



The Impact of National Logistics Ecosystem Policy on Indonesia's Logistics Service Performance: The Roles of Human Resources Competency and Digitalization

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Abstract. This study investigates the impact of the National Logistics Ecosystem (NLE) policy implementation on logistics service performance in Indonesia, emphasizing the mediating role of human resource (HR) competencies and the moderating effect of digitalization on sustainable economic development. Indonesia is the world's largest archipelagic country and faces its own set of logistics challenges. For instance, logistics costs are high (14.29% of GDP), and the country is 57th out of 139 in the Logistics Performance Index. The NLE policy's goal is to make logistics processes easier by integrating systems and going digital. A sequential explanatory mixed-method approach was utilized, comprising 378 quantitative respondents and 20 qualitative key informants. The data were examined through structural equation modelling and thematic analysis. The results show that the quality of logistics policy governance and industry competition both have a positive effect on the logistics ecosystem's ability to innovate and its operational efficiency. This, in turn, improves the performance of logistics services. The implementation of NLE greatly enhances HR competencies, acting as a mediator in this relationship. Digitalization and the maturity of the digital ecosystem partially mitigate these effects, whereas receptiveness to global best practices does not exhibit significant moderation. Qualitative findings indicate obstacles such as inadequate system readiness, deficiencies in HR expertise, bureaucratic complexities, inconsistent infrastructure, and technical issues, including subpar user interfaces and system interruptions. Suggestions include strengthening HR through training and certification, making infrastructure development fairer, simplifying regulations, improving system integration and real-time monitoring, and making public services more user-friendly. This study enhances theoretical frameworks by integrating policy implementation theory, the resource-based view, and innovation diffusion theory, while also offering empirical guidance for optimizing the implementation of the National Logistics Ecosystem (NLE) to foster Indonesia's sustainable economic development.

Keywords: National Logistics Ecosystem, logistics service performance, human resource competencies, digitalization, sustainability.

1 Introduction

Logistics serves a strategic function as the essential component of national and global economies by facilitating the movement of goods across regions, islands, and countries. In today's economy, how well logistics works is a key factor in a country's competitiveness, its economic growth, and how easy it is for people to access goods and services. The World Economic Forum 2019 says that for every 1% increase in logistics efficiency, international trade rises by 2% and economic growth by 3%. A 2022 study by the McKinsey Global Institute found that countries with better logistics attract 15% more foreign direct investment and build more resilient economic ecosystems that can withstand global disruptions.

Indonesia, with more than 17,000 islands and the world's largest archipelago, faces unique and complex logistics challenges. The Coordinating Ministry for Economic Affairs of Indonesia said in 2024 that the country's logistics costs were 14.29% of GDP in 2023. This was down from 23.5% in 2020, but it was still much higher than that of other ASEAN countries, such as Malaysia (10.6%), Thailand (11.1%), and Singapore (8.3%). High logistics costs make it harder for the economy to compete nationally and cause prices to differ by as much as 300% between eastern regions and Java. Indonesia's logistics performance ranking is still not great; in the 2023 Logistics Performance Index (LPI) by the World Bank, it ranked 57th out of 139 countries, with a score of 3.0 out of 5.0. Singapore (1st, 4.3), Malaysia (32nd, 3.6), Thailand (35th, 3.5), and Vietnam (43rd, 3.3) are all ahead of this ranking. Table 1 shows the LPI component scores. Even though customs, infrastructure, and international shipments have improved, logistics competence, tracking and tracing, and timeliness have worsened. These declines suggest difficulties with human resource proficiency and the application of digital technology, warranting further examination.

Table 1. Logistics Performance Index (LPI) Indonesia 2023

LPI Component	2023 Score	2018 Score	Change	Rank 2023 (out of 139 countries)	Rank 2018 (out of 160 countries)
Overall	3,0	2,98	+0,02	57	46
Customs	2,8	2,67	+0,13	63	62
Infrastructure	2,9	2,89	+0,01	58	54
International shipments	3,0	2,82	+0,18	52	42
Logistics Competence	2,9	3,10	-0,20	62	41
Tracking & Tracing	3,0	3,30	-0,30	53	38
Timeliness	3,3	3,67	-0,37	48	41

Source: World Bank LPI Report 2023; processed.

