Platform-Enabled Horizontal Collaboration Strategy as a Strategy to Improve the Sustainable Logistics Performance of Logistics Companies

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ABSTRACT

The logistics sector in Indonesia faces high costs, infrastructure gaps, and turbulence from e-commerce growth and regulatory changes, especially in West Java, a key hub for third-party logistics providers. Digital transformation promises better efficiency, but many firms fail to convert digital tools into balanced sustainable performance across economic, environmental, and social dimensions. This study examines how logistics ecosystem turbulence and digital logistics agility affect sustainable logistics performance among third-party logistics firms in West Java. It also investigates the mediating roles of platform-enabled horizontal collaboration strategy, customer experience management, and competitive implementation through single and sequential paths. Data were collected via a cross-sectional survey from 312 valid respondents and analyzed using partial least squares structural equation modeling. Findings indicate that logistics ecosystem turbulence, platform-enabled horizontal collaboration strategy, customer experience management, and competitive implementation significantly and positively influence sustainable logistics performance. Digital logistics agility shows no direct effect. Mediation analysis reveals platform-enabled collaboration as a central link between turbulence/digital agility and sustainable outcomes, while customer experience management and competitive implementation are key mechanisms that turn collaboration into performance gains. Sequential mediation confirms sustainable results arise from interconnected steps: collaboration followed by customer focus and strong execution.

Keywords: *Competitive Implementation, Customer Experience Management, Digital Logistics Agility, Logistics Ecosystem Turbulence, Sustainable Logistics Performance.*

INTRODUCTION

The logistics industry plays a pivotal role in supporting economic growth, trade integration, and supply chain resilience. Increasing customer expectations, global competition, and sustainability pressures have transformed logistics operations, particularly for Third-Party Logistics (3PL) providers operating in complex supply chain networks (Carter & Rogers, 2008; Christopher, 2016). In emerging economies such as Indonesia, logistics performance is constrained by high logistics costs, infrastructure gaps, and fragmented regulatory frameworks. These challenges are especially evident in West Java, a major logistics and industrial hub, where intense freight movement and rapid e-commerce growth increase operational complexity (Christopher, 2022; Hadžikadunić et al., 2023). West Java hosts a significant portion of Indonesia's 3PL firms, with hundreds of companies active in freight forwarding, warehousing, and distribution, driven by its proximity to Jakarta and major manufacturing zones.

Digital transformation has been widely promoted as a key solution to logistics inefficiencies. Digital platforms, real-time tracking systems, and analytics are expected to

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enhance flexibility and responsiveness. Consequently, Digital Logistics Agility (DLA) has emerged as an important capability enabling firms to sense and respond rapidly to environmental changes (Overby et al., 2006; Teece, 2007). However, empirical evidence suggests that digital agility does not automatically translate into sustainable logistics performance. Many firms experience a disconnect between digital investments and long-term performance outcomes, particularly in environmental and social dimensions. This phenomenon reflects the digitalization paradox, where technological advancement fails to yield proportional productivity and sustainability gains (Brynjolfsson et al., 2017; Vial, 2021).

Despite growing interest in digital tools and collaboration in Indonesia's logistics sector, a clear research gap remains. According to Wibowo et al. (2024), while studies on supply chain collaboration exist in East Java contexts, limited empirical work examines how platform-enabled horizontal collaboration mediates the link between ecosystem turbulence, digital agility, and sustainable outcomes specifically among 3PL firms in West Java. Recent efforts, such as the National Logistics Ecosystem (NLE) platform, highlight government pushes for data sharing and collaboration, yet evidence on their translation into balanced economic, environmental, and social performance is scarce, especially under turbulent conditions like regulatory shifts and e-commerce volatility. This gap is notable because firm-level digital investments often fail without ecosystem-level orchestration, leaving questions about how turbulence drives or hinders sustainable logistics performance unanswered in Indonesia's context.

The limitations of digitalization are exacerbated by the increasingly turbulent nature of logistics environments. Logistics Ecosystem Turbulence (LET), characterized by regulatory uncertainty, technological change, and demand volatility, has become a structural condition rather than a temporary disruption (Jaworski & Kohli, 1993; Miller, 1993; Christopher, 2016). Under high levels of ecosystem turbulence, firm-level optimization alone is insufficient to sustain performance. Instead, firms are required to collaborate, coordinate resources, and align operations across organizational boundaries. Platform-enabled horizontal collaboration has therefore emerged as a strategic response to ecosystem-level complexity (Cruijssen et al., 2007; Parker et al., 2016). Nevertheless, collaboration and digital integration must be translated into customer value and executed consistently to generate sustainable outcomes. Customer Experience Management (CEM) and effective strategy execution, reflected in 3PL Competitive Implementation (3CI), are critical mechanisms through which collaboration and digital capabilities produce tangible performance results (Hrebiniak, 2006; Lemon & Verhoef, 2016).

