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-RESEARCH ARTICLE-

TRANSFORMING DIGITAL LOGISTICS CAPABILITY INTO COLD-CHAIN PERFORMANCE: ROLES OF CAPABILITY AND ENVIRONMENTAL UNCERTAINTY IN MEKONG DELTA EXPORTING FIRMS

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—Abstract—

Within Vietnam's Mekong Delta pangasius export sector, this study investigates how Digital Logistics Capability (DLC) influences Cold-chain Logistics Performance (CLP), considering the mediating role of Cold-chain Logistics Capability (CLC) and the moderating effect of Environmental Uncertainty (EU). Guided by the Resource-Based View (RBV), Dynamic Capability Theory (DCT), and Contingency Theory, the study develops a conceptual model linking DLC, CLC, CLP, and EU. Structural Equation Modelling (SEM) was employed to analyse data collected from pangasius-exporting firms. The findings indicate that DLC significantly enhances both CLC and CLP, while CLC also exerts a positive effect on CLP and partially mediates the relationship between DLC and CLP. In addition, EU amplifies the positive influence of CLC on CLP. Collectively, the findings extend the application of RBV, DCT, and Contingency Theory within the cold-chain logistics context while offering practical insights for strengthening seafood logistics performance and enhancing the competitive position of seafood exporters.

Keywords: Digital Logistics Capability; Cold-Chain Logistics Capability; Cold-Chain

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Logistics Performance; Environmental Uncertainty.

JEL Classification: L91, M11, Q22.

INTRODUCTION

Vietnam's seafood export industry, particularly the pangasius sector, represents a major contributor to national export earnings and employment across the Mekong Delta, the country's principal hub for pangasius farming, processing, and export activities. Most pangasius produced in this region is supplied to key international markets, including the United States, the European Union, and China. Given the product's highly perishable nature, preserving a consistent temperature throughout storage, handling, and transportation is essential. Consequently, an effective cold chain plays a critical role in safeguarding product quality, ensuring compliance with importing countries' standards, and strengthening exporters' competitiveness in global markets (Fugate et al., 2010; Wang et al., 2015).

In recent years, exporters operating in the Mekong Delta have encountered mounting challenges arising from an increasingly dynamic international marketplace. Alongside intensifying competition, they must respond to volatile customer demand, stricter technical specifications, enhanced traceability requirements, more rigorous food safety regulations, and continual changes in trade policies and global supply chains. These conditions require firms to strengthen their adaptive capabilities to sustain CLP and preserve their international competitive position (Jaworski & Kohli, 1993). Emerging digital technologies, including the Internet of Things, Big Data analytics, Cloud Computing, and integrated digital platforms, are transforming logistics operations by enabling real-time visibility, improving decision-making, and enhancing operational efficiency (Ivanov & Dolgui, 2021).

Nevertheless, technology adoption alone is insufficient to guarantee superior logistics outcomes. RBV argues that organisational resources generate value only when effectively deployed through organisational capabilities, making logistics capability the mechanism through which digital resources are translated into operational improvements and sustainable competitive advantage (Matwiejczuk, 2019; Wang et al., 2015). Within the pangasius export industry, implementing digital technologies without developing strong CLC is unlikely to produce substantial operational gains. Robust CLC enables firms to maintain temperature integrity, preserve product quality, coordinate logistics activities efficiently, respond to unexpected disruptions, and satisfy customer requirements. Consistent with DCT, organisations sustain long-term competitiveness by continually reconfiguring their resources and operational processes to match changing environmental conditions (Teece et al., 1997). Accordingly, firms possessing stronger CLC are better positioned to exploit DLC, thereby achieving superior CLP (Gligor & Holcomb, 2012; Yildiz & Yildiz, 2022).

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Although digitalisation in logistics has attracted considerable scholarly attention, several important research gaps remain. First, existing studies predominantly examine logistics and supply chain systems in general, with limited emphasis on cold-chain operations within the pangasius export industry. Second, prior research has largely assessed the direct performance outcomes of digital technologies while giving insufficient attention to the mediating role of CLC in the relationship between DLC and CLP. Third, despite extensive discussion of uncertainty in previous studies, limited evidence exists regarding the moderating influence of EU on the association between CLC and CLP, particularly among pangasius exporters in the Mekong Delta. Addressing these gaps is essential for explaining how DLC contributes to enhanced CLP in an industry characterised by stringent cold-chain requirements and substantial environmental volatility (Fornell & Larcker, 1981).

Accordingly, this study develops and empirically examines a research model that investigates the relationships among DLC, CLC, and CLP within pangasius-exporting firms operating in Vietnam's Mekong Delta. The findings are expected to extend the existing knowledge of digital logistics capabilities while providing practical guidance for managers seeking to strengthen logistics operations and improve international competitiveness.

THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Theoretical Background

This study is grounded in three complementary theoretical perspectives: RBV, DCT, and Contingency Theory. RBV posits that organisations achieve sustained competitive advantage by developing resources that are valuable, rare, and difficult for competitors to imitate (Wernerfelt, 1984). Within this perspective, digital technologies constitute strategic resources because they facilitate information exchange, enhance logistics coordination, and support informed managerial decision-making. However, these resources create value only when organisations possess the capabilities required to utilise them effectively (Wang et al., 2015; Wernerfelt, 1984).