The main research problems stem from Indonesia's logistics performance issues, including fragmented and inconsistent policy governance, low transparency, and complex bureaucratic regulations involving multiple ministries and overlapping rules. There is a big difference between making policies at the central level and implementing them. For example, standard operating procedures at ports and airports can differ by as much as 40%. The domestic logistics industry is highly competitive, with private companies accounting for 73% of the market. To stay competitive, companies need to develop new ideas and maintain reliable service standards. The government's National Logistics Ecosystem (NLE) policy, which began with Presidential Instruction No. 5/2020, aims to address these problems by integrating logistics processes, making them easier to follow, and encouraging digitalization to make the logistics system more competitive globally.

Previous studies have suggested general ways to solve logistics problems through digital transformation, improving innovation skills, and training workers. For instance, [1] points out that NLE has a positive effect on transparency and efficiency but also notes that implementers feel differently about and discuss it. Other studies stress the significance of innovation ecosystems [2], operational efficiency [3], and digital readiness [4] for logistics performance. However, most previous research emphasizes direct policy-performance relationships without examining the mediation effects of innovation capability, HR competence, and operational efficiency, or the moderation effects of digitalization, digital ecosystem maturity, and openness to global best practices—interrelated variables that critically influence the effectiveness of national logistics policy. Moreover, few studies employ mixed-method approaches combining quantitative and qualitative analyses, which are necessary to deeply explore underlying mechanisms and comprehend Indonesia's logistics complexity as a geographically and culturally diverse archipelago.

This study makes significant theoretical contributions by integrating public policy implementation theory, the resource-based view in logistics, and digital innovation diffusion theory into a comprehensive conceptual framework. Practically, it provides concrete recommendations for optimizing NLE implementation, enhancing logistics HR competencies, and accelerating digital transformation in Indonesia's logistics sector. The findings will support policymakers in formulating effective policies, industry players in capability development, and educational institutions in aligning curricula with industry needs. While the Resource-Based View and Dynamic Capability Theory offer insights into leveraging internal resources for competitive advantage, and the Diffusion of Innovation Theory explains technology adoption, a research gap remains in combining these perspectives to analyze the effectiveness of NLE implementation. Moreover, the mediating role of human resource competency and the moderating effect of digitalization have not been sufficiently explored—an important gap given Indonesia's lag in digital adoption compared to ASEAN peers and significant HR competency deficits in digital logistics, supply chain analytics, and strategic logistics management.

Therefore, this study analyzes the impact of the National Logistics Ecosystem (NLE) policy on logistics service performance in Indonesia, considering the mediating role of HR competencies and the moderating role of digitalization within the context of sustainable economic development. The conceptual framework integrates three independent variables (logistics policy governance quality, NLE implementation, and logistics industry competition intensity), three mediators (logistics ecosystem innovation capability, HR competence, and operational process efficiency), one dependent variable (logistics service performance), and three moderators (digitalization, digital ecosystem maturity, and openness to global best practices). The academic and practical urgency of this research is reinforced by Indonesia's government targets to reach the top 30 in the LPI global ranking by 2030 and to reduce logistics costs to 8% of GDP [5]. It aligns with the 2030 National Logistics Strategy, emphasizing digital transformation and HR development as pillars of national logistics competitiveness.

The novelty of this research lies in its systematic approach to identifying weaknesses in NLE implementation from bureaucratic, human resource, and operational perspectives. It combines quantitative and qualitative methods to analyze root causes, producing a contextually relevant strategy model applicable to multiple stakeholders. This integrative framework fills significant gaps in the literature on logistics policy implementation for developing archipelagic nations. In summary, this study offers a comprehensive, evidence-based examination of Indonesia's NLE policy implementation challenges and opportunities, providing valuable theoretical insights and practical guidance to sustainably enhance national logistics performance.

2 Literature Review

2.1 Theoretical Foundations

This study integrates multiple theoretical perspectives to comprehensively analyze the implementation of the National Logistics Ecosystem (NLE) policy and its impact on logistics service performance in Indonesia. The foundational theories include Public Policy Implementation Theory, Resource-Based View (RBV), Diffusion of Innovation Theory, Dynamic Capability Theory, Institutional Theory, Organizational Culture Theory, and the Triple Bottom Line (TBL) Sustainability Theory.