This study aims to address the identified research gap by examining the effects of LET, DLA, Platform-Enabled Horizontal Collaboration Strategy (PE), CEM, and 3CI on Sustainable Logistics Performance (SLP) among 3PL firms in West Java, Indonesia. Specifically, the research investigates both direct effects and single as well as sequential mediation mechanisms to explain how environmental turbulence and digital capabilities are transformed into sustainable logistics outcomes. By doing so, the study seeks to provide clearer insights into why digital agility alone may not suffice and how collaborative and execution-oriented strategies can bridge this gap in an emerging economy setting like Indonesia.

LITERATURE REVIEW & HYPOTHESIS DEVELOPMENT

Logistics Ecosystem, Digital Logistics, and Sustainable Logistics Performance

Sustainable Logistics Performance (SLP) refers to a firm's ability to achieve balanced economic, environmental, and social outcomes. Unlike traditional logistics performance measures, SLP emphasizes long-term value creation and responsible resource utilization (Carter & Rogers, 2008; Ahi & Searcy, 2013; Rodrigues et al., 2025). According to Carter and Rogers (2008), sustainable supply chain management requires integrating these three dimensions to ensure long-term viability, which is particularly relevant in emerging markets where resource constraints and regulatory pressures are high.

Logistics Ecosystem Turbulence (LET) refers to the uncertainty and dynamism logistics firms face from rapid regulatory changes, technological advances, demand volatility, and complex inter-organizational relationships. Recognized as a structural feature of modern logistics, LET can increase operational risk and reduce performance stability but also drive adaptive and innovative strategies (Jaworski & Kohli, 1993; Miller, 1993; Wiredu et al., 2024). In contexts like Indonesia, infrastructure gaps and policy shifts heighten turbulence, encouraging firms to adopt more resilient practices and potentially boosting sustainable logistics performance (Hadžikadunić et al., 2023).

Digital Logistics Agility (DLA) is a firm's ability to leverage digital technologies to sense environmental changes and respond quickly and flexibly through sensing, decision-making, and operational reconfiguration using logistics platforms, real-time tracking, and data analytics. In the dynamic capabilities literature, DLA is seen as critical for organizational adaptability (Overby et al., 2006; Teece, 2007; Sinha & Ola, 2021; Quansah et al., 2022; Feng & Abd Rani, 2024). Although it can enhance operational responsiveness and efficiency, its direct impact on sustainable performance remains inconsistent due to fragmented digital systems, limited cross-organizational integration, and inward-focused optimization (Brynjolfsson et al., 2017; Vial, 2021). In emerging economies, digital tools improve flexibility but often require complementary strategies to be effective.

H1: Logistics ecosystem turbulence has a significant effect on sustainable logistics performance.
H2: Digital logistics agility has a significant effect on sustainable logistics performance.

Factors Influencing Sustainable Logistics Performance

Platform-Enabled Horizontal Collaboration Strategy (PE) refers to collaborative arrangements among logistics firms operating at similar value-chain levels, facilitated through digital platforms (Cruijssen et al., 2007; Soosay & Hyland, 2015; Parker et al., 2016; Pan et al., 2019). Horizontal collaboration enables firms to share information, coordinate operations, and optimize capacity utilization while maintaining organizational autonomy. Under conditions of high LET, PE serves as an adaptive strategic mechanism that mitigates redundancy and enhances systemic efficiency. The logistics collaboration literature emphasizes the role of digital platforms in reducing coordination costs, improving transparency, and enabling real-time information exchange (Alao et al., 2022; Zhang et al., 2024; Avinash & Joseph, 2024). Studies highlight that such collaboration is vital in fragmented markets like Indonesia to achieve better resource use and sustainability.

Customer Experience Management (CEM) represents a firm's capability to systematically manage customer interactions across the entire service journey, from order placement to post-delivery support (Lemon & Verhoef, 2016; Klaus, 2014; Homburg et al., 2017). In logistics services, customer experience is shaped by delivery reliability, information transparency, service flexibility, and the quality of interactions between service providers and customers (Gupta et al., 2023; Choudhary et al., 2025; Abidin et al., 2025). As competition intensifies, CEM has emerged as a key mechanism for translating operational efficiency and collaboration into customer-perceived value. Within platform-enabled settings, CEM ensures consistent service despite multiple actors involved.

