

Digital Transformation, Green Logistics Capability, and Operational Efficiency in Indonesian Freight Forwarding: The Sequential Mediating Mechanisms of Technology Adoption and Service Excellence

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ABSTRACT



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This study examines the sequential mediating roles of technology adoption and service excellence in the relationships among digital transformation, green logistics capability, and operational efficiency in Indonesian freight forwarding companies. This quantitative causal-explanatory research employed a cross-sectional survey of 250 managers from freight forwarding companies in Indonesia. Data analysis utilized Structural Equation Modeling-Partial Least Squares (SEM-PLS) with SmartPLS 3.0 and bootstrapping with 5,000 subsamples. Data analysis utilized Structural Equation Modeling-Partial Least Squares (SEM-PLS) with SmartPLS 3.0 and bootstrapping with 5,000 subsamples. The findings confirm all seven direct hypotheses and both sequential mediation hypotheses. Digital transformation significantly influences technology adoption ($\beta=0.385$, $p<0.001$), whereas green logistics capability positively affects it ($\beta=0.342$, $p<0.001$). Technology adoption substantially enhances service excellence ($\beta=0.431$, $p<0.001$), which in turn drives operational efficiency ($\beta=0.402$, $p<0.001$). Crucially, the sequential mediation pathways—digital transformation $\rightarrow$ technology adoption $\rightarrow$ service excellence $\rightarrow$ operational efficiency and green logistics capability $\rightarrow$ technology adoption $\rightarrow$ service excellence $\rightarrow$ operational efficiency—are both significant, demonstrating that technology adoption and service excellence function as complementary sequential mechanisms. This research provides theoretical contributions by extending dynamic capabilities theory through the identification of sequential micro-foundations. It offers practical implications for forwarding managers, industry associations, and policymakers regarding integrated digital and green strategies.

Keywords: Digital Transformation, Green Logistics Capability, Technology Adoption, Service Excellence, Operational Efficiency, Freight Forwarding

1. Introduction

The freight forwarding industry plays a strategic role in Indonesia's logistics ecosystem by facilitating domestic and international trade across an archipelagic country consisting of more than 17,000 islands. The rapid expansion of e-commerce and post-pandemic economic recovery have increased demand for integrated logistics services. Nevertheless, Indonesia continues to face structural challenges reflected in declining

logistics competitiveness, relatively high logistics costs, and increasing pressure to improve operational efficiency and service reliability (Badan Pusat Statistik, 2025; World Bank, 2023; Ministry of Transportation, 2024). These challenges require freight forwarding companies to continuously develop organizational capabilities that enable them to respond effectively to technological disruption and rapidly changing market conditions.

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Dynamic Capabilities Theory (DCT) provides the primary theoretical lens for explaining how firms achieve sustainable performance under environmental turbulence. According to Teece et al. (1997) and Teece (2007), organizations create superior performance by sensing environmental changes, seizing strategic opportunities, and continuously reconfiguring organizational resources and capabilities. In the freight forwarding context, digital transformation and green logistics capability represent strategic dynamic capabilities that enable firms to respond simultaneously to digital disruption and sustainability demands. However, these capabilities only create value when they are successfully transformed into operational capabilities that improve organizational performance (Helfat & Peteraf, 2015).

Digital transformation has become a strategic priority within the logistics industry. Technologies such as Transportation Management Systems (TMS), Internet of Things (IoT), artificial intelligence, cloud computing, blockchain, and electronic documentation systems have significantly improved visibility, coordination, and operational decision-making throughout supply chains (Hanelt et al., 2021; Kembro & Norrman, 2022). Despite these technological developments, many Indonesian freight forwarding companies continue to experience limited operational improvements because digital investments are frequently implemented without sufficient organizational adoption and capability integration (Alifyanda, 2024).

At the same time, sustainability has become another strategic imperative for logistics firms. Increasing environmental regulations, stakeholder expectations, and ESG initiatives require freight forwarding companies to integrate environmentally responsible practices into logistics operations. Green logistics capability including green technology, environmental orientation, green collaboration, and environmentally integrated operational processes has increasingly been recognized as an important organizational capability that simultaneously enhances environmental performance and business competitiveness (Hart, 1995; Khairunissa & Santosa, 2022; Duzgun, 2026).

Although previous studies have demonstrated positive relationships between digital transformation, green logistics practices, technology adoption, service quality, and organizational performance, several important research gaps remain. First, previous logistics studies generally investigate digital transformation and green logistics capability separately, whereas firms increasingly implement both strategies simultaneously (Hanelt et al., 2021; El Bhilat & Hamidi, 2025). Second, most studies focus on direct effects while providing limited explanation of the internal capability-building mechanisms through which these strategic initiatives generate operational efficiency (Liu et al., 2023; Wieland et al., 2021). Third, empirical evidence from freight forwarding companies in developing economies, particularly Indonesia and other ASEAN countries, remains

limited despite their distinct institutional and operational characteristics.

From the perspective of Dynamic Capabilities Theory, these unresolved issues represent a capability transformation problem. Strategic capabilities such as digital transformation and green logistics capability must first be reconfigured into operational capabilities before generating organizational performance. Accordingly, this study proposes that technology adoption and service excellence function as sequential capability-building mechanisms that translate strategic resources into operational efficiency. Technology adoption reflects an organization's capability to absorb and utilize digital technologies, whereas service excellence represents the capability to convert technological resources into superior logistics services, ultimately enhancing operational efficiency (Teece, 2007).

The supporting theories provide complementary explanations for this sequential transformation process. Resource-Based View (RBV) explains why digital transformation and green logistics capability constitute valuable organizational resources that generate competitive advantage (Barney, 1991; Barney et al., 2021). Natural Resource-Based View (NRBV) extends this perspective by emphasizing environmental capabilities as strategic assets (Hart, 1995). Technology Acceptance Model (TAM) explains how perceived usefulness and perceived ease of use determine successful technology adoption (Davis, 1989; Venkatesh et al., 2003), whereas Stakeholder Theory explains how pressures from regulators, customers, and business partners encourage firms to strengthen sustainability practices and service excellence (Freeman, 1984; Kumar et al., 2021). Rather than serving as independent theoretical foundations, these theories complement Dynamic Capabilities Theory by explaining specific mechanisms embedded within the broader capability reconfiguration process.

This study addresses several important gaps in the logistics transformation literature. Unlike previous studies that primarily examine isolated relationships or single mediating variables, this research develops and empirically tests a sequential mediation model linking digital transformation and green logistics capability with operational efficiency through technology adoption and service excellence. The study therefore extends Dynamic Capabilities Theory by operationalizing technology adoption and service excellence as sequential micro-foundations through which sensing, seizing, and transforming processes generate operational outcomes. Furthermore, the study contributes empirical evidence from Indonesian freight forwarding companies, offering insights that are relevant to logistics firms operating in other ASEAN countries and emerging economies facing comparable digitalization and sustainability challenges.