Public Policy Implementation Theory provides a framework to understand how policy design translates into concrete outcomes through effective coordination and governance mechanisms [6], [7]. It emphasizes the importance of transparency, accountability, and stakeholder participation in policy success. In the context of NLE, governance quality is critical to creating an environment conducive to innovation and efficient logistics operations [8].

2.2 Conceptual Constructs in Logistics Performance

The literature defines logistics service performance as the effectiveness and efficiency in delivering logistics services, measured through indicators such as customs clearance, infrastructure quality, shipment timeliness, tracking accuracy, and customer satisfaction [2], [3], [24]. The quality of logistics policy governance encompasses transparency, accountability, inter-agency coordination, and consistent regulatory frameworks that directly influence operational outcomes [25].

Industry competition intensity drives logistics service providers to innovate and optimize operational processes to maintain competitiveness [9]. Empirical studies confirm that competitive pressure accelerates adoption of digital technologies and process improvements [26].

2.3 Review of Previous Studies

Empirical studies on policy implementation highlight the evolution from traditional top-down models to integrative frameworks that emphasize coordination, communication, and capacity building [7]. [37] Identify a lack of validated quantitative instruments for measuring policy implementation outcomes, especially outside healthcare contexts, underscoring the need for sector-specific tools, such as those for NLE.

Qualitatively assess NLE's effectiveness in Indonesia, revealing progress in transparency and efficiency but noting challenges in implementor attitudes and communication [1]. [3] Demonstrate the critical role of e-logistics and IT capabilities in enhancing logistics performance in Vietnam, reinforcing the importance of digitalization. Cross-cultural studies by [12] link national cultural dimensions to logistics performance, indicating that cultural factors shape policy implementation and organizational behavior. [12] and [32] empirically confirm that HR competencies mediate the relationship between management practices and logistics performance, emphasizing the role of human capital development.

2.4 Research Gaps and Justification

Despite rich theoretical and empirical contributions, several gaps remain. There is a lack of empirically validated instruments specifically designed to measure NLE implementation in Indonesia. Most studies employ single-method approaches and cross-sectional designs, limiting a holistic understanding of complex interactions among policy, HR competencies, and digitalization.

Theoretical integration of policy implementation, RBV, and innovation diffusion within the context of a logistics digital ecosystem remains underexplored. Simultaneous examination of mediating roles of HR competencies and operational efficiency, alongside moderating effects of digitalization, digital ecosystem maturity, and openness to global practices, is scarce.

3 Methodology

3.1 Research Paradigm and Approach

This study adopts a post-positivist paradigm that emphasizes objectivity while acknowledging the complexity and limitations inherent in measuring social phenomena. Such a paradigm supports the investigation of complex causal relationships among National Logistics Ecosystem (NLE) policy implementation, human resource (HR) competencies, digitalization, and logistics service performance within Indonesia's unique archipelagic context.

The research employs a mixed-methods approach with a sequential explanatory design, systematically integrating quantitative and qualitative methods. This design prioritizes quantitative analysis to test the theoretical model and hypotheses, followed by qualitative exploration to deepen understanding of the quantitative findings. The sequential explanatory design allows the researcher to collect qualitative data after quantitative analysis to explain, confirm, or contrast findings, enhancing the overall validity and richness of the research outcomes.

3.2 Population and Sampling Techniques

Table 2 below showed that the quantitative population comprised 6,712 employees: 3,865 from PT. Samudera Indonesia Tbk and 2,847 from PT. Pelabuhan Indonesia (Persero) across 14 NLE-implementing ports. These organizations were selected due to their direct operational involvement in NLE implementation. The qualitative population included regulators from key ministries, academics, industry association leaders (e.g., ALFI, APTRINDO, ASDEKI), and professional trainers from logistics certification bodies, offering multi-stakeholder perspectives on the logistics ecosystem.

Quantitative sampling used stratified proportional random sampling based on population size and organizational divisions, following Slovin's formula with a 5% margin of error, resulting in a target sample of 378 respondents (rounded to 400 to account for non-response). Stratification ensured representative coverage across operational, IT, customer service, and finance (PT. Samudera Indonesia) and terminal operations, IT, and commercial divisions (PT. Pelabuhan Indonesia).

Qualitative sampling employed purposive sampling to select 20 key informants with deep knowledge and involvement in NLE implementation. Criteria included a minimum of five years' logistics experience, direct NLE involvement, and strategic organizational roles. Informants represented management levels from both companies, regulators, and academia/industry associations.