DCT further explains that sustained organisational performance depends on a firm's ability to continuously reconfigure its resource base in response to changing business conditions (Teece et al., 1997). For seafood exporters, merely adopting digital technologies is insufficient; digital resources must be effectively converted into CLC. This capability enables firms to maintain temperature control, preserve product quality, respond rapidly to operational disruptions, and consistently meet customer requirements. Consequently, CLC allows organisations to derive greater benefits from DLC, ultimately leading to improved CLP (Gligor & Holcomb, 2012; Wang et al., 2015). Contingency Theory complements these perspectives by emphasising that organisational outcomes depend on external environmental conditions, which shape the effectiveness of resources and capabilities (Jaworski & Kohli, 1993). Consistent with this perspective, the present study proposes that while CLC positively influences CLP, the magnitude of this relationship varies according to the level of EU experienced by firms. Higher levels of EU are therefore expected to alter the extent to which CLC contributes to enhanced CLP.

RESEARCH CONSTRUCTS

Digital Logistics Capability (DLC)

Big Data, Cloud Computing, and digital platforms improve information visibility, strengthen coordination across logistics activities, and enhance operational efficiency (Matwiejczuk, 2019). From the RBV perspective, digital technologies represent valuable organisational resources capable of supporting competitive advantage. Nevertheless, competitive gains arise not from technology ownership alone but from an organisation's ability to deploy these technologies effectively (Wernerfelt, 1984). Accordingly, DLC refers to a firm's capacity to utilise digital technologies to optimise logistics operations through real-time information sharing, improved coordination, and faster managerial decision-making (Ivanov & Dolgui, 2021). Strengthening DLC also enables organisations to better manage supply chain risks and operational uncertainties (Wang et al., 2015). Within the seafood export industry, stronger DLC is expected to enhance CLC, which subsequently contributes to improved CLP.

Cold-Chain Logistics Capability (CLC)

Maintaining product quality throughout every stage of the logistics process is essential for seafood exporters seeking to satisfy the stringent requirements of international markets. Unlike conventional logistics, cold-chain logistics demands continuous temperature control across storage, handling, and transportation to minimise spoilage and product losses. Achieving this objective requires more than investments in infrastructure and technology; firms must also possess strong operational capabilities to manage cold-chain activities effectively. According to logistics capability theory, sustainable competitive advantage is achieved when organisations outperform competitors in planning, coordinating, and controlling logistics operations (Gligor & Holcomb, 2012; Matwiejczuk, 2019). Similarly, Wieland (2021) argues that modern supply chain capabilities should extend beyond operational efficiency by enabling organisational adaptability and continuous transformation to generate long-term value under changing environmental conditions. Previous research has likewise demonstrated that stronger logistics capabilities improve customer responsiveness, reduce supply chain risks, and enhance operational performance, even in uncertain environments (Wang et al., 2015).

Given the perishable nature of seafood products, effective cold-chain operations require specialised organisational capabilities. In this study, CLC denotes a firm's ability to plan, coordinate, and manage logistics activities throughout the entire cold-chain process to maintain appropriate temperature conditions, preserve product quality, and fulfil customer requirements. Developing stronger CLC also enables firms to maximise the benefits derived from DLC, thereby improving CLP and reinforcing their competitiveness in international markets (Mentzer & Konrad, 1991).

Cold-Chain Logistics Performance (CLP)

CLP reflects a firm's effectiveness in executing logistics activities. Beyond cost efficiency, it encompasses customer responsiveness, service quality, and overall logistics outcomes (Fugate et al., 2010). Similarly, Fugate et al. (2010) define logistics performance as an organisation's capability to satisfy customer requirements through the effective utilisation of logistics resources. Within the seafood export industry, CLP emphasises maintaining product quality, ensuring on-time delivery, preserving temperature integrity throughout the cold chain, and improving overall logistics efficiency.

Environmental Uncertainty (EU)

The contemporary business environment is characterised by continual change driven by globalisation, technological advancement, international competition, and evolving regulatory policies. Under such conditions, organisations often find it difficult to anticipate market developments, assess their potential impact, or predict the likelihood of external changes, a situation commonly described as EU. Jaworski and Kohli (1993) define EU as the degree to which firms encounter difficulties in forecasting changes related to customers, competitors, and other external environmental factors. As uncertainty increases, planning, resource allocation, and managerial decision-making become progressively more challenging. Within logistics, EU may arise from fluctuating market demand, shifting trade regulations, supply chain disruptions, rapid technological change, and evolving customer expectations (Wang et al., 2015). For seafood exporters, these uncertainties are further intensified by increasingly complex international trade conditions and rising quality requirements. Accordingly, this study conceptualises EU as a contextual factor that moderates the relationship between CLC and CLP.

