification (X_3) recorded the highest mean, 4.26. Communication of field findings to tenant management reached 4.43, while inspection of physical environmental facilities reached 4.27. Estate records also indicated 92% agreement between operational logbook data and semester reports when rechecked by internal auditors. These results illustrate how on-site verification reduces the distance between documentary compliance and operational reality. The governance implication is not that private oversight replaces public regulation, but that an estate-level intermediary can provide higher-frequency observation and earlier correction within the boundaries of delegated authority. This interpretation is aligned with the environmental-governance emphasis on fit, coordination, and accountability across actors (Bennett and Satterfield, 2018) and with international EIP frameworks that assign a central role to park management in coordinating environmental performance (Negesa et al., 2023).

Enforcement and sanctions (X_4) remained high at 4.13 but was the weakest of the four dimensions. The item concerning firmness of administrative sanctions for repeated violations scored 4.00. More importantly, secondary records showed a 60% close-loop rate for previous findings, implying that 40% of findings were repeated in the following semester, and corrective repair of damaged environmental facilities could require 12–15 days. These data explain why a relatively strong monitoring system can coexist with incomplete corrective closure. The constraint is partly institutional: the estate manager can issue written warnings and escalate cases, while heavier public-law sanctions remain within the

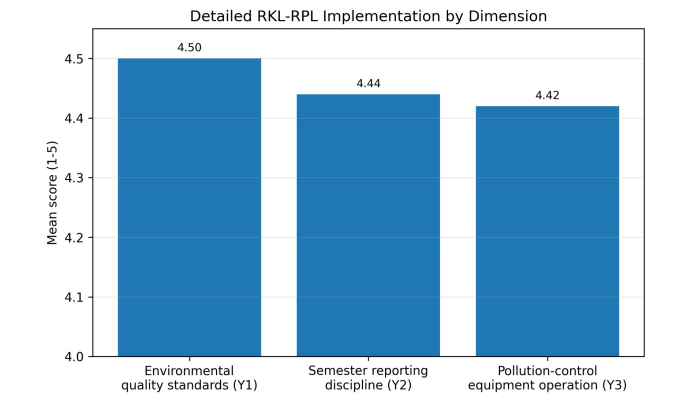


Figure 2. Detailed RKL-RPL Implementation by Dimension

authority of government environmental supervisors under the applicable regulatory framework. The result is compatible with broader evidence that command-and-control instruments can have heterogeneous effects when compliance costs, firm capacity, and enforcement arrangements differ (Chen et al., 2022; Mu et al., 2022; Ou and Jiang, 2023).

3.2 Detailed RKL-RPL Implementation by Tenants

The overall mean for Detailed RKL-RPL implementation was 4.45, classified as very high. The dimension pattern in Figure 2 shows environmental-quality compliance ($Y_1 = 4.50$), semester reporting discipline ($Y_2 = 4.44$), and consistency of pollution-control equipment operation ($Y_3 = 4.42$). The close range of these means indicates that implementation was not concentrated in a single administrative component. Nevertheless, the secondary records reveal important pockets of risk that would be obscured by the aggregate mean alone. Table 4 presents the mean scores and descriptive categories for the three implementation dimensions.

Table 4. Descriptive Results for Detailed RKL-RPL Implementation

Dimension	Mean	Category
Y_1 Environmental-quality standards	4.50	Very High
Y_2 Semester reporting discipline	4.44	Very High
Y_3 Pollution-control equipment operation	4.42	Very High
Overall Y	4.45	Very High

For Y_1 , compliance with environmental quality standards was supported by operational evidence. The questionnaire score for wastewater-quality compliance was 4.45, and the available estate records showed average BOD of 35 mg/L and COD of 80 mg/L in the observed tenant sample. Thirty-eight of 40 tenants (95%) met the applicable air-quality and noise criteria in the reviewed records, and all reviewed Certificates of Analysis were issued by accredited environmental laboratories. At the same time, hazardous-waste storage

remained a weaker point: the corresponding perception item scored 3.85 and 12 tenants received administrative warnings. This divergence is methodologically important because it shows why perception data should be read alongside records and inspections. Recent research on environmental information disclosure similarly finds that the quality of information and its connection with organizational processes matter for sustainability performance (Ding et al., 2022).