Table 2. Sample Distribution by Organization

Organization	Population	Proportion	Sample	Division Focus
PT. Samudera Indonesia TBK	3.865	57.6 %	230	Operations IT, Customer Service, Finance
PT. Pelabuhan Indonesia (Persero)	2.847	42.2%	170	Terminal Operations, IT, Commercial
Total	6.712	100%	400	-

Source: Researcher's Processed Data (2025)

3.3 Data Collection Methods

Multiple data collection methods were employed to ensure comprehensive, in-depth information, aligned with the mixed-methods, sequential, explanatory design. Quantitative data were collected via structured questionnaires based on operationalized research variables, using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) to elicit nuanced responses [39]. Questionnaires were distributed online (Google Forms), in printed format for low-internet areas, and through the internal mobile applications of both organizations. A pilot test with 50 respondents assessed clarity, completion time, and initial psychometric properties.

3.4 Conceptual Definitions and Variable Operationalization

The study operationalizes 10 key latent variables categorized into independent, mediating, dependent, and moderating constructs. Each variable was defined conceptually and operationalized with dimensions and indicators derived from a comprehensive literature review and expert input [40]. For example, policy governance quality includes transparency, accountability, institutional coordination, stakeholder participation, and regulatory consistency [41]. Competition intensity covers tariff rivalry, service quality competition, technological innovation, and market positioning [9]. NLE implementation is measured by digital platform adoption, capacity-building programs, process standardization, system integration, and operational monitoring [2]. Innovation capability encompasses technological adoption, process innovation, collaboration networks, learning capacity, and adaptability [42], [43], [44]. Operational efficiency includes time, cost, resource utilization, process standardization, and technology ROI [45]. R competency measures technical, managerial, digital, interpersonal, and adaptive skills [12], [32]. Digitalization and digital ecosystem maturity assess technology adoption, system integration, infrastructure quality, digital literacy, and regulatory support [4], [46], [47], [48]. Openness to global best practices encompasses benchmarking, knowledge transfer, international collaboration, and compliance with standards [36]. Logistics service performance includes service speed, accuracy, reliability, flexibility, and customer satisfaction [3], [23].

3.5 Data Analysis Methods

Quantitative Data Analysis. Structural Equation Modelling (SEM) was employed to test the hypothesized relationships among variables, including mediation and moderation effects. SEM facilitates the simultaneous estimation of multiple dependent relationships and latent constructs, making it suitable for complex models such as the integrated NLE implementation framework. Software AMOS 26 was used for analysis, with rigorous evaluation of measurement validity (convergent and discriminant) and reliability, as well as structural model fit and hypothesis testing. Multicollinearity and common method bias were assessed to ensure robustness.

Qualitative Data Analysis. Qualitative data from interviews and documents were analyzed using thematic coding with NVivo 14 software. Coding followed an iterative process to identify emergent themes related to barriers, facilitators, and contextual factors influencing NLE implementation and logistics performance. Triangulation with quantitative findings enhanced interpretive validity and provided comprehensive insights into underlying mechanisms.

Integration of Quantitative and Qualitative Results. Integration occurred at the interpretation stage, where qualitative insights explained, confirmed, or nuanced quantitative results. This mixed-method triangulation strengthened the validity of conclusions and provided actionable recommendations grounded in empirical evidence.

3.6 Instrument Testing

Research instruments underwent expert validation to ensure content validity and pilot testing to assess clarity and reliability. Quantitative scales were tested for internal consistency (Cronbach's alpha), composite reliability, and average variance extracted (AVE). Qualitative protocols were reviewed for comprehensiveness and appropriateness.

3.7 Validity and Reliability

Quantitative Component. Measurement models demonstrated acceptable convergent validity (factor loadings > 0.7 , AVE > 0.5) and discriminant validity (Fornell-Larcker criterion). Reliability indices exceeded thresholds (Cronbach's alpha and composite reliability > 0.7). Multicollinearity was within acceptable limits (VIF < 5).

Qualitative Component. Credibility was ensured through member checking, prolonged engagement, and triangulation. Dependability and confirmability were enhanced by audit trails and peer debriefing.