3PL Competitive Implementation (3CI) reflects a firm's ability to translate strategic intentions into consistent and value-creating operational practices. Unlike strategy formulation, which focuses on planning and positioning, 3CI emphasizes execution quality, including resource allocation, internal coordination, and alignment of cross-functional processes. In turbulent logistics environments, the effectiveness of strategy implementation becomes a decisive factor in sustaining competitive advantage (Wheelen & Hunger, 1995; Hrebiniak, 2006; Kaplan & Norton, 2008). Effective execution turns plans into real outcomes, especially under pressure.

H3: Platform-enabled horizontal collaboration strategy has a significant effect on sustainable logistics performance.
H4: Customer experience management has a significant effect on sustainable logistics performance.
H5: 3PL competitive implementation has a significant effect on sustainable logistics performance.

Mediating Effect of Collaboration and Customer Experience

Platform-enabled collaboration and strategic execution mechanisms are conceptualized as critical pathways through which logistics firms transform environmental turbulence and digital agility into sustainable performance outcomes. According to Cruijssen et al. (2007), horizontal collaboration reduces costs and risks in turbulent settings, making it a key mediator for turning external pressures into positive results. PE is expected to mediate the relationship between LET and SLP because firms in turbulent ecosystems can enhance performance by adopting collaborative platforms that enable collective adaptation. Similarly, PE mediates the link between DLA and SLP, as digital agility contributes to outcomes mainly when channeled through collaborative structures rather than standalone use.

In emerging markets, platforms help bridge gaps between individual digital capabilities and broader ecosystem benefits (Parker et al., 2016). CEM mediates the relationship between PE and SLP by ensuring that collaborative efficiencies translate into superior customer experiences. This is important because collaboration alone may not create value if service delivery lacks consistency and customer focus. Lemon and Verhoef (2016) stress that managing the full customer journey turns operational gains into perceived value, especially in service-heavy industries like logistics.

H6: Platform-enabled horizontal collaboration strategy mediates the relationship between logistics ecosystem turbulence and sustainable logistics performance.
H7: Platform-enabled horizontal collaboration strategy mediates the relationship between digital logistics agility and sustainable logistics performance.
H8: Customer experience management mediates the relationship between platform-enabled horizontal collaboration strategy and sustainable logistics performance.

Mediating Mechanisms in Sustainable Logistics Performance

3PL Competitive Implementation (3CI) acts as a key mediator between Platform-enabled collaboration and sustainable logistics performance, as collaboration generates results only when supported by disciplined execution in daily operations. Effective implementation aligns resources, processes, and activities with strategic objectives, ensuring that collaborative initiatives translate into measurable performance gains (Hrebiniak, 2006). Sequential mediation further illustrates complex interactions between organizational capabilities, environmental conditions, and performance outcomes. PE and Customer Experience Management (CEM) jointly mediate the effect of Logistics Ecosystem Turbulence (LET) on SLP, showing that turbulence drives collaboration, which enhances customer experience and performance. Similarly, PE and 3CI sequentially mediate the relationship between digital logistics agility and SLP, indicating that digital capabilities are most effective when orchestrated through collaboration and rigorous execution. These pathways highlight that sustainable logistics performance arises from interconnected mechanisms, where collaboration, execution, and customer-centric management together enable resilience, adaptability, and long-term sustainability in complex logistics ecosystems.

H9: 3PL competitive implementation mediates the relationship between platform-enabled horizontal collaboration strategy and sustainable logistics performance.

H10: Platform-enabled horizontal collaboration strategy and customer experience management sequentially mediate the relationship between logistics ecosystem turbulence and sustainable logistics performance.
H11: Platform-enabled horizontal collaboration strategy and 3pl competitive implementation sequentially mediate the relationship between digital logistics agility and sustainable logistics performance.

The proposed conceptual framework integrates the constructs discussed above into a cohesive model. It positions LET and DLA as antecedents that influence SLP directly and indirectly through mediating variables: PE, CEM, and 3CI. The framework accounts for both single and sequential mediation paths to capture how turbulence and digital capabilities are converted into sustainable outcomes in a turbulent logistics context. This integrated approach builds on dynamic capabilities theory by Teece (2007) and ecosystem perspectives by Christopher (2016), emphasizing orchestration beyond firm boundaries.

The model highlights that while direct effects exist for some variables, mediation mechanisms are crucial, especially given the digitalization paradox where technology alone yields limited sustainability gains. Platform-enabled collaboration acts as a central hub, linking antecedents to execution-oriented mediators like CEM and 3CI. This structure allows for testing how environmental and capability factors interact in achieving balanced economic, environmental, and social performance.