RELATIONSHIPS AMONG THE RESEARCH CONSTRUCTS

The Relationship Between DLC and CLC

Consistent with RBV, digital technologies generate strategic value only when they are transformed into organisational capabilities that support business operations

(Wernerfelt, 1984). Accordingly, firms can leverage DLC to strengthen information management while improving the planning, coordination, and control of logistics activities. Previous research indicates that logistics capabilities evolve through effective adaptation to environmental changes, coordinated resource utilisation, and the integration of relevant information across organisational processes (Gligor & Holcomb, 2012).

Similarly, Swafford et al. (2008) argue that digital capability strengthens existing SC capabilities by enhancing organisational connectivity, facilitating information sharing, and improving coordination among supply chain partners, thereby supporting the development of more advanced SC capabilities. For seafood exporters, maintaining appropriate temperatures, preserving product quality, and ensuring reliable deliveries require continuous coordination throughout the cold chain. Effective utilisation of DLC enables real-time monitoring, faster information exchange, and more efficient data processing, thereby strengthening cold-chain control, improving customer responsiveness, and enhancing delivery reliability (Wang et al., 2015). Consequently, DLC is expected to positively influence CLC.

H1: *Digital Logistics Capability has a significant and positive effect on Cold-chain Logistics Capability.*

The Relationship Between CLC and CLP

CLC represents a critical organisational capability through which firms convert resources into superior operational outcomes. From the RBV perspective, effective coordination of logistics activities enhances operational performance by enabling firms to outperform competitors, satisfy customer requirements more effectively, and manage logistics processes efficiently (Fugate et al., 2010). Previous studies further suggest that strong logistics capabilities improve organisational adaptability and reduce supply chain risks, particularly under volatile operating conditions (Wang et al., 2015). Within cold-chain operations, CLC extends beyond transportation and distribution to include maintaining appropriate storage conditions, preserving product quality, and responding rapidly to disruptions across warehousing and transportation activities (Gligor & Holcomb, 2012).

More recently, Zhang and Mohammad (2024) reported that adaptive and resilient cold-chain capabilities contribute to improved operational performance. Likewise, Matwiejczuk (2019) identifies organisational capability as a strategic asset that strengthens long-term competitiveness. For seafood exporters, stronger CLC is expected to minimise product losses, maintain product quality, improve delivery reliability, and enhance compliance with the requirements of international buyers, thereby leading to superior CLP. Accordingly, the following hypothesis is proposed:

H2: *There is positive feedback between Cold-chain Logistics Capability and Cold-chain Logistics Performance.*

The Relationship Between DLC and CLP

Digitalisation continues to reshape logistics and SCM through technologies such as the Internet of Things, Big Data, Cloud Computing, and Artificial Intelligence (AI), which enable the collection, analysis, and exchange of real-time information to improve the visibility, coordination, and control of logistics operations. From the RBV perspective, DLC constitutes a strategic organisational resource that enhances productivity and performance by streamlining processes, reducing operational costs, and improving service quality (Wernerfelt, 1984). In the logistics domain, Wang et al. (2015) argue that firms with superior information management and coordination capabilities are better equipped to manage operational risks and achieve higher logistics performance. Similarly, Matwiejczuk (2019) suggests that leveraging technology-enabled logistics capabilities contributes to sustainable competitive advantage and improved organisational performance. More recent evidence further supports this relationship. (Bag et al., 2021a; Bag et al., 2021b) found that stronger digital capabilities enhance supply chain integration, improve operational efficiency, and increase customer value. Within the seafood export industry, DLC enables real-time temperature monitoring, continuous shipment tracking, and data-driven decision-making, thereby reducing product losses, improving delivery accuracy, and enhancing CLP. Consequently, firms with stronger DLC are expected to achieve superior CLP.

H3: *Digital Logistics Capability positively influences Cold-chain Logistics Performance.*

The Moderating Role of EU in the Relationship Between CLC and CLP

Contingency Theory suggests that organisational performance is influenced by the external environment, implying that environmental conditions may alter the strength of the relationship between CLC and CLP. Firms operating in uncertain environments often encounter difficulties in forecasting changes in market demand, customer expectations, technological developments, and regulatory requirements, which collectively represent EU (Jaworski & Kohli, 1993). Within logistics operations, EU may emerge from demand fluctuations, supply chain disruptions, changing trade regulations, and increasing requirements related to compliance, traceability, and inspection procedures (Wang et al., 2015). Previous research indicates that uncertainty can strengthen the contribution of supply chain capabilities to organisational outcomes.

Wong et al. (2011) found that Supply Chain Integration Capability (SCIC) provides greater value under highly dynamic conditions, a finding further supported by Inman and Green (2022) and Hatani and Rommy (2024), who highlighted the importance of

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capabilities in uncertain environments. Similarly, Wang et al. (2025) demonstrated that uncertain conditions reinforce the positive relationship between supply chain competence and organisational performance by enhancing supply chain resilience. For pangasius exporters, increasing market volatility, stricter quality standards, evolving quarantine requirements, and complex logistics challenges require continuous development of CLC. Firms with stronger CLC are better positioned to maintain product quality, ensure delivery reliability, and respond effectively to cold-chain disruptions. Therefore, this study proposes that EU strengthens the positive relationship between CLC and CLP.