4 Results

4.1 Overview of Respondents

Data collection was conducted through questionnaires distributed online to employees of PT. Samudera Indonesia and PT. Pelabuhan Indonesia during June 2025, yielding 387 valid responses as detailed in Table 3 below. The respondent profile shows a predominance of male participants (78.6%), with the largest age group being 18-25 years (34.9%). Educational backgrounds were diverse, with the majority holding senior high school diplomas (31.7%), followed by bachelor's degrees (30.7%). Organizational affiliation was nearly evenly split between PT. Samudera Indonesia (50.3%) and PT. Pelabuhan Indonesia (49.7%). Job positions varied, with the largest group categorized as "others" (29.9%), and the majority had work experience ranging from 6 to 10 years (26.7%). This diverse demographic ensures a representative sample for the study's logistics ecosystem context.

Table 3. Characteristics of respondents

Size	Item	Percentage (%)
Gender	Female	21.4
	Male	78.6
Age (years)	18-25	34.9
	26-35	28.6
	36-45	25.9
	45-60	9.8
	>60	0.8
Education Levels	Senior high school diplomas	31.7
	Diploma	27
	S1	30.7
	S2	9.8
	S3	0.8
Organizational affiliation	PT. Pelabuhan Indonesia	49.7
	PT. Samudera Indonesia	50.3
Position	Terminal Operations	25.1
	Area Manager	9.3
	Supervisor	15.9
	GM/Manager	2.6
	Engineer	17.2
	Others	29.9
Length of services (years)	<2	13.8
	2-5	22
	6-10	26.7
	11-15	12.4

Size	Item	Percentage (%)
	>15	25.1

Source: Researcher’s Processed Data (2025)

4.2 Descriptive Statistics of Key Variables

Descriptive analyses of the primary variables reveal moderate mean scores across indicators, reflecting ongoing challenges and progress in the implementation of the National Logistics Ecosystem (NLE) policy.

4.3 Data Quality and Validity Tests

Table 4 showed the multicollinearity tests for all variables showed Variance Inflation Factor (VIF) values below 5, indicating no multicollinearity issues. Convergent validity was confirmed with all indicator outer loadings exceeding 0.7, and Average Variance Extracted (AVE) values above the 0.5 threshold for all constructs. Discriminant validity was supported by Fornell-Larcker criteria and Heterotrait-Monotrait (HTMT) ratios below 0.85. Reliability analyses yielded Cronbach’s alpha and composite reliability values above 0.7 across all variables, confirming internal consistency and measurement reliability.

Table 4. Results of AVE (Average Variance Extracted) Testing

Variable	Critical Value	AVE	Description
Logistics Policy Governance Quality (X1)	0.5	0.573	Valid
Logistics Industry Competition (X2)	0.5	0.649	Valid
NLE Policy Implementation (X3)	0.5	0.751	Valid
Logistics Ecosystem Innovation Capability (M1)	0.5	0.625	Valid
Operational Process Efficiency (M2)	0.5	0.622	Valid
Human Resource Competence (M3)	0.5	0.648	Valid
Digitization (Z1)	0.5	0.65	Valid
Digital Ecosystem Maturity (Z2)	0.5	0.654	Valid
Openness to Global Best Practices (Z3)	0.5	0.643	Valid
Logistics Service Performance (Y)	0.5	0.643	Valid

Source: Researcher’s Processed Data (2025)

Based on the analysis results of the Average Variance Extracted (AVE), it was found that each variable was valid, particularly in meeting discriminant validity. This is because each variable exceeded the critical limit of 0.50, thus being declared valid. Therefore, with these results, all indicators will be analyzed in further testing. The measurement results of the Fornell-Larcker Criterion are presented in the Table 5 below:

Table 5. Results of Fomell-Larcker Criterion Testing

Variable	Digitization (Z1)	Operational Process Efficiency (M2)	NLE Policy Implementation (X3)	Logistics Industry Competition (X2)	Logistics Ecosystem Innovation Capability (M1)	Digital Ecosystem Maturity (Z2)	Openness to Global Best Practices (Z3)	Logistics Service Performance (Y)	Human Resource Competence (M3)	Logistics Policy Governance Quality (X1)
Digitization (Z1)	0.806									
Operational Processes Efficiency (M2)	0.683	0.789								
NLE Policy Implementation (X3)	0.75	0.774	0.866							
Logistics Industry Competition (X2)	0.334	0.555	0.424	0.805						
Logistics Ecosystem Innovation Capability (M1)	0.685	0.628	0.789	0.287	0.791					