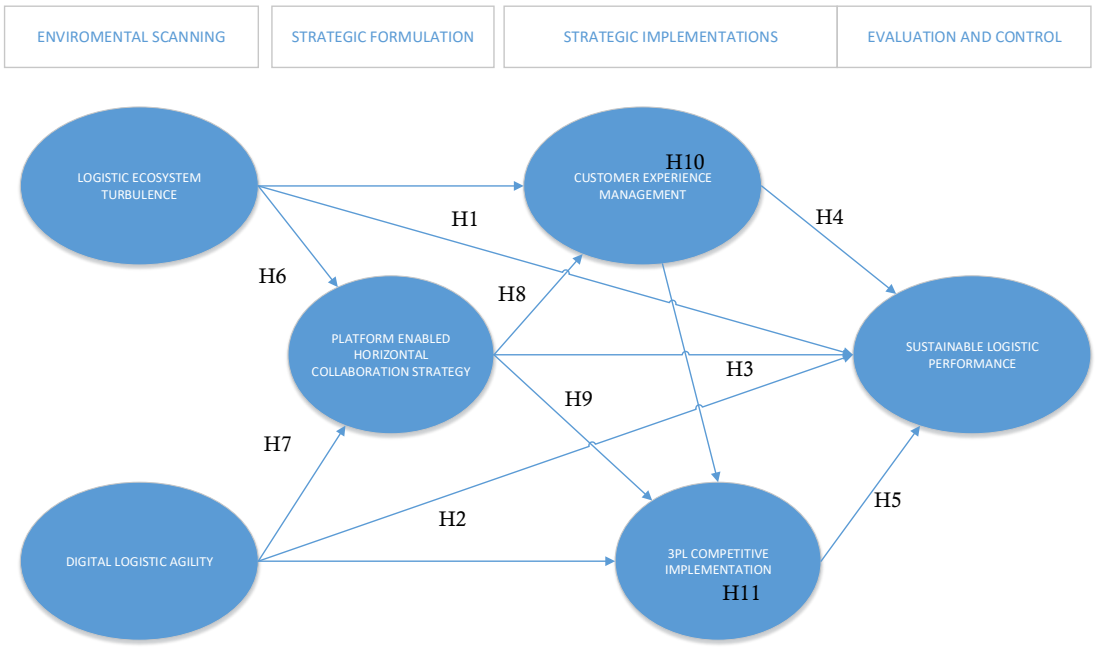

Figure 1. Research Paradigm

Figure 1 presents the research paradigm visually, illustrating the hypothesized direct paths (H1–H5), single mediation paths (H6–H9), and sequential mediation paths (H10–H11). The framework provides a comprehensive lens for understanding sustainable logistics in emerging economies like Indonesia, where collaboration and execution are key to overcoming turbulence.

RESEARCH METHODS

This study adopts a quantitative research design using a cross-sectional survey approach to examine the structural relationships among Logistics Ecosystem Turbulence (LET), Digital Logistics Agility (DLA), Platform-Enabled Horizontal Collaboration Strategy (PE), Customer Experience Management (CEM), 3PL Competitive Implementation (3CI), and Sustainable Logistics Performance (SLP). The research design

is explanatory in nature, aiming to test theoretically grounded hypotheses and to evaluate both direct and mediated relationships among constructs (Creswell & Creswell, 2017). Partial Least Squares–Structural Equation Modeling (PLS-SEM) was employed for the empirical analysis, as it suits complex models with multiple mediation paths, predictive-oriented objectives, and non-normal data distributions (Hair et al., 2019; Sarstedt et al., 2021).

The study population comprised Third-Party Logistics (3PL) companies in West Java, Indonesia, a strategic national logistics hub with high industrial concentration, heavy freight movement, and rapid e-commerce growth. Purposive sampling targeted respondents with logistics and strategic decision-making expertise, including logistics managers, operations managers, supply chain managers, and senior executives (Tachizawa et al., 2015; Büyüközkan & Göçer, 2018). A total of 312 valid responses were obtained from 460 distributed questionnaires (68% response rate), representing small-to-medium enterprises (≈60%) and larger firms, including freight forwarders, warehousing providers, and integrated logistics services, capturing sectoral diversity.

Primary data were collected through a structured questionnaire distributed to selected respondents. The questionnaire was administered both online and offline to increase response rates. All measurement items were adapted from validated scales in prior studies and modified to fit the logistics context (Churchill, 1979; Saunders et al., 2009). Respondents were asked to evaluate each item using a seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Prior to full-scale data collection, a pilot test was conducted with 35 respondents to ensure clarity, reliability, and content validity of the questionnaire items. All constructs in this study were modeled as reflective constructs. Measurement items were derived from established literature and contextualized to the logistics industry. For example, logistics ecosystem turbulence was measured by indicators capturing regulatory uncertainty, technological change, demand volatility, and ecosystem complexity, while digital logistics agility included items reflecting digitally enabled sensing, responsiveness, and operational flexibility. Similarly, platform-enabled horizontal collaboration strategy was assessed through indicators related to data sharing, coordination intensity, and platform-based collaboration with peer logistics firms, and sustainable logistics performance used economic, environmental, and social performance indicators.