H4: *The association between CLC and CLP is strengthened by EU; that is, the more uncertain an environment is, the more it strengthens the positive relationship between CLC and CLP.*

The Mediating Role of CLC

RBV suggests that technological resources alone are unlikely to generate superior performance unless firms possess the organisational capabilities required to effectively exploit their value (Wernerfelt, 1984). Similarly, DCT argues that sustainable competitive advantage (SCA) emerges when firms are able to continuously integrate, reconfigure, and deploy resources in response to changing conditions in ways that competitors cannot easily replicate (Teece et al., 1997). Together, these perspectives indicate that digital technologies primarily influence organisational outcomes through the development of intermediate capabilities rather than through direct effects alone.

Within logistics contexts, digital technologies strengthen firms' abilities to acquire, analyse, and share information, thereby improving the coordination and control of logistics processes. However, these benefits are maximised when supported by strong logistics capabilities, including customer responsiveness, delivery reliability, and effective service management (Gligor & Holcomb, 2012; Wang et al., 2015). Recent evidence further demonstrates that digital technologies and Industry 4.0 initiatives enhance organisational performance mainly when they complement and strengthen existing supply chain and operational capabilities rather than acting as independent performance drivers (Huang et al., 2023). For pangasius exporters, the benefits of DLC are expected to be realised through the development of CLC, which enables firms to improve CLP. Enhanced CLP supports effective cold-chain management through real-time temperature monitoring, improved traceability, quality preservation, and reliable delivery performance. Accordingly, CLC is expected to mediate the relationship between DLC and CLP.

H5: *Cold-chain Logistics Capability plays a mediating role between Digital Logistics Capability and Cold-chain Logistics Performance.*

Drawing upon the preceding theoretical foundations and empirical evidence, this study develops the conceptual framework presented in Figure 1.

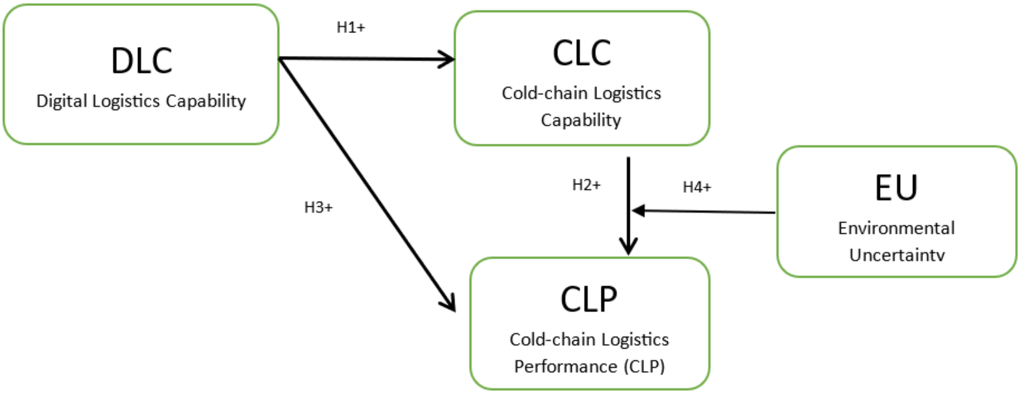

Figure 1: Conceptual Framework Depicting the Hypothesized Relationships among Digital Logistics Capability (DLC), Cold-chain Logistics Capability (CLC), Cold-Chain Logistics Performance (CLP), and the Moderating Role of Environmental Uncertainty (EU)

RESEARCH METHODOLOGY

Sample and Data Collection

The study focused on pangasius-exporting enterprises located in Vietnam's Mekong Delta. Respondents included managers and employees with direct knowledge and practical experience in logistics, supply chain management, import-export operations, and digital transformation activities within their organisations. These participants were selected because of their familiarity with cold-chain practices and the implementation of digital technologies in operational processes. Data were collected through a structured questionnaire administered using both online and face-to-face approaches. Eligible firms were identified and recruited through convenience and snowball sampling techniques. The questionnaire items were adapted from established studies, evaluated by academic and industry specialists, and subsequently improved through expert assessments and pilot testing to ensure clarity, relevance, and overall quality. Following Hair Jr et al. (2019), a minimum of 350 valid responses was deemed appropriate for conducting SEM analysis.

Measurement Scales

The measurement instruments were adapted from previously validated scales in the literature and modified to suit the operational environment of pangasius exporters in the Mekong Delta. Before the main data collection phase, all measurement items were

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assessed by academic and industry experts, and necessary revisions were implemented to improve clarity, content validity, and contextual relevance. DLC was measured using five indicators adapted from the Technological Capability scale developed by Bag et al. (2021b), capturing the application of digital technologies, including IoT, Big Data, and Cloud Computing, in supporting supply chain and logistics activities. CLC was conceptualised as a second-order construct consisting of three first-order dimensions: Cold-chain Innovation Capability (CIC), Cold-chain Process Capability (CPC), and Cold-chain Flexibility Capability (CFC). Each dimension was measured using three indicators, resulting in nine items adapted from the Logistics Capability scale proposed by Wang et al. (2015).