Variable	Digitization (Z1)	Operational Process Efficiency (M2)	NLE Policy Implementation (X3)	Logistics Industry Competition (X2)	Logistics Ecosystem Innovation Capability (M1)	Digital Ecosystem Maturity (Z2)	Openness to Global Best Practices (Z3)	Logistics Service Performance (Y)	Human Resource Competence (M3)	Logistics Policy Governance Quality (X1)
Digital Ecosystem Maturity (Z2)	0.655	0.653	0.712	0.292	0.647	0.809				
Openness to Global Best Practices (Z3)	0.643	0.646	0.719	0.274	0.654	0.607	0.802			
Logistics Service Performance (Y)	0.83	0.814	0.905	0.453	0.815	0.793	0.798	0.802		
Human Resource Competence (M3)	0.683	0.682	0.75	0.383	0.69	0.639	0.636	0.816	0.805	
Logistics Policy Governance Quality (X1)	0.237	0.245	0.378	-0.056	0.539	0.203	0.205	0.369	0.48	0.757

Source: Researcher's Processed Data (2025)

4.4 Measurement Model Validity and Reliability

Convergent validity was confirmed with all indicators exhibiting outer loadings above 0.7 as detailed in Table 6. Average Variance Extracted (AVE) values for all constructs exceeded 0.5, and composite reliability values were above 0.7, confirming internal consistency and construct validity. Discriminant validity was supported by the Fornell-Larcker criteria and Heterotrait-Monotrait (HTMT) ratios below 0.85, indicating constructs are distinct.

Table 6. Reliability Test Result

Variable	Critical Value	Cronbach's Alpha	Composite Reliability	Description
Logistics Policy Governance Quality (X1)	0.6	0.947	0.953	Reliable
Logistics Industry Competition (X2)	0.6	0.961	0.965	Reliable
NLE Policy Implementation (X3)	0.6	0.976	0.978	Reliable
Logistics Ecosystem Innovation Capability (M1)	0.6	0.957	0.962	Reliable
Operational Process Efficiency (M2)	0.6	0.957	0.961	Reliable
Human Resource Competence (M3)	0.6	0.961	0.965	Reliable
Digitization (Z1)	0.6	0.961	0.965	Reliable
Digital Ecosystem Maturity (Z2)	0.6	0.962	0.966	Reliable
Openness to Global Best Practices (Z3)	0.6	0.96	0.964	Reliable
Logistics Policy Governance Quality (X1)	0.6	0.96	0.964	Reliable

Source: Researcher's Processed Data (2025)

4.5 Structural Model Evaluation

The structural model in Figure 1 demonstrated strong explanatory power with R-square values of 0.29 for Innovation Capability (M1), 0.308 for Operational Efficiency (M2), 0.664 for HR Competencies (M3), and 0.948 for Logistics Service Performance (Y), indicating the model explains 94.8% of the variance in logistics service performance.

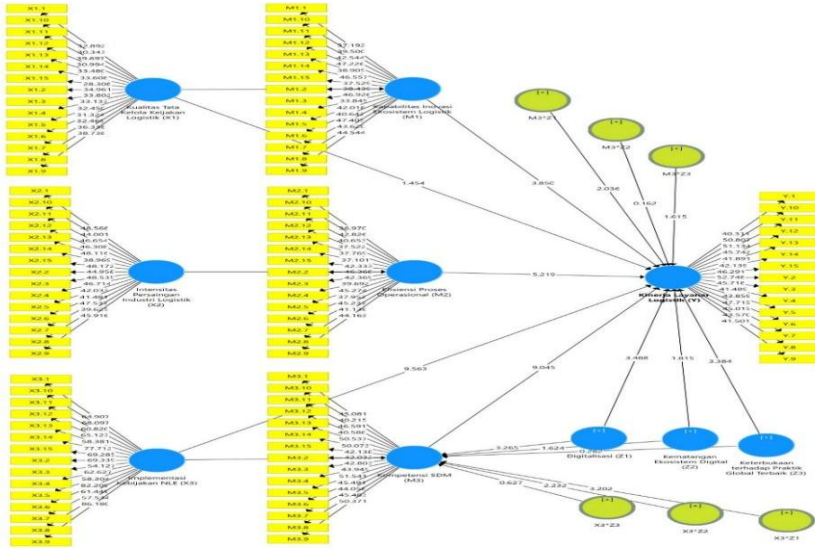


Fig. 1. Measurement Model (Inner Model)

In assessing a model with PLS, we begin by looking at the R-square and Q-square for each dependent latent variable. Table 7 shows the results of estimating R-square and Q-square using SmartPLS.