Accordingly, this study aims to examine the effects of digital transformation and green logistics capability on operational efficiency through the sequential mediating roles of technology adoption and service excellence. The findings are expected to contribute theoretically by

extending Dynamic Capabilities Theory through a sequential capability transformation mechanism while providing practical implications for freight forwarding companies seeking to integrate digital transformation and sustainability initiatives to achieve operational excellence.

2. Literature Review

2.1 Dynamic Capabilities Theory

Dynamic Capabilities Theory (DCT) serves as the primary theoretical foundation of this study because it explains how organizations achieve sustained competitive performance by continuously adapting to dynamic business environments. Unlike traditional strategic management theories that emphasize the possession of valuable resources, DCT argues that long-term organizational success depends on a firm's ability to sense environmental changes, seize emerging opportunities, and transform organizational resources into new capabilities (Teece et al., 1997; Teece, 2007).

The logistics industry has experienced unprecedented environmental turbulence driven by digitalization, globalization, increasing customer expectations, and sustainability pressures. Consequently, freight forwarding companies are required not only to possess technological and environmental resources but also to continuously reconfigure these resources into organizational capabilities that improve operational performance (Helfat & Peteraf, 2015). Within the context of this research, digital transformation and green logistics capability are conceptualized as first-order dynamic capabilities that enable organizations to respond to technological disruption and environmental change. However, these strategic capabilities cannot directly improve operational efficiency. Instead, organizations must first develop internal operational capabilities that facilitate capability deployment. Therefore, this study proposes that technology adoption and service excellence represent sequential capability reconfiguration mechanisms through which strategic capabilities are translated into superior operational efficiency. Accordingly, Dynamic Capabilities Theory provides the overarching explanation for the proposed sequential mediation model, in which firms continuously reconfigure strategic resources into operational capabilities before achieving organizational performance.

2.2 Supporting Theoretical Perspectives

Although Dynamic Capabilities Theory provides the principal theoretical explanation, several complementary theories help explain specific relationships within the proposed research model.

Resource-Based View (RBV)

Resource-Based View argues that sustainable competitive advantage originates from organizational resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991; Barney et al., 2021). From this perspective, digital transformation and green logistics capability constitute strategic organizational resources that strengthen firms' capability portfolios. However, RBV primarily explains what

strategic resources firms possess, whereas Dynamic Capabilities Theory explains how these resources are continuously reconfigured into organizational capabilities. Therefore, RBV functions as a supporting theory rather than the primary theoretical foundation.

Natural Resource-Based View (NRBV)

Natural Resource-Based View extends RBV by emphasizing environmental capabilities as sources of sustainable competitive advantage (Hart, 1995). Green logistics capability—including environmentally friendly technologies, green collaboration, environmental orientation, and green process integration—represents a strategic capability that enables firms to simultaneously improve environmental sustainability and business performance (Khairunissa & Santosa, 2022; Duzgun, 2026). Within this study, NRBV complements Dynamic Capabilities Theory by explaining the strategic importance of environmental capability development.

Technology Acceptance Model (TAM)

Technology Acceptance Model explains how individuals and organizations adopt new technologies through perceptions of usefulness and ease of use (Davis, 1989; Venkatesh et al., 2003). Since digital transformation cannot generate organizational value without successful technology utilization, TAM provides the theoretical basis for explaining why technology adoption functions as the first capability-building mechanism linking digital transformation with subsequent organizational outcomes.

Stakeholder Theory

Stakeholder Theory argues that organizational performance increasingly depends on firms' ability to satisfy multiple stakeholder expectations, including customers, governments, regulators, business partners, and society (Freeman, 1984; Kumar et al., 2021). Increasing environmental regulations and customer demand for sustainable logistics encourage freight forwarding companies to strengthen green logistics capability and continuously improve service quality. Consequently, Stakeholder Theory complements Dynamic Capabilities Theory by explaining the external pressures that motivate organizational capability development.

2.3 Service Excellence as a Dynamic Capability

Service Excellence Theory emphasizes that superior organizational performance is achieved when firms consistently deliver reliable, responsive, convenient, and trustworthy services that exceed customer expectations (Parasuraman et al., 1988; Zeithaml et al., 1990). Within logistics services, service excellence extends beyond customer satisfaction by improving process reliability, reducing operational errors, accelerating service delivery, and strengthening customer relationships.

From the perspective of Dynamic Capabilities Theory, service excellence represents the transforming stage of capability deployment. After organizations successfully adopt digital technologies, these technologies must be embedded into operational processes that create superior customer value.

Consequently, service excellence functions as an organizational capability through which technological resources are translated into improved operational efficiency.

This conceptualization also explains why service excellence is positioned as the second mediator in the proposed sequential mediation model. Technology adoption provides the technological infrastructure necessary for organizational transformation, whereas service excellence represents the operational manifestation of successful capability reconfiguration that ultimately improves organizational efficiency.

2.4 Conceptual Synthesis

Figure 1 integrates Dynamic Capabilities Theory with four complementary theoretical perspectives to explain the proposed sequential mediation mechanism.

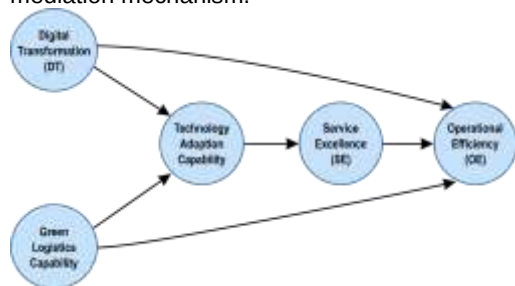


Figure 1: Conceptual Framework

Dynamic Capabilities Theory serves as the overarching theoretical framework by explaining how organizations continuously reconfigure strategic capabilities into superior operational performance. Within this framework, digital transformation and green logistics capability represent first-order dynamic capabilities that enable firms to respond to technological disruption and sustainability challenges. These strategic capabilities must subsequently be transformed into operational capabilities before generating organizational outcomes.

Technology adoption constitutes the first capability-building mechanism through which organizations absorb and institutionalize digital technologies. Service excellence subsequently transforms these technological capabilities into customer value and operational effectiveness. Finally, operational efficiency represents the organizational outcome of successful capability deployment.

The complementary theories strengthen this explanation from different perspectives. Resource-Based View explains the strategic value of digital and green resources. Natural Resource-Based View extends this argument by emphasizing environmental capabilities as sources of sustainable advantage. Technology Acceptance Model explains organizational technology utilization, whereas Stakeholder Theory explains external pressures encouraging sustainability and service improvement. Rather than functioning as independent theoretical foundations, these theories provide complementary explanations for specific

relationships embedded within the broader Dynamic Capabilities framework.

Consequently, the proposed sequential mediation model extends Dynamic Capabilities Theory by identifying technology adoption and service excellence as sequential micro-foundations through which digital transformation and green logistics capability are translated into operational efficiency.

