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Coopetition in Port Competitiveness and Maritime Logistics Networks: An Integrative Framework for Container Terminal Ecosystems

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ABSTRACT

Purpose: This study develops a port-specific framework for governing coopetition across container terminals, port systems, and maritime logistics networks. Design/methodology/approach: An integrative literature review and thematic conceptual synthesis combined evidence from three complementary streams: coopetition and strategic management, port competition and competitiveness, and maritime logistics-network governance. Evidence was organized around actors, motives, mechanisms, relational conditions, governance safeguards, risks, and performance outcomes. Findings: Coopetition is most consequential where competing port actors confront shared system interdependencies while continuing to compete for cargo, vessel calls, investment, customers, and market position. Five operational domains are identified: strategic and institutional coordination, infrastructure and capacity sharing, operational synchronization, digital and information-based collaboration, and sustainability- and resilience-oriented cooperation. Major risks include opportunism, information leakage, dependency, power asymmetry, regulatory exposure, and failures in data governance. Research limitations/implications: The framework is conceptual and does not estimate causal effects. Its propositions require empirical testing through surveys, comparative case studies, network analysis, game-theoretic modelling, simulation, and multi-criteria decision-making in regional port systems. Originality/value: The study reframes coopetition as a decision-oriented construct tailored to the operational and governance realities of ports. It connects shared infrastructure, digital interoperability, hinterland coordination, environmental investment, and contingency capacity with the need to preserve independent pricing, customer acquisition, innovation, and commercial differentiation. The resulting framework supports port authorities, terminal operators, shipping lines, and regulators in identifying legitimate collaborative domains while maintaining fair competition, system reliability, and collective value creation.

1. Introduction

Maritime transport underpins international commerce and constitutes a strategic component of coastal and offshore economies. More than four-fifths of global merchandise trade by volume is carried by sea, while recent interruptions at major maritime chokepoints have demonstrated that port and logistics performance has implications far beyond routine operations, affecting economic security, supply-chain

continuity, and national competitiveness [1]. Contemporary ports therefore function not simply as cargo-transfer facilities, but as interconnected logistics platforms, information nodes, industrial interfaces, and governance environments in which public and private organizations pursue interdependent objectives under simultaneous competitive and collaborative pressures.

Container terminals provide a particularly visible expression of this transformation. They compete intensely for vessel calls, cargo volumes, transshipment flows, hinterland traffic, investment, and service reputation, yet their performance is simultaneously conditioned by shared resources and institutional arrangements that no individual terminal can fully control. Maritime access, navigational safety, inland corridors, customs procedures, digital standards, environmental requirements, emergency-response capabilities, and port-community systems all shape terminal outcomes. Consequently, the competitiveness of ports increasingly depends on the quality of coordination among port authorities, terminal operators, shipping lines, inland transport providers, freight forwarders, customs agencies, and cargo interests.

This combination of rivalry and interdependence creates a persistent strategic tension. Competitive pressure remains essential because it encourages productivity, innovation, service improvement, and cost discipline. At the same time, fragmented decision-making can generate congestion, duplicated investment, inefficient use of shared infrastructure, environmental externalities, and reduced system resilience. Cooperation is therefore indispensable in selected domains. The concept of coopetition captures this coexistence by describing relationships in which actors remain competitors in some activities while deliberately collaborating in others [2-4].

Despite the maturity of coopetition research in strategic management and innovation, its application to port systems and maritime logistics remains comparatively fragmented. Existing port scholarship has developed substantial knowledge on inter-port rivalry, competitiveness, governance, terminal-operator networks, shipping alliances, hinterland integration, digitalization, and sustainability, but these streams are often examined separately. Operational reality, by contrast, requires simultaneous consideration of competition and cooperation. Song [5] established port co-opetition as a strategic option, but the contemporary context now includes supply-chain disruption, decarbonization, digital platforms, capacity-sharing arrangements, mega-vessel deployment, and regional port-system planning, creating a need for an updated and operationally grounded framework.

Against this background, the present study reformulates coopetition as a port-specific governance and competitiveness framework for container terminals and maritime logistics networks. The guiding research question asks how coopetition can be conceptualized and operationalized within contemporary port ecosystems. The study integrates strategic coopetition theory with the operational, technological, institutional, and environmental characteristics of port systems; identifies the mechanisms through which selective collaboration among rivals can support competitiveness; and specifies governance safeguards intended to limit opportunism, anti-competitive conduct, and conflicts over value appropriation.