CLP was operationalised as a first-order construct comprising four indicators associated with operational efficiency, delivery timeliness, product quality preservation, and export performance. These measures were adapted from the Logistics Performance scale developed by Fugate et al. (2010). EU was measured as a first-order construct using four items representing uncertainty arising from market demand, export market conditions, international trade policies, and logistics costs, based on the scale developed by Jaworski and Kohli (1993). All constructs were evaluated using a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). The complete measurement items and their corresponding sources are provided in the Appendix (Ismael, 2025; Zahari & Kaliannan, 2023).

Data Analysis

SPSS Version 26 and AMOS Version 24 were employed for data analysis. Cronbach's Alpha, Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA) were applied to evaluate the reliability and validity of the measurement instrument. Convergent and discriminant validity were subsequently assessed to confirm the adequacy of the measurement model. Following the establishment of satisfactory psychometric properties, SEM was conducted to examine the proposed hypotheses. As CLC was modelled as a second-order construct, the second-order factor score approach was adopted. Specifically, the three first-order dimensions, CIC, CPC, and CFC, were initially estimated, and their factor scores were subsequently used to construct the second-order CLC measure. Bootstrapping, together with the Sobel test (Sobel, 1982), was employed to assess the significance and robustness of the indirect effect. To examine the moderating role of EU, an interaction term between CLC and EU factor scores was generated and incorporated into the SEM model for further analysis.

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RESULTS AND DISCUSSION

Qualitative Findings

The study began with a qualitative phase involving individual interviews with four experts specialising in logistics and supply chain management, seafood exports, and digital transformation. The purpose of this phase was to evaluate the suitability of the proposed framework and obtain contextual insights for refining the measurement items within the pangasius export environment of the Mekong Delta. The experts confirmed that DLC, CLC, CLP, and EU were appropriate constructs for the research context. They also recommended minor adjustments to the wording of several measurement items to improve their relevance, clarity, and applicability to cold-chain logistics activities. These modifications were limited to semantic improvements and did not alter the conceptual meaning or theoretical foundations of the original scales. Based on the expert feedback, the questionnaire was subsequently refined before implementation in the main quantitative survey. Further details regarding the qualitative phase are provided in Appendix A.

Reliability Analysis

No construct demonstrated reliability concerns, as Cronbach's Alpha values exceeded the recommended threshold of 0.70 for DLC, CLP, and EU. Since CLC was specified as a second-order construct, reliability assessment was conducted at the first-order level. The Cronbach's Alpha values for CIC, CPC, and CFC were all within acceptable ranges, confirming satisfactory internal consistency among their respective measurement items. Furthermore, all items achieved acceptable item-total correlations above the recommended value of 0.30, and no indicators were removed from subsequent analyses. Overall, the measurement scales satisfied the reliability criteria proposed by Nunnally (1994) and were considered suitable for further statistical evaluation. Detailed results are presented in Table 1.

Table 1: Reliability Analysis of the Measurement Scales

Construct/Dimension		Cronbach's Alpha	Number of Items	Decision
DLC		.811	5	Accepted
CLP		.809	4	Accepted
EU		.866	4	Accepted
CLC	CIC	.834	3	Accepted
	CPC	.856	3	Accepted
	CFC	.878	3	Accepted

Source: Compiled by the authors.

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Exploratory Factor Analysis (EFA)

The items retained following the reliability assessment were further analysed using EFA. The dataset demonstrated suitability for factor analysis, with a Kaiser–Meyer–Olkin (KMO) value exceeding the recommended threshold of 0.50 (0.751), while Bartlett's Test of Sphericity was statistically significant ($p < 0.001$). The six extracted factors corresponded with the proposed framework and accounted for 89.8% of the total variance, indicating strong explanatory power above the recommended 50% criterion (Hair Jr et al., 2019). The EFA results confirmed that the measurement items loaded onto their respective constructs, including DLC, CLP, and EU. For CLC, the three proposed first-order dimensions, CIC, CPC, and CFC, were empirically supported, confirming its second-order structure. Regarding construct validity, all factor loadings exceeded the acceptable threshold of 0.50, and no substantial cross-loadings were identified. Therefore, the measurement model demonstrated satisfactory convergent and discriminant validity. All validated constructs were retained for subsequent CFA and SEM analyses, with detailed results reported in Table 2.

Table 2: Rotated Component Matrix

Item	1	2	3	4	5	6
cic1				.859		
cic2				.861		
cic3				.779		
cpc1						.767
cpc2						.774
cpc3						.798
cfc1					.843	
cfc2					.843	
cfc3					.820	
eu1		.706				
eu2		.801				
eu3		.776				
eu4		.725				
dlc1	.711					
dlc2	.701					
dlc3	.737					
dlc4	.734					
dlc5	.806					
clp1			.765			
clp2			.722			
clp3			.761			
clp4			.725			

Source: Compiled by the authors.