Following the conceptual synthesis presented above, the proposed hypotheses are developed based on Dynamic Capabilities Theory, which explains how firms transform strategic capabilities into operational outcomes through sequential capability reconfiguration mechanisms. The complementary theories—Resource-Based View, Natural Resource-Based View, Technology Acceptance Model, and Stakeholder Theory—provide supporting explanations for specific relationships within the research model. Accordingly, the hypotheses emphasize the causal relationships among the research variables rather than repeating the theoretical foundations previously discussed.

Direct Effect

H1a: Digital Transformation → Technology Adoption

Digital transformation enables firms to integrate digital infrastructure, automate operational processes, and enhance organizational learning. According to Dynamic Capabilities Theory, these initiatives strengthen an organization's capability to reconfigure resources in response to technological change, thereby facilitating technology adoption. Empirical studies consistently report that organizations with higher levels of digital transformation demonstrate greater technology utilization and digital capability development (Liu et al., 2023; Melanie et al., 2024; Arianto et al., 2025).

H1a: Digital transformation positively affects technology adoption.

H1b: Green Logistics Capability → Technology Adoption

Green logistics capability encourages firms to adopt environmentally friendly technologies and digital solutions that improve operational sustainability. Organizations with stronger environmental capabilities tend to accelerate technology implementation because digital systems facilitate energy efficiency, emissions monitoring, and environmentally responsible logistics operations (Duzgun, 2026).

H1b: Green logistics capability positively affects technology adoption.

H2a: Digital Transformation → Service Excellence

Digital transformation improves organizational responsiveness, service accuracy, and operational integration, enabling firms to provide superior logistics services. As firms successfully deploy digital technologies throughout operational

processes, service quality and customer experience improve significantly (Liu et al., 2023; Zhang et al., 2025).

H2a: Digital transformation positively affects service excellence.

H2b: Green Logistics Capability → Service Excellence

The implementation of environmentally responsible logistics practices strengthens organizational reputation while simultaneously improving service reliability and operational consistency. Consequently, firms with stronger green logistics capability are more likely to deliver superior logistics services (Praditya & Surjasa, 2022; Khoiriyah et al., 2025).

H2b: Green logistics capability positively affects service excellence.

H3: Technology Adoption → Service Excellence

Technology adoption enables organizations to utilize digital systems that improve service responsiveness, shipment visibility, process accuracy, and customer communication. From the perspective of Dynamic Capabilities Theory, technology adoption represents an intermediate capability that supports the transformation of strategic resources into superior service performance. Recent studies consistently demonstrate that successful technology adoption enhances service quality across logistics operations (Melanie et al., 2024; Arianto et al., 2025).

H3: Technology adoption positively affects service excellence.

H4: Service Excellence → Operational Efficiency

Service excellence contributes to operational efficiency by reducing service failures, minimizing process delays, improving coordination, and enhancing resource utilization. Organizations capable of consistently delivering reliable logistics services achieve higher operational performance through improved process effectiveness and lower operating costs (Zhang et al., 2025; Khoiriyah et al., 2025).

H4: Service excellence positively affects operational efficiency.

Single Mediation

H5a: Technology Adoption mediates the relationship between Digital Transformation and Service Excellence.

Dynamic Capabilities Theory suggests that digital transformation creates organizational value only after digital technologies are effectively adopted and embedded into operational processes. Technology adoption therefore functions as the capability-building mechanism through which digital transformation enhances service excellence (Liu et al., 2023; Melanie et al., 2024).

H5a: Technology adoption mediates the relationship between digital transformation and service excellence.

H5b: Technology Adoption mediates the relationship between Green Logistics Capability and Service Excellence.

Green logistics capability encourages the implementation of environmentally oriented digital technologies, which subsequently improve service quality. Accordingly, technology adoption acts as an intermediary mechanism linking green logistics capability with service excellence (Khairunissa & Santosa, 2022; Duzgun, 2026).

H5b: Technology adoption mediates the relationship between green logistics capability and service excellence.

H6a: Service Excellence mediates the relationship between Digital Transformation and Operational Efficiency.

Digital transformation improves operational efficiency when digital capabilities are translated into superior logistics services. Consequently, service excellence serves as the organizational capability through which digital transformation creates operational value (Zhang et al., 2025).

H6a: Service excellence mediates the relationship between digital transformation and operational efficiency.

H6b: Service Excellence mediates the relationship between Green Logistics Capability and Operational Efficiency.

Green logistics capability contributes to operational efficiency by strengthening environmentally responsible service delivery. Therefore, service excellence functions as the mediating mechanism through which green capabilities improve operational performance (Khoiriyah et al., 2025).

H6b: Service excellence mediates the relationship between green logistics capability and operational efficiency.

Sequential Mediation

H7a: Technology Adoption and Service Excellence sequentially mediate the relationship between Digital Transformation and Operational Efficiency.

Building upon Dynamic Capabilities Theory, this study proposes that digital transformation does not directly improve operational efficiency. Instead, firms must first develop technology adoption capabilities before transforming these capabilities into service excellence, which subsequently enhances operational efficiency. This sequential capability transformation mechanism represents the central theoretical proposition of the present study and extends previous logistics research that primarily examined isolated mediating effects (Hayes, 2018; Hair et al., 2019; Liu et al., 2023).

H7a: Technology adoption and service excellence sequentially mediate the relationship between digital transformation and operational efficiency.

H7b: Technology Adoption and Service Excellence sequentially mediate the relationship between Green Logistics Capability and Operational Efficiency.

Similarly, green logistics capability is expected to improve operational efficiency through a sequential process in which environmentally oriented capabilities facilitate technology adoption, technology adoption strengthens service excellence, and superior service performance ultimately enhances operational efficiency. This sequential mechanism extends Dynamic Capabilities Theory by explaining how environmental capabilities are transformed into operational outcomes through multiple capability-building stages (Hart, 1995; Duzgun, 2026; Pham et al., 2025).

H7b: Technology adoption and service excellence sequentially mediate the relationship between green logistics capability and operational efficiency.

The framework also reflects the integration of multiple theoretical perspectives. The Resource-Based View provides the resource logic (Teece, 2007). The Technology Acceptance Model provides the technology adoption logic (Davis, 1989). The Natural-Resource-Based View provides the environmental logic (Hart, 1995). Stakeholder Theory provides the external legitimacy logic (Freeman, 1984). The integration of these perspectives provides a comprehensive explanation of the hypothesized relationships.

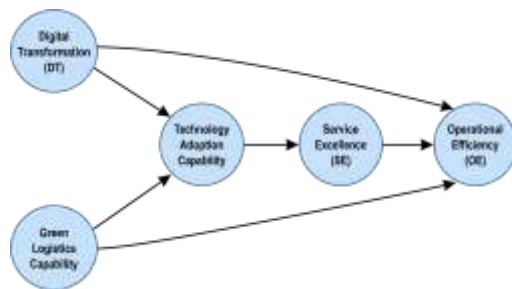


Figure 1: Conceptual Framework

3. Method

3.1 Research Design

This study employed a quantitative research approach with a causal-explanatory design to examine the relationships among digital transformation, green logistics capability, technology adoption, service excellence, and operational efficiency. A cross-sectional survey was conducted because the study aimed to empirically test the proposed sequential mediation model at a single point in time. Given the predictive orientation of the research model and the presence of multiple mediating constructs, Partial Least Squares Structural Equation Modeling (PLS-SEM) was selected as the analytical approach. PLS-SEM is appropriate for complex predictive models, does not require multivariate normality, and performs well with

latent variables measured by multiple indicators (Hair et al., 2022).