2. Background

2.1. Coopetition as a Strategic Paradox

Coopetition challenges the conventional assumption that competition and cooperation represent mutually exclusive strategic choices. Competitive strategy traditionally emphasizes rivalry, differentiation, and market positioning, whereas cooperative strategy focuses on alliances, resource pooling, and joint value creation. Coopetition combines these logics by recognizing that organizations may collaborate in carefully defined areas while continuing to compete elsewhere. This perspective is especially relevant to networked industries in which firms rely on common infrastructure, standards, technologies, or market-development efforts while simultaneously competing for customers and revenues. The conceptual foundations, typologies, benefits, limitations, and paradoxical nature of coopetition are well established in [6-11].

Research in strategic management identifies several recurring motivations for coopetition, including access to complementary resources, uncertainty reduction, shared innovation expenditure, knowledge exchange, market development, risk distribution, and coordinated responses to external pressures [6, 7]. These advantages are accompanied by inherent tensions. Knowledge exchange may expose proprietary capabilities; collaborative efficiency gains may strengthen a rival; and joint initiatives may produce unequal distributions of value. Effective coopetition therefore depends on explicit boundaries, monitoring arrangements, trust-building mechanisms, and institutional rules that protect collaborative value creation without eroding competitive independence.

More recent research has moved beyond conceptual definition toward the management and operationalization of coopetitive relationships. Studies emphasize information asymmetry, conflicting objectives, role ambiguity, appropriation risk, and the need to distinguish cooperative activities from competitively sensitive domains [12-15]. Such concerns are particularly consequential in ports, where commercial actors operate within complex socio-technical systems and alongside public-interest responsibilities. Evidence on network embeddedness, technological collaboration among rivals, international coopetition, and the operational attributes of

coopetitive strategies further reinforces the importance of governance design [16-19].

2.2. Port Competition, Competitiveness, and Maritime Logistics Networks

Traditional analyses of port competition have focused on port choice, cargo throughput, terminal productivity, shipping-line preferences, port charges, geographic position, nautical accessibility, and hinterland connectivity. Contemporary competitiveness, however, is substantially broader. Recent reviews indicate that infrastructure and cost remain important, but logistics integration, connectivity, service quality, governance capacity, environmental performance, digital capability, and resilience increasingly determine competitive position [20, 21]. Research on port classification, cluster governance, intra-port competition, and port management provides additional institutional foundations for understanding this multidimensional environment [22-25].

Ports consequently compete as components of interconnected maritime supply chains rather than as isolated facilities. Their attractiveness to shipping lines and cargo owners depends on the combined performance of terminals, inland connections, customs systems, labour arrangements, environmental practices, information infrastructure, and port-community coordination. Competitive advantage therefore increasingly requires access to and orchestration of network-level resources. This creates a natural setting for coopetition: ports and terminal operators may continue to compete for cargo and commercial contracts while coordinating investments in common infrastructure, intermodal corridors, standards, emergency response, environmental initiatives, and information exchange. The evolution of port regionalization, logistics restructuring, maritime supply-chain integration, terminalization, and port development provides a strong basis for this interpretation [26-30].

Maritime logistics research has long shown that shipping lines, ports, and terminal operators occupy overlapping roles as competitors and partners. Network-design studies demonstrate that strategic coordination among port authorities, carriers, and terminal operators can generate system value, although the allocation of that value frequently remains contested [31]. Recent reviews applying game theory to maritime supply chains likewise identify competition and cooperation as simultaneous forces and highlight the importance of well-designed cooperative mechanisms for the stability of alliances and logistics networks [36]. Empirical work on cooperative terminal networks, maritime consolidation, logistics coopetition, and shipping-industry cases provides further support for this view [32-35].

2.3. Relevance to Coastal, Offshore, and Maritime Engineering

Port coopetition is directly relevant to coastal, offshore, and maritime engineering because it affects the planning and performance of maritime transportation systems, harbour and waterfront infrastructure, terminal operations, digital port architecture, resilience, and sustainable technology. Its significance therefore extends beyond business strategy. Decisions about cooperation among competing actors influence infrastructure utilization, traffic distribution, terminal capacity priorities, hinterland-corridor development, environmental investment, data-platform architecture, and contingency planning. These are also core concerns in contemporary logistics systems, operations management, and industrial engineering. Research on digital transformation, smart ports, transportation-system modelling, and port capacity sharing illustrates how coopetitive arrangements can shape both operational and technological design choices [37-40].