Table 7. Results of R-Square and Q-Square Testing

Variable	R Square	Q Square
Logistics Ecosystem Innovation Capability (M1)	0.29	0.179
Operational Efficiency (M2)	0.308	0.189
Human Resource Competence (M3)	0.664	0.39
Logistics Service Performance (Y)	0.948	0.597

Source: Researcher’s Processed Data (2025)

4.6 Hypothesis Testing

The path coefficient analysis and significance testing ($p < 0.05$) yielded the following key findings as shown in Table 8:

Table 8. Hypothesis Testing Results

Variable	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Operational Efficiency (M2) → Logistics Service Performance (Y)	0.113	0.114	0.022	5.219	0.000

Variabel	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Implementation of NLE Policy (X3) → Human Resource Competence (M3)	0.498	0.492	0.041	12.226	0.000
Logistics Industry Competition Intensity (X2) → Operational Process Efficiency (M2)	0.555	0.555	0.05	11.197	0.000
Logistics Ecosystem Innovation Capability (M1) → Logistics Service Performance (Y)	0.084	0.086	0.022	3.85	0.000
Human Resource Competence (M3) → Logistics Service Performance (Y)	0.187	0.187	0.021	9.045	0.000
Quality of Logistics Policy Governance (X1) → Logistics Ecosystem Innovation Capability (M1)	0.539	0.542	0.048	11.289	0.000
M3*Z1 → Logistics Service Performance (Y)	0.086	0.074	0.042	2.036	0.042
M3*Z2 → Logistics Service Performance (Y)	-0.005	-0.004	0.031	0.162	0.871
M3*Z3 → Logistics Service Performance (Y)	0.059	0.068	0.037	1.615	0.107
X3*Z1 → Human Resource Competence (M3)	0.191	0.176	0.06	3.202	0.001
X3*Z2 → Human Resource Competence (M3)	0.131	0.139	0.059	2.232	0.026
X3*Z3 → Human Resource Competence (M3)	0.028	0.027	0.045	0.627	0.531
Logistics Industry Competition Intensity (X2) → Operational Process Efficiency (M2) → Logistics Service Performance (Y)	0.063	0.063	0.013	4.676	0.000

Variabel	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Quality of Logistics Policy Governance (X1) → Logistics Ecosystem Innovation Capability (M1) → Logistics Service Performance (Y)	0.045	0.046	0.012	3.727	0.000
Implementation of NLE Policy (X3) → Human Resource Competence (M3) → Logistics Service Performance (Y)	0.093	0.092	0.013	6.97	0.000

Source: Researcher's Processed Data (2025)

4.7 Qualitative Findings

The qualitative analysis of interviews with 20 key informants revealed several critical barriers and facilitators in NLE implementation:

- **System and Human Resource Unpreparedness:** Many respondents highlighted the lack of readiness in digital infrastructure and workforce skills, especially in remote regions, as major obstacles.
- **Bureaucratic Complexity:** Complex regulatory frameworks and overlapping institutional responsibilities hinder smooth policy execution.
- **Infrastructure Disparities:** Uneven distribution of digital and physical infrastructure across Indonesia's vast archipelago creates operational challenges.
- **Technical Issues:** Suboptimal user interface/user experience (UI/UX) of NLE platforms and frequent system disruptions negatively impact user adoption and satisfaction.
- **Multi-Stakeholder Collaboration:** Strong collaboration among port operators, technology providers, government agencies, and customers was identified as a key driver for innovation and accelerated adoption.

These findings complement the quantitative results by providing context-specific explanations for observed statistical relationships and highlighting areas for policy and operational improvements.

4.8 Discussion of Findings

The findings confirm that effective governance quality in logistics policy fosters innovation capability within the logistics ecosystem, consistent with public policy implementation and innovation systems theories. This is novel in the logistics context, where governance transparency, accountability, and coordination create an environment conducive to technological and process innovations.