3.2 Population and Sampling

The target population comprised freight forwarding companies operating in Indonesia and registered with the Indonesian National Freight Forwarders Association (INFA) and the Indonesian Chamber of Commerce and Industry (KADIN). These organizations represent the formal logistics sector responsible for domestic and international freight forwarding activities.

Purposive sampling was employed because the study focused on organizations that had implemented both digital transformation initiatives and green logistics practices. Probability sampling was considered inappropriate because not all forwarding companies possess these organizational characteristics. Purposive sampling therefore ensured that respondents possessed sufficient knowledge and experience to evaluate the constructs investigated in this study, consistent with recommendations for explanatory business research (Sekaran & Bougie, 2016).

Companies were eligible if they (1) had operated for at least three years, (2) served a minimum of twenty corporate customers, (3) utilized digital logistics systems such as online shipment tracking or transportation management systems, and (4) had implemented environmental sustainability initiatives.

Power analysis following Hair et al. (2022) indicated that a minimum sample exceeding 200 observations would provide adequate statistical power for the proposed structural model. Accordingly, 350 questionnaires were distributed, yielding 250 completed questionnaires. After screening for completeness and eligibility, all 250 responses were retained for analysis, resulting in a response rate of 71.4%.

3.3 Respondent Screening and Data Collection

To ensure data quality, respondents were screened before questionnaire distribution. Eligible respondents were required to occupy managerial or executive positions directly responsible for logistics operations, supply chain management, digital transformation, or strategic decision-making. In addition, respondents were required to possess at least three years of professional experience and to be actively involved in organizational digital transformation and operational improvement initiatives.

Each participating company was represented by only one qualified respondent. Before distributing the questionnaire, the researchers contacted each company to identify the individual with the greatest knowledge of digital transformation, green logistics capability, and operational performance. Company names, respondent positions, and corporate e-mail addresses were verified during data collection. During data cleaning, duplicate organizational identities and duplicate e-mail addresses were removed to ensure that each company contributed only one observation.

Data were collected over eight weeks using three distribution channels: (1) official corporate e-mail, (2) professional logistics associations and LinkedIn networks, and (3) direct researcher assistance when necessary. Two reminder messages were distributed during Weeks 3 and 6 to improve the response rate.

3.4 Procedures to Reduce Common Method Bias

Several procedural remedies were implemented before data collection to minimize common method bias (Podsakoff et al., 2003). First, respondents were assured that their responses would remain anonymous and confidential. Second, respondents were informed that there were no right or wrong answers and that participation was solely for academic purposes, thereby reducing evaluation apprehension. Third, questionnaire items representing different constructs were arranged in mixed order to minimize respondents' ability to infer the research hypotheses. Fourth, all questionnaire items were written using simple and unambiguous language to reduce misunderstanding and response bias. Finally, participation was voluntary, and respondents were allowed to withdraw at any stage without consequence.

3.5 Measurement Instrument

Data were collected using a structured questionnaire measured on a five-point Likert scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). All measurement items were adapted from previously validated international studies and modified to fit the Indonesian freight forwarding context.

Table 1. Measurement of Research Constructs

Construct	Dimensions	Indicators	Primary References
Digital Transformation	Digital infrastructure, process integration, digital capability	9	Liu et al. (2023); Melanie et al. (2024)
Green Logistics Capability	Green technology, environmental orientation, green collaboration, green process integration	12	Khairunissa & Santosa (2022); Duzgun (2026)
Technology Adoption	Perceived usefulness, perceived ease of use, actual usage	9	Davis (1989); Venkatesh et al. (2003)
Service Excellence	Responsiveness, reliability, convenience, assurance	12	Zeithaml et al. (1990); Lin & Liang (2011)
Operational Efficiency	Time efficiency, cost efficiency, resource utilization, error reduction	12	Liu et al. (2023); Zhang et al. (2025)

Prior to the main survey, a pilot study involving 30 respondents was conducted to evaluate questionnaire clarity, readability, and contextual appropriateness. These respondents met the study criteria but were excluded from the final sample.

3.6 Non-response Bias

To assess the possibility of non-response bias, early respondents were compared with late respondents using independent-sample t-tests following the procedure suggested by Armstrong and Overton (1977). No statistically significant differences were observed between the two groups across the principal study variables ($p > 0.05$), indicating that non-response bias is unlikely to influence the findings.

3.7 Data Analysis

Data analysis was performed using SmartPLS 3 (Ringle et al., 2024). The analysis followed the two-stage PLS-SEM procedure recommended by Hair et al. (2022).

The first stage evaluated the measurement model by examining indicator reliability, internal consistency reliability (Cronbach's Alpha and Composite Reliability), convergent validity (Average Variance Extracted), and discriminant validity using both the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio.

The second stage evaluated the structural model by examining collinearity (VIF), coefficient of determination (R^2), predictive relevance (Q^2), effect size (f^2), standardized root mean square residual (SRMR), and hypothesis testing through bootstrapping with 5,000 resamples. Direct, indirect, and sequential mediation effects were evaluated using bias-corrected bootstrap confidence intervals at the 5% significance level.

3.8 Assessment of Common Method Bias

Following data collection, common method bias was further examined using both procedural and statistical approaches. Harman's Single-Factor Test indicated that the first factor accounted for **36.2%** of the total variance, below the recommended threshold of 50% (Podsakoff et al., 2003). In addition, all full-collinearity VIF values were below 3.3, indicating that common method bias was unlikely to threaten the validity of the research findings (Kock, 2015).

3.9 Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Economics and Business, Universitas Pancasila. Participation was voluntary, and informed consent was obtained electronically before respondents completed the questionnaire. Respondents were assured that their identities would remain confidential and that the collected data would be used exclusively for academic research purposes. All data were stored securely and accessed only by the research team.

4. Results And Discussion

4.1 Respondent Profile

This study involved 250 respondents consisting of directors, operational managers, logistics managers, digital transformation managers, and supply chain managers from freight forwarding companies in Indonesia registered with INFA. Based on the data collection results, the questionnaire return rate reached 71.4% from the 350 questionnaires distributed.