For instance, neighbouring ports may coordinate selected dredging programmes, inland corridors, emergency facilities, or green-energy infrastructure to reduce redundant investment while maintaining rivalry in cargo attraction and service performance. Terminal operators may adopt common data standards or contingency-capacity arrangements while preserving independent productivity strategies and customer contracts. Shipping alliances can coordinate network operations in ways that reshape port-call patterns while carriers remain commercial competitors. Such arrangements influence berth and yard utilization, vessel turnaround, terminal congestion, hinterland flows, resource allocation, and environmental externalities. A port-specific coopetition framework can therefore support more coherent system-level decision-making, including collective responses to disruption, decarbonization, and environmental innovation [41, 42].

3. Methodology

An integrative literature review combined with conceptual synthesis was adopted to develop the framework. Rather than estimating a pooled statistical effect, the study seeks to connect concepts that are dispersed across strategic management, port competitiveness, and maritime logistics research and to translate them into a domain-specific explanatory structure. This design is appropriate when a field is theoretically fragmented and when synthesis is required to generate constructs, relationships, and testable propositions for subsequent empirical investigation.

3.1. Study Domain Selection

The analytical domain was limited to ports, container terminals, maritime logistics networks, and port competitiveness because these settings combine intense market rivalry with pronounced operational

interdependence. Container terminals are especially suitable for examining coopetition because their performance is shaped by shipping-line concentration, growth in vessel size, congestion, digitalization, hinterland connectivity, capacity constraints, and sustainability requirements. The selected domain also lies within maritime transportation and port technology and intersects with logistics systems and operations-oriented research concerned with infrastructure use, coordination, reliability, and system performance.

3.2. Materials and Methods

The synthesis drew on three complementary literature streams. The first comprised foundational and contemporary studies of coopetition in strategic management, innovation, inter-organizational relationships, and network governance. The second covered port competition and competitiveness, including work on competitiveness determinants, terminal networks, port governance, and port-community arrangements. The third addressed maritime logistics and transportation systems, with particular attention to shipping alliances, capacity sharing, port-hinterland coordination, digital transformation, sustainability, and resilience.

3.3. Data Collection Strategy

Evidence was drawn primarily from peer-reviewed journal articles, supplemented by scholarly books and authoritative maritime reports where broader sectoral context was required. Search terms paired coopetition-related concepts with port and maritime terminology, including combinations such as coopetition and port, co-opetition and container terminal, cooperation and competition in maritime logistics, port competition and cooperation, port competitiveness and logistics networks, shipping alliances and ports, capacity sharing and ports, and digital-port collaboration. Maritime reports were used selectively to contextualize recent issues such as trade disruption, chokepoint vulnerability, decarbonization, and port resilience rather than to substitute for peer-reviewed conceptual evidence.

3.4. Method of Analysis

A thematic synthesis was used to structure the evidence. The literature was first organized around recurring categories covering actors, motives, mechanisms, relational conditions, risks, governance safeguards, and outcomes. Each category was then translated into port-specific operational meaning. In a subsequent stage, the categories were integrated into a conceptual architecture linking external pressures and internal motives with relational conditions, coopetition mechanisms, governance arrangements, and performance consequences. The final stage converted the resulting theoretical relationships into propositions suitable for empirical testing across ports, container terminals, and regional maritime logistics systems.