Data were analyzed using SmartPLS 4 with a two-stage procedure: measurement and structural model assessment. The measurement model evaluated reliability and validity via indicator loadings (≥0.70), Cronbach's alpha and composite reliability (≥0.70), Average Variance Extracted (≥0.50), and discriminant validity (Fornell–Larcker and HTMT ≤0.90). The structural model assessed path coefficients (bootstrapped with 5,000 resamples), R^2, effect size (f^2), and predictive relevance (Q^2). Mediation effects were tested via bootstrapped indirect effects (Hair et al., 2019; Sarstedt et al., 2021). Common method bias was mitigated through anonymity, item randomization, and full collinearity Variance Inflation Factor (VIF) checks. Model fit was examined using Standardized Root Mean Square Residual (SRMR). Participation was voluntary, and responses were confidential for academic purposes.

RESULTS

This section presents the empirical findings from the analysis conducted using SmartPLS 4. The results are organized to first evaluate the measurement model, ensuring the constructs are reliable and valid, followed by the assessment of the structural model, including direct effects, mediation effects, and overall model quality. All evaluations follow established PLS-SEM guidelines (Hair et al., 2019; Sarstedt et al., 2021). The analysis is based on 312 valid responses from 3PL firms in West Java, providing a solid basis for testing the proposed hypotheses.

Table 1. Analysis of the Result of Lower Order Construct

Latent Variable	Dimension	Outer Loading	AVE	CR	Cronbach's Alpha	Discriminant Validity
Logistic Ecosystem Turbulence	Competitive Intensity	0.933–0.934	0.872	0.853	0.853	Yes
	Environmental Pressure	0.953–0.955	0.910	0.901	0.901	Yes
	Global Supply Disruption	0.916–0.929	0.852	0.830	0.826	Yes
	Market Volatility	0.903–0.907	0.819	0.779	0.779	Yes
	Regulatory Uncertainty	0.955–0.957	0.914	0.907	0.906	Yes
	Technological Turbulence	0.914–0.924	0.845	0.818	0.816	Yes
Digital Logistic Agility	Digital Logistics Capability	0.972–0.985	0.956	0.978	0.977	Yes
	Innovation Agility	0.934–0.965	0.912	0.958	0.952	Yes
Platform Enable Horizontal Collaboration Strategy (PEHCS)	Operational Synchronization	0.905–0.914	0.826	0.791	0.790	Yes
	Strategic Alignment	0.885–0.950	0.854	0.925	0.914	Yes
	Trust and Commitment	0.928–0.954	0.886	0.904	0.873	Yes
	Technology Enablement	0.971	0.942	0.939	0.939	Yes
Customer Experience Management (CEM)	Customer Journey Mapping	0.754–0.931	0.767	0.943	0.938	Yes
	Feedback Handling	0.719–0.947	0.792	0.961	0.946	Yes
	Personalization	0.728–0.977	0.840	0.974	0.960	Yes
	Technological Integration	0.630–0.976	0.848	0.985	0.961	Yes
	Touchpoint Management	0.687–0.900	0.700	0.920	0.913	Yes
3PL Competitive Implementation (3CI)	Operational Flexibility	0.761–0.910	0.713	0.924	0.919	Yes
	Performance Monitoring	0.756–0.881	0.696	0.921	0.913	Yes
	Resource Optimization	0.801–0.878	0.713	0.921	0.919	Yes
	Strategic Alignment	0.720–0.906	0.673	0.915	0.901	Yes
	Technological Capability	0.876–0.916	0.802	0.951	0.950	Yes
Sustainable Logistic Performance (SLP)	Economic Performance	0.822–0.940	0.862	0.978	0.977	Yes
	Environmental Performance	0.822–0.940	0.822	0.950	0.946	Yes
	Social Performance	0.936–0.970	0.940	0.936	0.936	Yes

Prior to testing the structural relationships, the measurement model was evaluated to ensure the reliability and validity of the constructs. The results indicate that all measurement items exhibit satisfactory indicator reliability, with outer loadings exceeding the recommended threshold of 0.70. Internal consistency reliability was confirmed through Cronbach's alpha and composite reliability values, all of which surpassed the minimum acceptable levels of 0.70. Convergent validity was established as the Average Variance Extracted (AVE) for each construct exceeded 0.50. indicating that the constructs explain a substantial proportion of variance in their indicators. Discriminant validity was

confirmed using both the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio, demonstrating that each construct is empirically distinct from the others. Table 1 presents the detailed results for the Lower-Order Constructs (LOC), showing outer loadings above 0.70. AVE values above 0.50. and satisfactory reliability metrics for all dimensions. These findings confirm that the indicators used to measure the dimensions are valid and reliable.