Table 2: Respondent Profile

Characteristic	Category	Freq.(n)	(%)
Position	Operational Manager	63	25.0
	Logistics Manager	50	20.0
	Supply Chain Manager	45	18.0
	Digital Transformation Manager	38	15.0
	Director	30	12.0
	Other Positions	24	10.0
	Total	250	100
Length of Service	> 5 years	113	45.0
	3-5 years	75	30.0
	1-3 years	45	18.0
	< 1 year	17	7.0
	Total	250	100
Company Size	Large (>250 employees)	113	45.0
	Medium (50-250 employees)	87	35.0
	Small (<50 employees)	50	20.0
	Total	250	100
Online Tracking System Usage	Yes	250	100
	No	0	0
	Total	250	100
Geographic Distribution	Jabodetabek	100	40.0
	Surabaya	45	18.0
	Medan	30	12.0
	Makassar	25	10.0
	Batam	20	8.0
	Semarang	15	6.0
	Bandung	10	4.0
	Other Locations	5	2.0
	Total	250	100

Source: Research Data, 2026

Note: $n = 250$. Percents may not sum to 100 due to rounding. Jabodetabek = Jakarta, Bogor, Depok, Tangerang, Bekasi metropolitan area.

Table 2 presents the demographic profile of the 250 respondents who participated in this

study. In terms of position, the largest group was operational managers (25%), followed by logistics managers (20%), supply chain managers (18%), digital transformation managers (15%), directors (12%), and other related positions (10%). This distribution indicates that respondents held strategic and operational roles relevant to digital transformation, green logistics, and operational efficiency decision-making.

Regarding length of service, nearly half of the respondents (45%) had more than five years of experience in the freight forwarding industry, followed by those with 3-5 years (30%), 1-3 years (18%), and less than one year (7%). The predominance of experienced respondents suggests that the data reflects informed perspectives on industry practices and transformation challenges.

In terms of company size, 45% of respondents came from large companies with more than 250 employees, 35% from medium-sized companies (50-250 employees), and 20% from small companies with fewer than 50 employees. This distribution captures the diversity of forwarding companies operating in Indonesia.

All respondents (100%) confirmed that their companies utilize online tracking systems, fulfilling the research inclusion criteria related to digital technology adoption. The geographic distribution shows that the majority of respondents were from Jabodetabek (40%), reflecting the concentration of forwarding companies in the Greater Jakarta area, followed by Surabaya (18%), Medan (12%), Makassar (10%), Batam (8%), Semarang (6%), Bandung (4%), and other locations (2%).

4.2 Description of Research Variables

The descriptive analysis shows the mean values for each variable as follows. Digital Transformation (X_1) recorded the highest mean on indicator DT7 (management willingness to invest in digital technology) at 4.18 (SD = 0.72), while indicator DT5 (automation of documentation processes) had the lowest mean of 3.72 (SD = 0.81), with an overall average for the Digital Transformation variable of 3.96 (SD = 0.52), categorized as "Agree".

Green Logistics Capability (X_2) showed the highest mean on GL7 (management commitment to environmentally friendly practices) at 4.22 (SD = 0.68) and the lowest on GL12 (implementation of environmental management systems) at 3.59 (SD = 0.85), with an overall average of 3.92 (SD = 0.58).

Technology Adoption (Z_1) had the highest mean on TA3 (digital system accuracy for tracking) at 4.30 (SD = 0.64) and the lowest on TA6 (adaptation time) at 3.88 (SD = 0.76), with an overall average of 4.13 (SD = 0.47).

Service Excellence (Z_2) recorded the highest mean on SE10 (cargo security and protection) at 4.38 (SD = 0.60) and the lowest on SE8 (one-stop service) at 4.04 (SD = 0.72), with an overall average of 4.21 (SD = 0.44).

Operational Efficiency (Y) had the highest mean on OE7 (fleet utilization) at 4.28 (SD =

0.65) and the lowest on OE5 (reduction in manual labor costs) at 3.92 (SD = 0.78), with an overall average of 4.12 (SD = 0.49).

Overall, all variables fall into the "Agree" category, indicating respondents' positive perceptions of the implementation of digital transformation and green logistics capability, as well as relatively good levels of technology adoption, service excellence, and operational efficiency.

4.3 Validity and Reliability Tests

Table 3: Convergent Validity and Reliability Results

Variable	Cronbach's Alpha	Composite Reliability	AVE	HTMT (max)
Digital Transformation	0.884	0.918	0.672	<0.85
Green Logistics Capability	0.892	0.925	0.681	<0.85
Technology Adoption	0.876	0.912	0.658	<0.85
Service Excellence	0.901	0.932	0.694	<0.85
Operational Efficiency	0.896	0.928	0.687	<0.85

Source: Research Data, 2026

Note: n = 250. AVE = Average Variance Extracted; HTMT = Heterotrait-Monotrait Ratio. All HTMT values are below the conservative threshold of 0.85, confirming discriminant validity (Henseler et al., 2015).

The convergent validity test results showed that all indicators had factor loadings > 0.70, ranging from 0.721 to 0.889, meeting the criteria of Hair et al. (2019). The Average Variance Extracted (AVE) values for each construct were: Digital Transformation (0.672), Green Logistics Capability (0.681), Technology Adoption (0.658), Service Excellence (0.694), and Operational Efficiency (0.687), all exceeding the recommended threshold of 0.50 (Fornell & Larcker, 1981).

Reliability testing yielded Cronbach's Alpha values: Digital Transformation (0.884), Green Logistics Capability (0.892), Technology Adoption (0.876), Service Excellence (0.901), and Operational Efficiency (0.896); and Composite Reliability values: Digital Transformation (0.918), Green Logistics Capability (0.925), Technology Adoption (0.912), Service Excellence (0.932), and Operational Efficiency (0.928). All values exceeded 0.70, indicating very good reliability (Nunnally & Bernstein, 1994). These results confirm that the measurement model meets all criteria for validity and reliability, providing confidence in the subsequent structural model testing.

Table 4: Discriminant Validity - Fornell-Larcker Criterion

Construct	DT	GLC	TA	SE	OE
Digital Transformation	0.820				
Green Logistics Capability	0.482	0.825			
Technology Adoption	0.512	0.468	0.811		
Service Excellence	0.435	0.491	0.527	0.833	
Operational Efficiency	0.456	0.443	0.498	0.509	0.829

Note: Diagonal values (bold) represent the square root of Average Variance Extracted (AVE). Off-diagonal values represent the correlations between constructs. Discriminant validity is established when diagonal values exceed the off-diagonal values in the same row and column (Fornell & Larcker, 1981).

Table 5: Discriminant Validity - Heterotrait-Monotrait Ratio (HTMT)

Construct Pair	HTMT Value	Threshold	Status
Digital Transformation ↔ Green Logistics Capability	0.637	<0.85	Achieved
Digital Transformation ↔ Technology Adoption	0.668	<0.85	Achieved
Digital Transformation ↔ Service Excellence	0.582	<0.85	Achieved
Digital Transformation ↔ Operational Efficiency	0.601	<0.85	Achieved
Green Logistics Capability ↔ Technology Adoption	0.614	<0.85	Achieved
Green Logistics Capability ↔ Service Excellence	0.643	<0.85	Achieved
Green Logistics Capability ↔ Operational Efficiency	0.589	<0.85	Achieved
Technology Adoption ↔ Service Excellence	0.687	<0.85	Achieved
Technology Adoption ↔ Operational Efficiency	0.652	<0.85	Achieved
Service Excellence ↔ Operational Efficiency	0.671	<0.85	Achieved

Source: Research Data, 2026

Note: HTMT = Heterotrait-Monotrait Ratio. Values below 0.85 indicate discriminant validity (Henseler et al., 2015).