Confirmatory Factor Analysis (CFA)

Prior to conducting the structural analysis, CFA was performed to evaluate the adequacy of the measurement model. As illustrated in Figure 2, the results demonstrated a satisfactory model fit. All fit indices achieved the recommended acceptance levels: χ^2 = 253.472, df = 194, χ^2/df = 1.307 (< 3) (Carmines & McIver, 1981); GFI = 0.955, CFI = 0.987, and TLI = 0.985 (all > 0.90); and RMSEA = 0.025 (< 0.08) (Hair Jr et al., 2019; Kline, 2023). These findings confirm that the measurement model provides an appropriate representation of the observed data. All standardised factor loadings exceeded 0.50 and were statistically significant, demonstrating satisfactory indicator reliability and supporting the relationships between observed indicators and their corresponding latent constructs (Gerbing & Anderson, 1988). For CLC, the three first-order dimensions exhibited strong loadings, providing further empirical support for its proposed second-order structure. As presented in Table 3, the measurement model satisfied the required reliability and validity criteria, with all constructs achieving acceptable values for Composite Reliability (CR) ≥ 0.70, Average Variance Extracted (AVE) ≥ 0.50, Maximum Shared Variance (MSV) < AVE, and Maximum Shared Variance (MSV) < Square Root of AVE (SR).

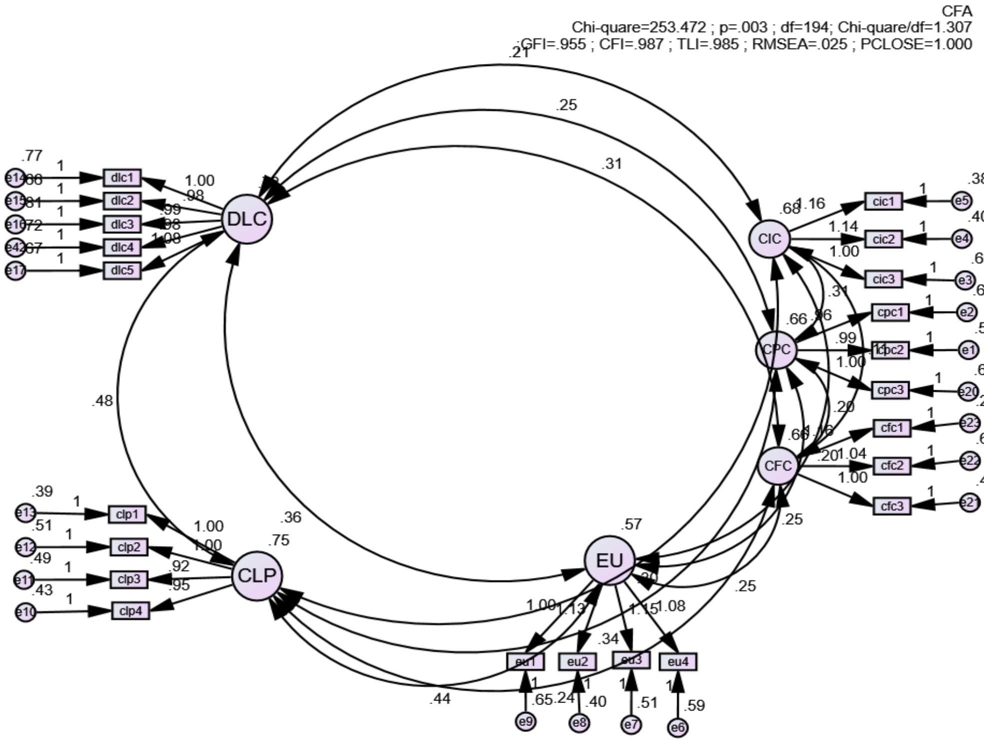

Figure 2: CFA Measurement Model
Source: Compiled by the authors.

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Structural Model Results

The proposed hypotheses were examined using SEM. As presented in Figure 3, the structural model demonstrated an acceptable level of fit: $\chi^2 = 296.178$, df = 145, $\chi^2/df = 2.043$ (< 3); GFI = 0.940, CFI = 0.962, and TLI = 0.955 (all exceeding the 0.90 threshold); and RMSEA = 0.046 (< 0.08) (Hair Jr et al., 2019; Kline, 2023). These results confirm the suitability of the structural model for hypothesis evaluation. The findings show that DLC has a significant positive effect on CLC ($\beta = 0.618$, $p < 0.001$), providing support for H1. Similarly, CLC significantly enhances CLP ($\beta = 0.332$, $p < 0.001$), confirming H2. DLC also demonstrates a significant positive influence on CLP ($\beta = 0.308$, $p < 0.001$), supporting H3. Furthermore, the interaction effect between CLC and EU on CLP is positive and significant ($\beta = 0.358$, $p < 0.001$), supporting H4, which proposes that EU strengthens the relationship between CLC and CLP. Detailed statistical results are reported in Table 4 and Figure 3.