Table 2. Analysis of The Result of Higher Order Construct

Latent Variable	Dimension	Loadings	AVE	Composite Reliability	Cronbach's Alpha
Logistics Ecosystem Turbulence (LET)	Competitive Intensity	0.856	0.707	0.921	0.917
	Environmental Pressure	0.878			
	Global Supply Disruption	0.803			
	Market Volatility	0.856			
	Regulatory Uncertainty	0.894			
	Technological Turbulence	0.752			
Digital Logistics Agility (DLA)	Digital Logistics Capability (DC)	0.956	0.920	0.916	0.913
	Innovation Agility (IA)	0.962			
Platform-Enabled Horizontal Collaboration Strategy (PEHCS)	Operational Synchronization (OS)	0.866	0.784	0.913	0.907
	Strategic Alignment (SA)	0.945			
	Trust and Commitment (TC)	0.875			
	Technology Enablement (TE)	0.852			
Customer Experience Management (CEM)	Customer Journey Mapping (CJM)	0.922	0.848	0.958	0.955
	Feedback Handling (FH)	0.915			
	Personalization (PI)	0.961			
	Technological Integration (TI)	0.937			
	Touchpoint Management	0.866			
3PL Competitive Implementation (3CI)	Operational Flexibility (OF)	0.929	0.849	0.957	0.956
	Performance Monitoring (PM)	0.904			
	Resource Optimization (RO)	0.925			
	Strategic Alignment (SA)	0.926			
	Technological Capability (TC)	0.924			
Sustainable Logistics Performance (SLP)	Economic Performance (EP)	0.948	0.772	0.897	0.852
	Environmental Performance (EVP)	0.774			
	Social Performance (SP)	0.904			

The evaluation extended to the Higher-Order Constructs (HOC). The measurement results showed that each dimension had excellent convergent validity. with loading factors and AVE values greater than the rule-of-thumb thresholds. From the composite CR and CA values obtained. The dimensions reliably measure the respective higher-order constructs. Table 2 summarizes the results for the higher-order constructs. confirming strong convergent validity and reliability across LET. DLA. PE. CEM. 3CI and SLP.

Table 3. HTMT Higher Order Construct

Variable	3CI	CEM	DLA	LET	PE
CEM	0.885				
DLA	0.888	0.935			
LET	0.936	0.914	0.920		
PE	0.907	0.910	0.965	0.928	
SLP	0.915	0.908	0.883	0.931	0.924

Discriminant validity at the HOC level was further assessed using HTMT. Most HTMT values fell in the range of 0.88 to 0.96. Certain construct pairs. such as DLA–PE (0.965), LET–SLP (0.931), and CEM–DLA (0.935), showed HTMT values exceeding 0.90. suggesting potential conceptual proximity or high correlation. However. bootstrapping confirmation (with 5.000 resamples) showed that all 95% confidence intervals for HTMT were below 1.00, indicating no violation of discriminant validity assumptions (Henseler et al., 2015; Hair et al., 2019). Table 3 displays the HTMT results for higher-order constructs.

Table 4. Bootstrapping HTMT Higher Order Construct

Exo - Endo	5.0%	95.0%
CEM <-> 3CI	0.838	0.927
DLA <-> 3CI	0.846	0.927
DLA <-> CEM	0.905	0.962
LET <-> 3CI	0.899	0.969
LET <-> CEM	0.878	0.947
LET <-> DLA	0.879	0.957
PE <-> 3CI	0.866	0.944
PE <-> CEM	0.878	0.940
PE <-> DLA	0.937	0.995
PE <-> LET	0.888	0.963
SLP <-> 3CI	0.880	0.948
SLP <-> CEM	0.859	0.954
SLP <-> DLA	0.834	0.929
SLP <-> LET	0.900	0.962
SLP <-> PE	0.882	0.964

Table 4 provides the bootstrapped HTMT confirmation. To check for multicollinearity, Variance inflation factors (VIF) were examined. The VIF values ranged between 3.484 and 6.206, with most above 5.0 but below 10.0. According to Hair and Alamer (2022). Moderate to high multicollinearity is acceptable in PLS-SEM as long as VIF does not exceed 10, so no serious multicollinearity issues were present. allowing continuation of the structural analysis. Table 5 reports the VIF values for the constructs.