The discriminant validity of the measurement model was assessed using three complementary criteria. First, the Fornell-Larcker criterion (Table 4) demonstrated that the square root of the Average Variance Extracted (AVE) for each construct—Digital Transformation (0.820), Green Logistics Capability (0.825), Technology Adoption (0.811), Service Excellence (0.833), and Operational Efficiency (0.829)—exceeded all inter-construct correlations. This confirms that each construct shares more variance with its own indicators than with other constructs in the model.

Second, the HTMT (Heterotrait-Monotrait Ratio) values (Table 5) ranged from 0.582 to 0.687, all well below the conservative threshold of 0.85 (Henseler et al., 2015). The highest HTMT value was observed between Technology Adoption and Service Excellence (0.687), while the

lowest was between Digital Transformation and Service Excellence (0.582). These results provide strong evidence of discriminant validity, indicating that the constructs are conceptually distinct.

4.4 Structural Model Evaluation

The structural model was evaluated through assessment of collinearity, coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and model fit (SRMR). Variance Inflation Factor (VIF) values for all constructs were below 3.0, ranging from 1.827 to 2.645, indicating no multicollinearity issues among predictor variables. The R -square value for Technology Adoption was 0.562, meaning 56.2% of the variation in technology adoption is explained by digital transformation and green logistics capability. The R -square value for Service Excellence was 0.678, indicating that 67.8% of the variation in service excellence is explained by technology adoption, digital transformation, and green logistics capability. The R -square value for Operational Efficiency was 0.724, indicating that 72.4% of the variation in operational efficiency is explained jointly by all predictor variables. These R^2 values are considered substantial according to the guidelines of Hair et al. (2019).

Table 6: R-Square and Effect Size Results

Endogenous Variable	R^2	Q^2	Effect Size (f^2)
Technology Adoption	0.562	0.384	0.312
Service Excellence	0.678	0.445	0.415
Operational Efficiency	0.724	0.492	0.487

Source: Research Data, 2026

The R -square values are considered substantial according to the guidelines of Hair et al. (2019). The Stone-Geisser Q^2 values for Technology Adoption (0.384), Service Excellence (0.445), and Operational Efficiency (0.492) are all greater than zero, confirming the model's predictive relevance (Hair et al., 2019). The effect sizes (f^2) for Technology Adoption (0.312) and Service Excellence (0.415) represent moderate-to-large effects according to Cohen's (1988) criteria.

To assess the model's predictive relevance, the Stone-Geisser Q^2 test was performed using the blindfolding procedure in SmartPLS 3.0 with an omission distance of 7. The Q^2 values for the endogenous latent variables were as follows: Technology Adoption ($Q^2 = 0.384$), Service Excellence ($Q^2 = 0.445$), and Operational Efficiency ($Q^2 = 0.492$). Since all Q^2 values are greater than zero, the model demonstrates adequate predictive relevance for all endogenous variables in the context of the Indonesian forwarding industry (Hair et al., 2019). These results confirm that the exogenous constructs have sufficient predictive power for the endogenous variables, supporting the structural model's out-of-sample validity.

The effect size (f^2) values indicated moderate to large effects for all relationships.

Technology Adoption showed f^2 of 0.312, Service Excellence showed f^2 of 0.415, and Operational Efficiency showed f^2 of 0.487, all exceeding the threshold for large effects ($f^2 > 0.35$). The Standardized Root Mean Square Residual (SRMR) value was 0.062, below the recommended threshold of 0.08, indicating good model fit (Hu & Bentler, 1999). The Normed Fit Index (NFI) was 0.89, approaching the recommended 0.90, further supporting adequate model fit (Byrne, 2016). These results confirm that the structural model meets all criteria for evaluation, providing confidence in the hypothesis testing results.

4.5 Hypothesis Testing

Hypothesis testing was conducted using bootstrapping with 5,000 resamples at a 5% significance level. The path analysis results are presented in Table 7. Digital Transformation had a positive and significant effect on Technology Adoption (H1a: $\beta = 0.385$, $t = 5.678$, $p < 0.001$). Green Logistics Capability also had a positive and significant effect on Technology Adoption (H1b: $\beta = 0.342$, $t = 4.987$, $p < 0.001$). Technology Adoption had a positive and significant effect on Service Excellence (H2: $\beta = 0.431$, $t = 6.234$, $p < 0.001$). Service Excellence had a positive and significant effect on Operational Efficiency (H3a: $\beta = 0.402$, $t = 5.876$, $p < 0.001$). Green Logistics Capability had a positive and significant effect on Service Excellence (H3b: $\beta = 0.316$, $t = 4.543$, $p < 0.001$). Digital Transformation had a positive and significant direct effect on Operational Efficiency (H4a: $\beta = 0.287$, $t = 3.876$, $p < 0.001$). Green Logistics Capability had a positive and significant direct effect on Operational Efficiency (H4b: $\beta = 0.265$, $t = 3.654$, $p < 0.001$).

Table 7: Hypothesis Testing Results (Direct Effects)

H	Path	β	t-value	p-value	Decision
H1a	DT → TA	0.385	5.678	<0.001	Supported
H1b	GL → TA	0.342	4.987	<0.001	Supported
H2	TA → SE	0.431	6.234	<0.000	Supported
H3a	SE → OE	0.402	5.876	<0.000	Supported
H3b	GL → SE	0.316	4.543	<0.001	Supported
H4a	DT → OE	0.287	3.876	<0.001	Supported
H4b	GL → OE	0.265	3.654	<0.001	Supported

Source: Research Data, 2026

Note: DT = Digital Transformation; GL = Green Logistics Capability; TA = Technology Adoption; SE = Service Excellence; OE = Operational Efficiency. β = standardized path coefficient. $**p < 0.001$.

4.6 Mediation Analysis

Table 8: Mediation Analysis Results (Indirect Effects)

H	Path	β	t-value	p-value	95% CI	Decision
H5a	DT→TA→SE	0.166	4.234	<0.001	[0.098, 0.245]	Supported
H5b	GL→TA→SE	0.147	3.876	<0.001	[0.082, 0.218]	Supported
H6a	DT→SE→OE	0.155	3.987	<0.001	[0.091, 0.229]	Supported
H6b	GL→SE→OE	0.127	3.654	<0.001	[0.072, 0.198]	Supported
H7a	DT→TA→SE→OE	0.067	3.456	<0.001	[0.035, 0.112]	Supported
H7b	GL→TA→SE→OE	0.059	3.234	<0.001	[0.028, 0.104]	Supported

Source: Research Data, 2026

Note: DT = Digital Transformation; GL = Green Logistics Capability; TA = Technology Adoption; SE = Service Excellence; OE = Operational Efficiency. β = standardized indirect effect. CI = 95% bias-corrected bootstrap confidence interval with 5,000 resamples. ** $p < 0.001$.