Table 3: Model Validity Measures

	CR	AVE	MSV	MaxR(H)	DLC	CIC	EU	CPC	CFC	CLP
DLC	0.845	0.522	0.399	0.846	0.723					
CIC	0.839	0.635	0.218	0.850	0.287***	0.797				
EU	0.835	0.560	0.467	0.841	0.542***	0.316***	0.748			
CPC	0.756	0.509	0.230	0.757	0.342***	0.467***	0.404***	0.713		
CFC	0.838	0.634	0.187	0.859	0.432***	0.170**	0.405***	0.309***	0.796	
CLP	0.859	0.605	0.467	0.861	0.632***	0.418***	0.683***	0.479***	0.347***	0.778

Source: Compiled by the authors.

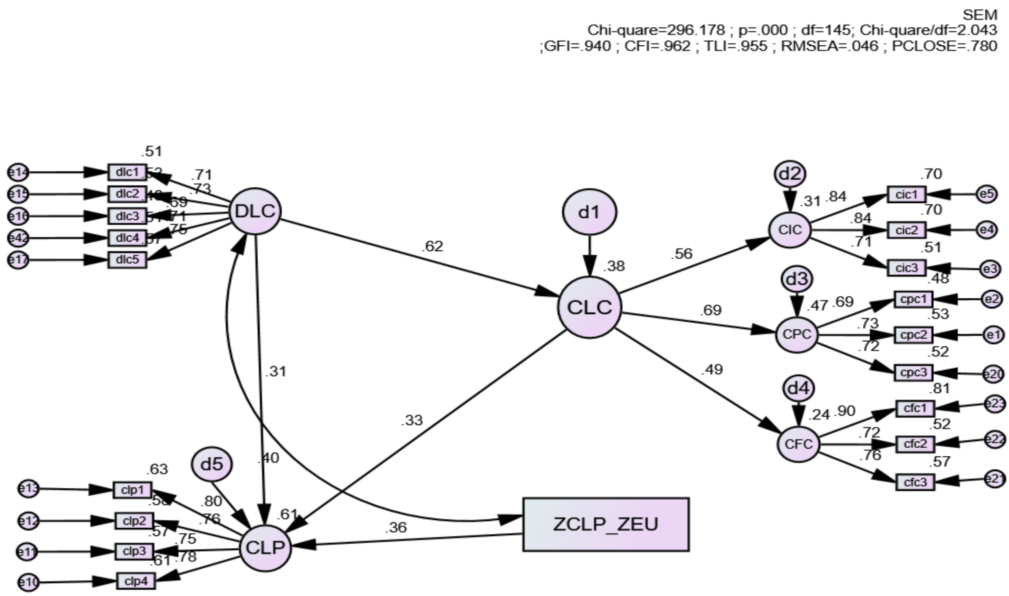

Figure 3: Structural Equation Model (SEM) Results
Source: Compiled by the authors.

Mediating Effect of CLC

The Sobel test was conducted to assess whether CLC mediates the relationship between DLC and CLP (Sobel, 1982). At the 5% significance level, the obtained test statistic (Z = 2.033) exceeded the critical value (Z = 1.960), confirming a statistically significant positive mediation effect. These results demonstrate that CLC significantly mediates the association between DLC and CLP. The findings indicate that DLC influences CLP through both direct and indirect pathways, with DLC contributing to the development of CLC, which subsequently enhances CLP. By adopting digital technologies, firms can improve the coordination, monitoring, and optimisation of cold-chain operations, thereby achieving superior performance outcomes. In addition to its direct effect on CLP, DLC exerts an indirect effect through CLC ($\beta = 0.618 \times 0.332 = 0.205$), which represents a meaningful contribution to the overall effect of DLC on CLP. This confirms the critical role of CLC as a mechanism through which DLC is transformed into improved CLP.

Table 4: Standardized Regression Weights

Hyp.	Path			Standardized Estimate	S.E.	C.R.	P
H1	CLC	<---	DLC	.618	.047	6.820	***
H2	CLP	<---	CLC	.332	.158	3.840	***
H3	CLP	<---	DLC	.308	.067	4.327	***
H4	CLP	<---	ZCLP_ZEU	.358	.028	8.568	***

Source: Compiled by the authors.

DISCUSSION

The findings support all proposed relationships, providing clear evidence regarding the role of DLC in enhancing CLP through CLC and confirming the moderating influence of EU. These results offer further theoretical validation for RBV, DCT, and Contingency Theory by extending their application to the cold-chain logistics context of pangasius exporters. The positive relationship between DLC and CLC is consistent with RBV, which argues that digital resources create competitive value when they are transformed into firm-specific capabilities (Wernerfelt, 1984). It also supports DCT, which emphasises that firms must continuously integrate, reconfigure, and deploy resources in response to environmental changes to maintain competitive advantage (Teece et al., 1997). This finding is consistent with previous studies by Gligor and Holcomb (2012), Wang et al. (2015), Matwiejczuk (2019), Huang et al. (2023), and Jing and Fan (2024), which highlight the importance of digital technologies in strengthening operational and supply chain capabilities.