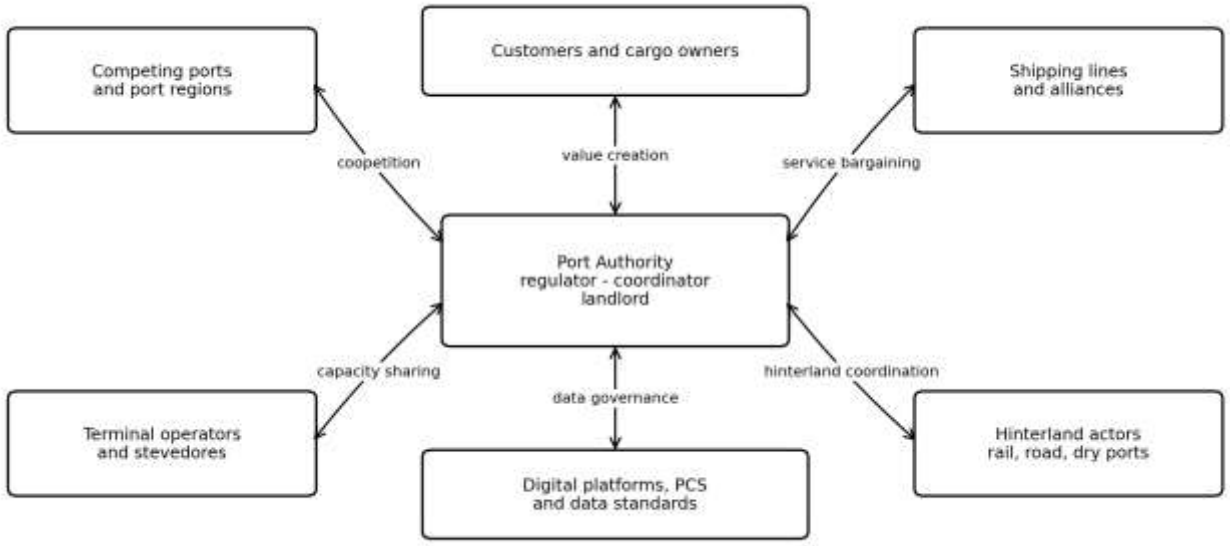

Figure 1. Port coopetition ecosystem in maritime logistics networks.

4. Findings

4.1. Operationalization of Port Coopetition Criteria

The synthesis suggests that port coopetition is best understood through the combined configuration of participating actors, cooperative activities, governance arrangements, and expected outcomes. Its operationalization differs from generic firm-level coopetition because ports combine commercial rivalry with infrastructure interdependence and public-interest responsibilities. Table 1 therefore translates the principal dimensions of coopetition into constructs that

can be observed and subsequently measured in port and terminal settings.

Table 1. Operationalization of port coopetition constructs

Construct	Code	Port-specific operational meaning	System-level relevance
Strategic-institutional coordination	PC1	Coordinated planning among port authorities, regulators, and regional actors concerning investment priorities, concessions, safety, security, and service standards while commercial identities remain separate.	Limits duplicative investment and supports coordinated system competitiveness.
Infrastructure and capacity sharing	PC2	Joint or coordinated access to berths, yards, inland depots, hinterland corridors, emergency capacity, green-energy facilities, or other common infrastructure.	Raises asset utilization and resilience, provided allocation rules are transparent.
Operational synchronization	PC3	Alignment of vessel calls, gate processes, truck appointments, rail windows, customs interfaces, and disruption-response activities.	Mitigates congestion, improves reliability, and supports terminal productivity.
Digital and data-based collaboration	PC4	Interoperable port-community systems, shared data standards, visibility platforms, cybersecurity protocols, and predictive information exchange.	Improves coordination and situational visibility while increasing data-governance requirements.
Sustainability and resilience cooperation	PC5	Joint environmental programmes, alternative-fuel infrastructure, emissions monitoring, climate adaptation, emergency response, and continuity planning.	Generates shared public value and strengthens long-term legitimacy and resilience.
Competitive differentiation	PC6	Continued rivalry through efficiency, service quality, innovation, pricing, customer relationships, and differentiated value propositions.	Maintains market discipline and prevents legitimate cooperation from drifting toward collusion.

4.2. Main Mechanisms of Coopetition in Ports and Container Terminals

Five recurring mechanisms emerge as especially relevant to competitiveness in ports and container terminals. Capacity-oriented coopetition enables actors to absorb demand peaks and disruptions through coordinated access to berths, yards, inland depots, corridors, or contingency capacity. Hinterland-oriented coopetition improves the reliability of shared road, rail, dry-port, and customs interfaces. Digital coopetition facilitates interoperable port-community systems, common data standards, and real-time visibility. Environmental coopetition supports joint investment in shore power, alternative fuels, emissions monitoring, and related green infrastructure. Resilience-oriented coopetition strengthens contingency planning, risk communication, cybersecurity preparedness, emergency response, and recovery. Together, these mechanisms show how selective collaboration can improve system performance while commercial rivalry remains intact.