The mediation analysis results provide support for all mediation hypotheses. Technology Adoption mediated the effect of Digital Transformation on Service Excellence (H5a: $\beta = 0.166$, $t = 4.234$, $p < 0.001$; 95% CI: 0.098, 0.245). Technology Adoption mediated the effect of Green Logistics Capability on Service Excellence (H5b: $\beta = 0.147$, $t = 3.876$, $p < 0.001$; 95% CI: 0.082, 0.218). Service Excellence mediated the effect of Digital Transformation on Operational Efficiency (H6a: $\beta = 0.155$, $t = 3.987$, $p < 0.001$; 95% CI: 0.091, 0.229). Service Excellence mediated the effect of Green Logistics Capability on Operational Efficiency (H6b: $\beta = 0.127$, $t = 3.654$, $p < 0.001$; 95% CI: 0.072, 0.198).

Crucially, the sequential mediation hypotheses were also supported. Technology Adoption and Service Excellence sequentially mediated the effect of Digital Transformation on Operational Efficiency (H7a: $\beta = 0.067$, $t = 3.456$, $p < 0.001$; 95% CI: 0.035, 0.112). Technology Adoption and Service Excellence sequentially mediated the effect of Green Logistics Capability on Operational Efficiency (H7b: $\beta = 0.059$, $t = 3.234$, $p < 0.001$; 95% CI: 0.028, 0.104). The confidence intervals for all indirect effects did not include zero, confirming the significance of the mediation pathways.

4.7 Discussion

4.7.1 Dynamic Capabilities as the Mechanism Linking Strategic Capabilities and Operational Efficiency

The findings demonstrate that digital transformation and green logistics capability significantly improve operational efficiency through a sequential capability-building process involving technology adoption and service excellence. These results reinforce Dynamic Capabilities Theory (DCT) as the primary theoretical foundation of this study. Rather than viewing organizational resources as direct determinants of performance, DCT argues that firms achieve superior performance by continuously sensing environmental change, seizing strategic opportunities, and transforming

organizational resources into operational capabilities (Teece et al., 1997; Teece, 2007).

The empirical findings support this proposition. Digital transformation and green logistics capability represent strategic capabilities that enable organizations to respond to technological disruption and sustainability pressures. However, these capabilities do not immediately enhance operational efficiency. Instead, organizations must first institutionalize digital technologies through technology adoption and subsequently translate those technological capabilities into superior logistics services through service excellence. This sequential capability transformation process illustrates how strategic initiatives are converted into measurable operational outcomes.

Therefore, the study extends Dynamic Capabilities Theory by empirically demonstrating that technology adoption and service excellence operate as sequential micro-foundations through which strategic capabilities are transformed into operational efficiency.

4.7.2 Discussion of Direct Effects

The positive influence of digital transformation on technology adoption indicates that organizations investing in digital infrastructure are more capable of integrating technological innovations into daily operations. This finding is consistent with previous studies reporting that digital transformation facilitates organizational learning and accelerates technology utilization (Liu et al., 2023; Melanie et al., 2024). Within the DCT perspective, digital transformation strengthens firms' sensing and seizing capabilities by enabling faster recognition and exploitation of technological opportunities.

Similarly, green logistics capability significantly enhances technology adoption and service excellence. Organizations implementing environmentally responsible logistics practices tend to invest in cleaner technologies, integrated logistics systems, and collaborative environmental initiatives. These findings support the arguments of the Natural Resource-Based View while simultaneously demonstrating that environmental capabilities function as dynamic capabilities capable of strengthening operational performance.

The positive relationship between technology adoption and service excellence further confirms that successful digital implementation improves responsiveness, service reliability, operational visibility, and customer communication. Technology adoption therefore represents an intermediate organizational capability rather than merely a technological investment. This finding is consistent with the Technology Acceptance Model, which emphasizes that technology generates organizational value only after successful utilization by users.

Finally, service excellence significantly improves operational efficiency. Superior logistics services reduce operational errors, improve process coordination, shorten delivery cycles, and optimize organizational resource utilization. This finding supports previous logistics research

demonstrating that operational excellence is achieved through continuous service improvement rather than technological investment alone.

4.7.3 Sequential Mediation as the Main Theoretical Contribution

The most important contribution of this study lies in the confirmation of the proposed sequential mediation mechanism. Previous logistics studies have primarily examined direct effects or single mediating variables linking digital transformation and organizational performance. In contrast, the present findings demonstrate that operational efficiency emerges through two consecutive organizational capabilities.

Technology adoption constitutes the first stage of capability development by enabling organizations to absorb and institutionalize digital technologies. Subsequently, service excellence represents the second stage in which technological capabilities are translated into customer value and operational effectiveness. This sequential mechanism explains why digital investments frequently fail to improve organizational performance when firms neglect capability development and service process transformation.

Consequently, the study advances Dynamic Capabilities Theory by identifying technology adoption and service excellence as sequential micro-foundations connecting strategic capabilities with operational outcomes. This theoretical extension contributes to the growing literature on capability transformation within logistics and supply chain management.

4.7.4 Comparison with Previous Studies

The findings of this study are generally consistent with previous research demonstrating that digital transformation and green logistics capability positively influence organizational performance through improvements in technological and operational capabilities. For example, Hanelt et al. (2021) argued that digital transformation enables firms to enhance organizational adaptability and create business value through the integration of digital technologies. Similarly, Melanie et al. (2024) reported that technology adoption significantly improves the operational performance of Indonesian logistics companies by facilitating process integration and service innovation. These findings support the present study by confirming that digital transformation constitutes a strategic capability that strengthens organizational competitiveness.

The positive influence of green logistics capability observed in this study is also consistent with previous research grounded in the Natural Resource-Based View. Khairunissa and Santosa (2022) found that environmentally oriented logistics practices improve firm performance through enhanced operational processes and sustainability initiatives. Likewise, Duzgun et al. (2025) demonstrated that green logistics capability contributes to both environmental and economic performance by improving resource utilization and reducing operational inefficiencies. The present

findings extend these studies by demonstrating that green logistics capability does not influence operational efficiency directly alone but operates through sequential organizational capability development.

The significant relationship between technology adoption and service excellence further supports earlier studies emphasizing the importance of digital technology utilization in improving logistics services. Davis (1989) and Venkatesh et al. (2003) proposed that technology creates organizational value only when it is effectively accepted and utilized by users. More recently, Liu et al. (2023) and Melanie et al. (2024) reported that successful technology adoption enhances logistics visibility, process coordination, and customer responsiveness, which subsequently improve service quality. The present findings reinforce these arguments by positioning technology adoption as the first capability-building mechanism that enables organizations to transform digital investments into superior service performance.