Furthermore, the results demonstrate that within the seafood export sector, the contribution of DLC to logistics performance is primarily realised through the enhancement of CLC rather than through direct performance improvements alone. The

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significant positive relationship between CLC and CLP further supports previous findings by Fugate et al. (2010), Wang et al. (2015), and Wong et al. (2011), which identify logistics capability and supply chain adaptability as critical determinants of operational performance, particularly under uncertain conditions. These findings are also consistent with Zhang and Mohammad (2024) and Hatani and Rommy (2024), who reported that stronger logistics capabilities improve operational outcomes in uncertain supply chain environments. For pangasius exporters, well-developed CLC enables more effective temperature management, reduces product losses, preserves quality standards, and supports compliance with international requirements related to traceability, food safety, and sustainability, thereby strengthening long-term competitiveness.

Additionally, the mediating role of CLC between DLC and CLP reinforces the argument that digital investments alone are insufficient to improve logistics outcomes unless they are converted into specialised organisational capabilities. This finding further supports DCT, as recent studies by Huang et al. (2023) and Bag et al. (2021b) demonstrate that organisational capabilities serve as an essential mechanism through which digital resources generate operational value. By empirically confirming this mediating mechanism within the cold-chain seafood export context, this study contributes evidence to an area that remains relatively underexplored. Finally, the moderating effect of EU indicates that the relationship between CLC and CLP becomes stronger under uncertain environmental conditions. This finding highlights that the effectiveness of CLC depends partly on the surrounding operating environment. When faced with unpredictable demand, regulatory changes, and logistics disruptions, firms with stronger CLC are better equipped to adapt and maintain superior CLP.

CONCLUSION AND IMPLICATIONS

Conclusion

This study examined the relationships among DLC, CLC, EU, and CLP within pangasius-exporting firms in Vietnam's Mekong Delta. The findings demonstrate that DLC positively influences both CLC and CLP, while CLC has a direct positive effect on CLP. Moreover, EU strengthens the relationship between CLC and CLP, indicating that the contribution of logistics capability to performance becomes more pronounced under higher levels of uncertainty. The study extends the application of RBV, DCT, and Contingency Theory to the seafood export context by empirically demonstrating that CLC is developed through DLC and that environmental conditions shape the extent to which CLC contributes to CLP. These findings provide further understanding of how digital resources, organisational capabilities, and external uncertainty interact to influence logistics outcomes in the cold-chain export industry.

Managerial Implications

The findings indicate that adopting digital technologies, including digital platforms, Cloud Computing, Big Data, and IoT, as components of DLC can enhance the collection, exchange, and processing of cold-chain information. Nevertheless, investment in digital resources alone is insufficient to generate superior outcomes. Firms should integrate these resources into CLC by optimising operational processes, strengthening temperature management practices, improving cross-functional coordination, and developing employees' digital competencies. Furthermore, organisations should proactively strengthen their ability to manage EU through effective risk management practices and continuous monitoring of changes in technical standards, traceability requirements, and sustainability regulations across international markets. Ultimately, developing a robust cold-chain system enables firms to enhance CLP and maintain competitiveness within increasingly dynamic global supply chains.

LIMITATIONS AND FUTURE RESEARCH

Although this study offers meaningful insights, several limitations should be acknowledged. First, the findings may have limited generalisability beyond pangasius-exporting firms in the Mekong Delta. Second, the cross-sectional research design restricts the ability to examine how the relationships among variables evolve over time. Future studies could address these limitations by extending the investigation to other seafood and agri-food sectors, adopting longitudinal approaches, and incorporating additional constructs, such as supply chain resilience and digital transformation maturity. Such extensions would provide deeper understanding of the mechanisms through which firms achieve improved CLP under conditions of EU.

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APPENDIX

Latent variable	**Items**	
CDL		Our company applies digital technologies to effectively monitor and manage logistics activities.
		Digital technologies improve the visibility and sharing of logistics information across our operations.
		Our company uses digital data to support decision-making in logistics operations.
		Logistics information is effectively integrated and shared through digital platforms.
		Digital technologies improve inventory management and overall logistics operations.
CLC	CIC	Our company continuously adopts innovative solutions to improve cold-chain logistics operations.
		Our company applies appropriate technologies to monitor and control temperature throughout cold-chain logistics operations.
		Our company continuously improves cold-chain logistics processes to meet export market requirements.
	CPC	Our company has standardized procedures for cold-chain logistics operations.
		Our company effectively controls product temperature during storage and transportation.
		Our company can promptly identify and resolve problems occurring in cold-chain logistics operations.
	CFC	Our company can flexibly adjust transportation schedules to meet customer requirements.
		Our company consistently delivers products on time even when market conditions change.
		Our company effectively minimizes product damage and quality deterioration during cold-chain logistics operations.
CLP		Our company's cold-chain logistics performance is superior to that of our major competitors.
		Our company performs cold-chain logistics activities efficiently and effectively.
		Our cold-chain logistics system consistently supports on-time delivery while maintaining product quality.
		Overall, our cold-chain logistics contributes positively to customer satisfaction and export performance.
EU		Customer demand in our export markets is difficult to predict.
		Requirements and standards in export markets change rapidly.
		International trade policies and regulations affecting our exports change frequently.
		Logistics and transportation costs fluctuate significantly.