Table 2. Main mechanisms of port coopetition

Mechanism	Illustrative operational application	Potential competitiveness contribution	Principal risk
Capacity sharing	Planned or contingency access to berth, yard, depot, or corridor capacity	Lower congestion; stronger resilience; improved asset utilization	Allocation conflict; dependency; uneven benefit distribution
Hinterland coordination	Joint scheduling and planning across road, rail, inland terminals, customs, and dry ports	More reliable corridors; shorter dwell time	Coordination burden; fragmented jurisdiction
Digital port platforms	Interoperable port-community systems, data standards, and predictive visibility tools	Greater information visibility; improved service reliability	Data leakage; cybersecurity exposure; strategic information loss
Green port collaboration	Shared shore-power systems, alternative-fuel facilities, and emissions-monitoring arrangements	Reduced environmental externalities; stronger legitimacy	Free-riding; disagreement over cost allocation
Safety and security cooperation	Joint emergency preparedness, nautical-safety arrangements, and cyber-incident protocols	Lower systemic risk; faster recovery	Trust limitations; ambiguity in responsibility
Market-facing competition	Independent pricing, customer acquisition, service design, and innovation	Continued incentives for efficiency, differentiation, and service improvement	Tension between commercial rivalry and shared initiatives

4.3. Coopetition Risks and Governance Safeguards

The potential benefits of port coopetition depend heavily on governance quality. Opportunism is a primary concern because actors may exploit shared infrastructure, information, or coordination arrangements to improve their own competitive position without making a proportional contribution. Commercially sensitive knowledge and data may also leak through collaborative platforms. Power asymmetry introduces a further risk when large shipping lines or terminal operators can influence

smaller actors or port authorities disproportionately. In addition, cooperation among competitors may create competition-law concerns if the boundary between legitimate coordination and collusive conduct is not transparent. Table 3 summarizes these risks together with governance mechanisms intended to contain them.

Table 3. Coopetition risks and recommended governance safeguards

Risk	How the risk emerges	Governance response
Opportunism and free-riding	Participants obtain benefits from common assets or initiatives without a proportional contribution.	Formal agreements, transparent cost-allocation rules, audit rights, and performance-linked participation.
Knowledge and data leakage	Collaborative systems expose commercially sensitive or strategically useful information.	Data classification, neutral trusteeship, access controls, anonymization, and cybersecurity safeguards.
Unequal bargaining power	Dominant actors capture disproportionate benefits or impose terms on weaker participants.	Independent coordination, representative stakeholder committees, and balanced concession arrangements.
Collusion and regulatory risk	Coordination is perceived or used as price fixing, market allocation, or other anti-competitive conduct.	Legal review, competition-law compliance, and explicit separation of collaborative and commercial domains.
Governance complexity	A large number of organizations increases decision time and transaction costs.	Defined governance architecture, clear roles, escalation procedures, and measurable performance indicators.
Strategic lock-in	Dependence on common systems or assets reduces flexibility or exit options.	Periodic review, modular infrastructure, exit provisions, and interoperable standards.

4.4. Proposed Conceptual Framework

The proposed framework treats port coopetition as an intermediate mechanism through which contextual pressures are translated into operational, strategic, and societal outcomes. External pressures include alliance consolidation, deployment of mega-vessels, chokepoint disruption, climate-related threats, decarbonization requirements, and customer expectations for reliable service. Internal motives include capacity limitations, technology deficits, instability in service performance, and the need to improve resource utilization. Relational conditions such as trust, power balance, institutional support, prior collaborative experience, and strategic compatibility shape whether coopetitive mechanisms can function effectively. Governance safeguards influence the strength and quality of these relationships by limiting opportunism, ambiguity, and regulatory exposure while supporting accountable coordination.