For Y_2 , semester reporting discipline was high but not flawless. Internal verification found 92% consistency between daily waste logbooks and semester reports. The average report was submitted eight days after the prescribed deadline, and document completeness against the required matrix averaged 78/100, with trend-evaluation fields frequently incomplete. The 60% close-loop rate was the most consequential weakness because reporting has limited environmental value if findings are documented but not resolved. This distinction between paper compliance and corrective completion is consistent with Indonesian evidence that environmental-management compliance varies across substantive and administrative components and requires sustained supervision (Panjaitan et al., 2023). It also reinforces the importance of environmental management systems that connect information, responsibility, and follow-up action (Wikaningrum and Hakiki, 2019).

For Y_3 , operation of pollution-control equipment was generally strong. Unannounced inspections in the reviewed 2025–2026 records found no illegal bypass line among the sampled tenants, routine preventive maintenance was commonly performed every three to four months, and field SOP audits reached 85% conformity. The principal vulnerability was response capacity when equipment failed: repairs could take 12–15 days because capital or operating expenditure often required approval from a tenant’s headquarters. Only 37.5% of tenants conducted annual spill-response drills. These observations show that very high average implementation can coexist with low-frequency but high-consequence weaknesses in emergency preparedness and financial responsiveness. Studies of environmental regulation and investment efficiency similarly show that compliance obligations interact with firm resources and investment constraints (Qi et al., 2022; Zhang et al., 2022).

3.3 Association Between Monitoring and Detailed RKL-RPL Implementation

Simple linear regression produced the equation $Y = 23.237 + 0.520X$. The slope was positive and statistically significant ($t = 5.195, p < 0.001$). Within the observed sample, a one-unit increase in the composite monitoring-unit score was associated with an estimated 0.520-unit increase in the composite Detailed RKL-RPL implementation score. Because both variables are bounded questionnaire composites and the observed data do not include $X = 0$, the intercept of 23.237 should be treated as a mathematical model constant rather than a meaningful estimate of implementation in the

complete absence of monitoring. The coefficient estimates and model statistics are presented in Table 5.

Table 5. Simple Linear Regression Results

Term/statistic	Estimate	<i>t</i>	<i>p</i>
Constant	23.237		
Monitoring-unit slope	0.520	5.195	< 0.001
R^2	0.415		

The coefficient of determination was $R^2 = 0.415$. Thus, 41.5% of the observed variance in Detailed RKL-RPL implementation was statistically explained by the linear relationship with the monitoring-unit score in this sample, while 58.5% remained unexplained by this one-predictor model. The unexplained portion cannot be divided into fixed shares for compliance cost, technical competency, production volatility, or any other factor without a separate multivariable analysis. Operational records point to plausible additional influences, including 12–15 day budget-related repair delays, the 40% recurrence of unresolved findings, and external market or certification pressures, but these observations are discussed qualitatively rather than presented as a statistical decomposition.

The size of R^2 is substantively meaningful for an institutional study because a single estate-level governance variable explains a substantial, but clearly incomplete, share of implementation differences. This is consistent with recent studies showing that environmental performance emerges from multiple pathways. Institutional pressure can operate through environmental management practices (Ngo, 2023), heterogeneous regulatory instruments can produce different outcomes across firms (Liu et al., 2022; Tang et al., 2023), and environmental regulation can generate both compliance costs and innovation responses (Mu et al., 2022; Zhang et al., 2022). The PT SIER result therefore supports a regulatory-intermediation interpretation: internal monitoring is an important part of the compliance architecture, but it does not subsume managerial finance, technical capacity, market pressure, or public enforcement.

The practical meaning of the positive slope is also visible in the dimension-level evidence. The strongest monitoring dimension, field supervision and verification, coincided with high reporting accuracy and strong operational control. Conversely, the weakest monitoring dimension, enforcement and sanctions, coincided with the 60% close-loop rate and repeated administrative findings. This correspondence does not establish causal mediation, but it provides a coherent operational explanation for why a stronger monitoring role is associated with better implementation. Similar international work shows that environmental regulation, technological innovation, and pollution-control capacity jointly shape industrial environmental efficiency rather than acting independently (Tu et al., 2022; Wang and Yan, 2022).