Furthermore, the positive relationship between service excellence and operational efficiency aligns with previous logistics research indicating that reliable, responsive, and customer-oriented services improve organizational effectiveness. Zeithaml et al. (1990) emphasized that service excellence enhances customer value through improved service reliability and responsiveness, while Zhang et al. (2025) demonstrated that superior logistics services significantly reduce delivery delays, operational errors, and resource waste. The present study confirms these findings within the Indonesian freight forwarding industry, highlighting service excellence as a critical organizational capability that converts technological capabilities into operational efficiency.

Despite these consistencies, the present study advances the existing literature in several important ways. First, previous studies have generally examined digital transformation (e.g., Hanelt et al., 2021; Liu et al., 2023) and green logistics capability (e.g., Khairunissa & Santosa, 2022; Duzgun et al., 2025) as separate strategic initiatives. In contrast, this study integrates both capabilities within a single conceptual framework grounded in Dynamic Capabilities Theory, providing a more comprehensive explanation of organizational capability development.

Second, earlier studies primarily investigated technology adoption or service quality as independent mediating variables. For example, Melanie et al. (2024) focused on technology adoption as a mediator, whereas studies on logistics service performance commonly examined service quality independently (Zeithaml et al., 1990). The present study extends this stream of research by demonstrating that technology adoption and service excellence function sequentially rather than independently, thereby revealing the capability transformation process through which strategic resources are translated into operational efficiency.

Third, empirical evidence concerning freight forwarding companies in emerging economies remains relatively limited. Most previous

studies were conducted in manufacturing industries or logistics sectors in developed countries. By focusing on Indonesian freight forwarding companies, this study contributes new empirical evidence from an emerging economy characterized by fragmented logistics infrastructure, heterogeneous digital readiness, and increasing sustainability pressures. These contextual characteristics provide additional insights into how Dynamic Capabilities Theory operates under institutional conditions that differ from those typically examined in previous studies.

Overall, these findings indicate that the proposed sequential mediation model provides a more comprehensive explanation of how digital transformation and green logistics capability are transformed into operational efficiency through technology adoption and service excellence. Consequently, this study contributes not only by integrating multiple strategic capabilities within a unified framework but also by extending Dynamic Capabilities Theory through the identification of technology adoption and service excellence as sequential micro-foundations linking strategic capabilities with operational outcomes.

4.7.5 Managerial Implications

The findings provide several practical implications for managers of freight forwarding companies.

First, digital transformation should not be evaluated solely based on technology investment. Managers should prioritize organizational technology adoption through employee capability development, digital training, and process integration to ensure that technological resources are effectively utilized.

Second, environmental sustainability initiatives should be integrated into operational strategies rather than treated merely as regulatory compliance. Investments in green logistics technologies, environmentally responsible transportation practices, and collaborative environmental programs can strengthen both service excellence and operational efficiency.

Third, service excellence should be viewed as a strategic organizational capability. Organizations should continuously improve responsiveness, reliability, shipment visibility, and customer communication because these capabilities constitute the final mechanism through which digital transformation and green logistics capability generate operational value.

Finally, the findings suggest that managers should implement digital transformation and sustainability initiatives simultaneously rather than independently. The sequential mediation model indicates that the greatest operational improvements are achieved when digital capability development is followed by effective technology adoption and continuous service excellence improvement.

4.7.6 Theoretical Implications

This study makes three principal theoretical contributions.

First, it reinforces Dynamic Capabilities Theory as the dominant theoretical explanation

for organizational capability transformation in the freight forwarding industry. Unlike previous studies emphasizing the Resource-Based View or Technology Acceptance Model individually, the present study positions these theories as complementary perspectives supporting Dynamic Capabilities Theory.

Second, the study extends Dynamic Capabilities Theory by empirically identifying technology adoption and service excellence as sequential micro-foundations linking strategic capabilities with operational efficiency. This capability transformation mechanism provides a more comprehensive explanation than direct-effect models commonly reported in previous logistics studies.

Third, the study contributes empirical evidence from Indonesian freight forwarding companies, thereby extending the generalizability of Dynamic Capabilities Theory to emerging logistics markets characterized by rapid digitalization, heterogeneous organizational capabilities, and increasing environmental sustainability requirements.

5. CONCLUSION

This study examined the relationships among digital transformation, green logistics capability, technology adoption, service excellence, and operational efficiency in Indonesian freight forwarding companies using a sequential mediation framework grounded in Dynamic Capabilities Theory (DCT). The empirical findings demonstrate that digital transformation and green logistics capability significantly enhance operational efficiency through the sequential mediating roles of technology adoption and service excellence. These findings indicate that strategic organizational capabilities do not automatically generate superior operational performance; rather, firms must first develop the capability to successfully adopt digital technologies and subsequently transform these technological capabilities into superior logistics services before achieving operational efficiency.

From a theoretical perspective, this study extends Dynamic Capabilities Theory by demonstrating that technology adoption and service excellence function as sequential micro-foundations linking strategic capabilities with operational outcomes. While previous studies have generally examined direct relationships or single mediation mechanisms, the present study provides empirical evidence that organizational capability transformation occurs through a sequential process in which digital transformation and green logistics capability are progressively translated into operational efficiency. In this context, Resource-Based View (RBV), Natural Resource-Based View (NRBV), Technology Acceptance Model (TAM), and Stakeholder Theory complement DCT by explaining specific mechanisms within the broader capability reconfiguration process.

The findings also provide several practical implications for freight forwarding companies. Managers should view digital transformation not merely as a technological investment but as an

organizational capability development process that requires employee readiness, technology adoption, and continuous service improvement. Likewise, green logistics initiatives should be integrated into core business operations through environmentally responsible technologies, process redesign, and collaborative sustainability practices rather than being implemented solely to satisfy regulatory requirements. Simultaneously investing in digital transformation and green logistics capability while strengthening technology adoption and service excellence is expected to improve operational efficiency and enhance long-term organizational competitiveness.

The results are also relevant for policy-makers and industry associations. Government agencies and logistics regulators should encourage digitalization and sustainable logistics through supportive policies, financial incentives, standardized digital infrastructure, and capacity-building programs for logistics firms, particularly small and medium-sized freight forwarding companies. Industry associations may further facilitate knowledge sharing, digital capability development, and the adoption of green logistics standards to accelerate industry-wide transformation.

This study has several limitations. First, the cross-sectional research design captures organizational conditions at a single point in time and therefore cannot fully explain the dynamic evolution of organizational capabilities. Second, the study focused exclusively on Indonesian freight forwarding companies, which may limit the generalizability of the findings to other logistics sectors or national contexts. Third, data were collected using self-reported questionnaires from a single respondent representing each organization, which may not fully capture multiple managerial perspectives despite the implementation of procedural and statistical controls for common method bias.

Future research is encouraged to employ longitudinal research designs to examine how digital transformation and green logistics capability evolve and influence organizational performance through changing capability development processes. Comparative cross-country studies involving ASEAN and other emerging economies would further enhance the external validity of the proposed model. Future studies may also incorporate additional dynamic capability dimensions—such as organizational learning capability, innovation capability, digital leadership, or organizational resilience—to further extend the theoretical understanding of capability transformation in logistics and supply chain management.

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