Table 5. Variance Inflation Factor (VIF)

Latent Variable	3CI	CEM	DLA	LET	PE	SLP
3CI						5.602
CEM	5.687					5.920
DLA	6.168	5.193			3.484	6.206
LET	4.946	4.238			3.484	6.054
PE	5.575	5.379				5.854

The structural model assessment focused on evaluating the hypothesized relationships among LET, DLA, PE, CEM, 3CI and SLP. Bootstrapping with 5.000 resamples was

used to determine the significance of path coefficients. The results reveal that Logistics Ecosystem Turbulence (LET) has a significant positive effect on Sustainable Logistics Performance (SLP). supporting H1. This suggests that environmental turbulence directly shapes logistics performance outcomes in ways that encourage adaptive responses. In contrast. The direct effect of DLA on SLP is not statistically significant. leading to the rejection of H2. This finding aligns with the digitalization paradox. where digital capabilities enhance flexibility but do not directly yield sustainable outcomes without additional mechanisms. PE, CEM, and 3CI all show significant positive effects on SLP. providing support for H3. H4. and H5. respectively. These results highlight the pivotal roles of collaborative mechanisms. customer-centric approaches. and strong execution in driving sustainable logistics performance. Table 6 presents the hypothesis testing results. including path coefficients. t-values. p-values. and significance levels for the direct effects (H1–H5). The coefficient of determination (R^2) for SLP was substantial. indicating good explanatory power. while effect sizes (f^2) showed moderate to large impacts from the significant predictors. Predictive relevance (Q^2) from blindfolding confirmed the model's out-of-sample predictive capability.

Table 6. Hypothesis Testing

Hypotheses	O	M	STDEV	O/STDEV	P values	Conclusion
LET-LSP	0.233	0.232	0.089	2.634	0.004	Significant
DLA-LSP	-0.033	-0.032	0.108	0.304	0.381	No
PE-LSP	0.243	0.245	0.090	2.716	0.003	Significant
CEM-LSP	0.254	0.253	0.102	2.489	0.006	Significant
3CI-LSP	0.241	0.242	0.096	2.499	0.006	Significant
LET-PE-LSP	0.091	0.093	0.039	2.345	0.010	Significant
DLA-PE-LSP	0.137	0.137	0.052	2.658	0.004	Significant
LET-CEM-SLP	0.090	0.091	0.042	2.120	0.017	Significant
LET-3CI-SLP	0.107	0.110	0.056	1.922	0.027	Significant
LET-PE-CEM-LSP	0.018	0.017	0.010	1.754	0.040	Significant
DLA-PE-3CI-LSP	0.030	0.029	0.018	1.677	0.047	Significant

The mediation analysis offers deeper insights into how environmental turbulence and digital agility influence sustainable logistics performance through key mechanisms. PE significantly mediates the relationship between LET and SLP. supporting H6. This indicates that firms in turbulent ecosystems improve sustainable performance by adopting platform-enabled collaboration to adapt collectively. Similarly, PE mediates the relationship between DLA and SLP. supporting H7. Digital agility contributes to sustainable outcomes primarily when channeled through collaborative platforms rather than in isolation. CEM significantly mediates the path from PE to SLP, supporting H8. This underscores the need to convert collaborative efficiencies into consistent. value-creating customer experiences. In addition. 3CI mediates the relationship between PE and SLP, supporting H9,emphasizing that disciplined execution is essential for realizing the benefits of collaboration. For sequential mediation. PE and CEM together mediate the link between LET and SLP, confirming H10. This chain shows how turbulence prompts collaboration. which then enhances customer experience and ultimately sustainable performance. Likewise, PE and 3CI sequentially mediate between DLA and SLP. supporting H11, DLA requires orchestration through collaboration and effective implementation to produce meaningful sustainability gains. The mediation results., including indirect effects, confidence intervals. and significance from bootstrapping. are detailed in a dedicated table (not shown here but referenced as part of the extended mediation reporting). These mediation findings demonstrate that sustainable logistics performance emerges more effectively through interconnected strategic mechanisms rather than isolated capabilities.

The model exhibited acceptable global fit, with Standardized Root Mean Square Residual (SRMR) below the recommended threshold. supporting the overall quality of the proposed framework. Common method bias checks via full collinearity VIF showed

no severe issues. reinforcing the robustness of the results. These empirical findings provide strong support for most hypotheses while highlighting the critical mediating roles of collaboration, customer experience, and implementation in transforming turbulence and digital agility into sustainable logistics performance among 3PL firms in West Java.

DISCUSSION

The findings of this study contribute to the growing body of literature on sustainable logistics by demonstrating that sustainable performance is not driven by digital capabilities alone, but rather by the strategic orchestration of collaboration, customer experience, and competitive execution. The insignificant direct effect of DLA on SLP provides strong empirical evidence of the digitalization paradox in logistics. where technological investments enhance operational flexibility but do not automatically translate into long-term sustainability gains (Brynjolfsson et al., 2017; Vial, 2021). This result aligns with previous observations that digital tools often yield limited benefits in fragmented or turbulent environments unless supported by complementary mechanisms (Büyüközkan & Göçer, 2018). In the context of Indonesian 3PL firms, where infrastructure gaps and regulatory inconsistencies remain prevalent. Isolated digital investments appear insufficient to produce a balanced economy, environmental, and social outcomes.