3.4 Comparative Discussion, Novelty, and Implications

The findings extend the eco-industrial park literature in three ways. First, prior work has demonstrated that park-level governance and management systems are essential to resource efficiency and environmental performance (Maynard et al., 2020; Song and Zhou, 2021; van Beers et al., 2020). The present study adds evidence at the tenant-compliance interface by showing how an internal monitoring unit is statistically associated with implementation of a tenant-specific environmental management instrument. Second, the study focuses on Detailed RKL-RPL, an Indonesian site-specific operational document, rather than on aggregate park sustainability indicators. Third, the combination of survey measures and operational records reveals the difference between high average compliance and specific weaknesses in hazardous-waste administration, corrective closure, repair response, and emergency drills.

The result is also compatible with international evidence that industrial-park transformation requires active park management and multiple interacting stakeholders. In Uganda, application of the international EIP framework identified management and institutional performance as central to park transformation (Negesa et al., 2023). Research on workplace sustainability in industrial parks likewise identifies internal self-regulation and external actors as complementary governance modes (Xu et al., 2023). The PT SIER case illustrates a comparable hybrid arrangement: the estate manager supplies high-frequency internal oversight, while public authorities retain formal coercive powers beyond the estate manager's mandate.

For PT SIER, the priority is therefore not simply to increase the number of inspections. The data indicate four more targeted actions. Education should shift from information delivery toward competency-based drills and corrective-action practice. Monitoring data should be linked to trend analysis so that repeated deviations are detected earlier. Corrective findings need explicit deadlines, ownership, and closure verification to raise the close-loop rate above the observed 60%. Finally, escalation protocols with public environmental supervisors should be standardized for repeated or material violations so that the institutional boundary between estate-level warnings and public-law sanctions does not produce avoidable enforcement delay. These recommendations are consistent with evidence that differentiated, credible regulation and organizational environmental practices are more effective than formal pressure alone (Chen et al., 2022; Ngo, 2023).

For tenants, the findings suggest that environmental compliance should be incorporated into routine capital planning, maintenance scheduling, and management review rather than handled as a semester-reporting exercise. The observed 12–15 day repair delay indicates that environmental equipment can become vulnerable when expenditure approval is disconnected from compliance risk. Likewise, the eight-day

average reporting delay and incomplete trend-analysis fields show that data governance requires attention even when laboratory compliance is strong. The literature on sustainability performance, environmental information disclosure, and environmental regulation supports this integrated view of operational capability, financing, and transparency (Ali et al., 2021; Ding et al., 2022; Ou and Jiang, 2023).

The environmental implication is that internal monitoring can act as an early-warning and feedback mechanism within a dense industrial system. Pollution-source analysis in chemical parks has shown the value of combining multiple evidence streams to identify and manage environmental pressures (Bai et al., 2023), while broader eco-industrial research links park development with measurable reductions in pollution and improved eco-efficiency (Dong et al., 2026; Lei and Wei, 2023). In PT SIER, the most defensible contribution is therefore not a claim that internal monitoring alone guarantees ecological sustainability, but that it provides an intermediary control layer capable of detecting deviations, verifying records, and accelerating corrective action before problems require higher-level public enforcement.

Several limitations qualify the interpretation. The sample comprises 40 tenants selected because they had Detailed RKL-RPL documents and consistently submitted semester reports. This eligibility criterion may select relatively organized or compliant firms and may therefore contribute to the very high Y mean. The study covers a single mature industrial estate and uses cross-sectional perception data, so the regression cannot establish temporal causality or generalize automatically to newer estates. Secondary operational indicators strengthen interpretation but were not modeled as independent predictors. Future studies should include non-reporting tenants, multiple industrial estates, longitudinal inspection data, and direct pollutant-load outcomes, and should test multivariable models that can separately estimate the contribution of technical capacity, financing, production intensity, and enforcement response.

4. CONCLUSIONS

The PT SIER Environmental Monitoring Unit demonstrated high performance, while tenant implementation of the Detailed RKL-RPL was very high. Stronger monitoring-unit performance was significantly associated with better implementation, supporting the role of internal estate-level oversight as an intermediary between site-specific environmental commitments and routine operational compliance. However, weaknesses in corrective-action closure and emergency preparedness indicate that high overall scores do not eliminate operational vulnerabilities. The main implication is that estate management should strengthen corrective follow-up, competency-based training, and coordinated escalation with public environmental authorities. These findings remain specific to the surveyed eligible tenants, and the cross-sectional design does not establish causality.

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