Competitive intensity drives operational efficiency improvements, supporting dynamic capabilities and RBV theories. The pressure to optimize resources and innovate promotes efficiency gains essential for logistics competitiveness. NLE policy implementation significantly enhances HR competencies, validating the role of capacity building, certification, and training embedded in the policy. This finding contributes to human capital development theory by demonstrating how policy-driven capacity enhancement translates into improved workforce competencies necessary for digital logistics.

Innovation capability, operational efficiency, and HR competencies each positively influence logistics service performance, underscoring their critical roles as mediators in the policy-performance link. These results align with prior studies emphasizing the importance of technological adoption, process optimization, and skilled human resources in logistics effectiveness. Digitalization acts as a significant moderator, amplifying the positive effects of NLE implementation on HR competencies and subsequently on logistics performance. This confirms technology amplification theory, highlighting the synergistic effects of digital adoption and human capital development. The significant moderation by digital ecosystem maturity on the NLE-HR competency link suggests that digital infrastructure and ecosystem readiness are vital enablers for policy impact. However, its non-significant moderation on HR competency to performance may indicate other factors influencing the final service outcomes.

The lack of significant moderation by openness to global best practices suggests institutional and cultural barriers may limit the effective translation of international standards into improved competencies and performance in Indonesia's logistics sector. Qualitative findings complement the quantitative results by revealing practical barriers such as system readiness issues, complex bureaucracy, uneven digital and physical infrastructure across regions, and technical challenges including suboptimal user interface and system disruptions. These insights emphasize the need for comprehensive strategies addressing structural, human, and technological dimensions to optimize NLE implementation.

4.9 Novelty and Scientific Contribution

This study provides a novel integrative model combining public policy implementation, RBV, innovation diffusion, and digital transformation theories to explain logistics service performance in Indonesia's unique archipelagic context. The simultaneous examination of mediating HR competencies and operational efficiency, alongside moderating digitalization and ecosystem maturity, advances theoretical understanding of logistics policy impacts. Practically, the findings offer evidence-based guidance for policymakers to strengthen governance, enhance HR capacity, accelerate digital transformation, and tailor interventions to regional disparities. The study highlights the critical role of digital ecosystem maturity and the limitations of global best practice

adoption, informing targeted policy and managerial actions. Openness to global best practices does not significantly moderate policy or competency effects.

5 Conclusion

This study comprehensively analysed the impact of the National Logistics Ecosystem (NLE) policy implementation on logistics service performance in Indonesia integrating the mediating role of human resource (HR) competencies and the moderating role of digitalization within the framework of sustainable economic development. The findings reveal that the quality of logistics policy governance and the intensity of industry competition positively influence the innovation capability of the logistics ecosystem and operational process efficiency, which in turn enhance logistics service performance. Moreover, the implementation of NLE significantly improves HR competencies, which serve as a critical mediator linking policy implementation to service performance. Digitalization and digital ecosystem maturity partially moderate these relationships, amplifying the positive effects of NLE implementation on HR competencies and subsequently on logistics performance, while openness to global best practices was not found to be a significant moderator. Qualitative insights identified key barriers such as system unpreparedness, HR competency gaps, complex bureaucracy, uneven infrastructure distribution, and technical issues, including suboptimal user interfaces and system disruptions.

Theoretically, this research advances knowledge by integrating public policy implementation theory, resource-based view, and innovation diffusion theory into a novel, comprehensive framework tailored to Indonesia's unique archipelagic context. Practically, it offers evidence-based recommendations for policymakers, industry practitioners, and educational institutions to optimize NLE implementation through strengthening HR capacity, equitable infrastructure development, regulatory simplification, improved system integration, and user-centric public services. The study's novelty lies in its systematic mixed-method approach that elucidates the mediating and moderating mechanisms underlying policy effectiveness, addressing significant gaps in logistics policy literature for developing, geographically complex nations. Future research should explore longitudinal impacts of NLE, expand geographic coverage to include more diverse regional contexts, and investigate the evolving role of digital ecosystems and global best practice adoption in enhancing logistics performance and sustainability. This study significantly contributes to the scholarly discourse on logistics management and public policy while providing actionable insights to support Indonesia's ambitions for a more competitive, efficient, and sustainable national logistics system.

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