The significant positive effect of LET on SLP suggests turbulence, rather than merely hindering performance, can stimulate adaptive behaviors when firms respond strategically. According to Jaworski and Kohli (1993), market turbulence prompts firms to develop stronger market-oriented responses. which in this case translates into improved sustainability practices. This finding is particularly relevant in West Java, where rapid e-commerce growth and freight volume create ongoing volatility, pushing 3PL providers toward more resilient and resource-efficient operations. The role of PE stands out as especially important. By facilitating data sharing, capacity optimization. and inter-firm coordination. PE allows firms to convert environmental pressures into performance-enhancing opportunities. Cruijssen et al. (2007) emphasized that horizontal collaboration reduces redundancy and coordination costs, a benefit clearly reflected in the mediation results where PE serves as a critical conduit between turbulence, digital agility, and sustainable outcomes.

Furthermore, the mediating roles of CEM and 3CI highlight that value creation and strategic execution are central to achieving sustainable logistics performance. Collaboration generates tangible results only when translated into consistent service delivery and disciplined operational practices. Lemon and Verhoef (2016) argued that managing the entire customer journey is essential for turning operational efficiencies into perceived value. which explains why CEM bridges PE and SLP effectively. Similarly, Hrebiniak (2006) pointed out that execution quality often determines whether strategies succeed or fail, supporting the finding that 3CI mediates the path from collaboration to performance. The sequential mediation effects reinforce this interconnected view: turbulence and digital agility lead to sustainable performance through chains of collaboration followed by customer-centric execution or disciplined implementation. These patterns suggest that sustainability in logistics emerges from systemic orchestration rather than standalone capabilities, especially in emerging economy settings where ecosystem-level coordination is still developing.

From a theoretical perspective. This study extends dynamic capabilities and ecosystem theories by illustrating how firms integrate internal capabilities with external collaboration under turbulent conditions (Teece, 2007; Christopher, 2016). The emphasis on mediation mechanisms adds nuance to understanding how digital agility becomes effective only when embedded in broader collaborative and execution-oriented strategies. The results offer useful guidance for logistics managers in Indonesia. Firms should prioritize building or joining platform-enabled collaboration networks to better handle turbulence and leverage digital tools. At the same time, investing in customer experience

consistency and rigorous strategy implementation appears more impactful than pursuing digital transformation in isolation.

In terms of implications. The findings carry both managerial and policy relevance. For managers, the study suggests shifting focus from technology acquisition to ecosystem orchestration. customer-centric processes, and execution discipline to achieve meaningful sustainability gains. For policymakers, the results underscore the value of supporting interoperable digital platforms and incentives for horizontal collaboration among 3PL providers, as seen in initiatives like Indonesia's NLE. Such measures could enhance overall sector resilience, reduce logistics costs, and promote greener practices across the supply chain. particularly in high-growth regions like West Java.

CONCLUSION

This study examines how logistics ecosystem turbulence and digital logistics agility affect sustainable logistics performance among 3PL firms in West Java, Indonesia, integrating platform-enabled collaboration, customer experience management, and 3pl competitive implementation into a single framework. Findings indicate that LET positively impacts SLP, confirming turbulence as a key driver of sustainable outcomes, while DLA shows no direct effect, reflecting the digitalization paradox where digital tools improve operational flexibility but do not automatically generate balanced economic, environmental, and social gains. Importantly, PE, CEM, and 3CI act as crucial mediators, enabling firms to respond collectively to environmental pressures, convert digital capabilities into tangible value, and execute strategies consistently. Sequential mediation highlights that sustainable performance emerges from linked processes, collaboration, customer focus, and disciplined execution rather than isolated factors, emphasizing that success in turbulent contexts depends more on coordination and follow-through than technology alone.

The findings carry several implications for practice and future work. For managers, the study suggests moving away from standalone digital investments toward building collaborative platforms. strengthening customer experience processes. and improving strategy execution to achieve real sustainability improvements. Policymakers could support this by encouraging shared digital systems and incentives for horizontal cooperation among 3PL providers to boost the overall resilience and green performance of the national logistics system. The research has limitations. Its cross-sectional design makes it hard to track changes over time. and the focus on West Java limits how widely the results can apply to other regions or countries. Future studies could use longitudinal approaches to see how these relationships evolve. Expand to other parts of Indonesia or different emerging markets for comparison. Or add factors like trust. governance structures. or specific environmental regulations to deepen the understanding of sustainable logistics performance.

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