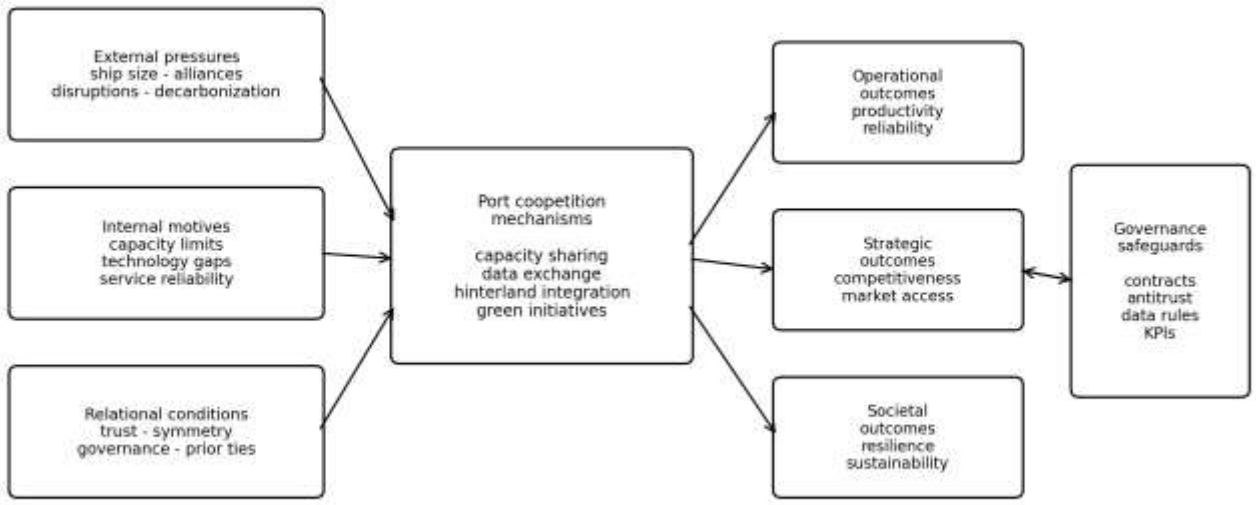

Figure 2. Proposed framework for port coopetition and competitiveness.

4.5. Research Propositions

The conceptual synthesis yields six propositions that make the framework empirically testable. Collectively, they specify the organizational, technological, regulatory, and relational conditions under which coopetition is expected to influence competitiveness, operational reliability, legitimacy, and resilience in port systems.

Table 4. Research propositions

Code	Proposition
P1	Port coopetition is more likely to strengthen competitiveness when cooperative activities are explicitly separated from market-facing competitive activities.
P2	Digital information-sharing capability mediates the relationship between port coopetition and operational reliability.
P3	Governance safeguards strengthen the positive relationship between port coopetition and competitiveness by limiting opportunism and regulatory uncertainty.
P4	Sustainability-oriented coopetition enhances port legitimacy and long-term competitiveness, particularly when environmental infrastructure requires substantial fixed investment.
P5	Power asymmetry among port authorities, terminal operators, and shipping lines intensifies coopetitive tension unless credible neutral coordination mechanisms are present.
P6	The competitiveness benefits of port coopetition are greater in regional port systems characterized by shared hinterlands and overlapping cargo markets than in geographically or commercially isolated port systems.

5. Discussion

The results position coopetition as an organizing logic for contemporary port systems rather than as a peripheral strategic option. A binary view in which ports either compete or cooperate does not adequately represent maritime logistics networks. Cargo and shipping services remain subjects of intense rivalry, yet many determinants of performance are shared, including maritime access, hinterland corridors, digital standards, customs interfaces, environmental infrastructure, and risk-management capabilities. Port competitiveness is therefore increasingly affected by the ability of actors to design and govern a workable boundary between collective system-level coordination and independent market-facing competition.

The framework extends the early port co-opetition perspective by incorporating structural changes that have intensified interdependence across maritime transportation. Song [5] presented co-opetition as a strategic response to evolving shipping-line behaviour. Since then, shipping alliances, larger vessels, vertical integration, digitalization, climate exposure, decarbonization requirements, and geopolitical disruption have increased the cost of fragmented action. These developments make selective collaboration more consequential for capacity utilization, network reliability, and service continuity, while also making the preservation of competitive incentives more important.

Digital infrastructure represents one of the most consequential enabling conditions for port coopetition. Port-community systems, visibility platforms, automated gates, and shared data standards can reduce coordination frictions and improve operational reliability across organizations. At the same time, information has strategic value, and digital collaboration may expose commercially sensitive data or create cybersecurity vulnerabilities. Effective digital coopetition therefore requires carefully differentiated data-access rules, neutral platform governance, cybersecurity controls, and mechanisms that separate information needed for operational coordination from information that should remain commercially confidential.

Sustainability provides another domain in which the logic of coopetition is particularly compelling. Shore power, alternative-fuel infrastructure, circular-economy facilities, emissions monitoring, dredging strategies, and climate-adaptation measures often involve high fixed costs and system-wide externalities that cannot be addressed efficiently by isolated actors. Coordinated investment can generate shared environmental and operational benefits, while ports and terminals continue to differentiate themselves through service quality, efficiency, innovation, and customer relationships. This connection is especially relevant to coastal and environmental engineering because environmental performance increasingly affects regulatory legitimacy, investment priorities, and the long-term viability of port development.

A critical implication of the framework is that coopetition must remain distinct from collusion. Legitimate coopetition concerns collaboration directed toward system-level value creation, common infrastructure, interoperability, resilience, or environmental objectives while preserving independent commercial decision-making. The arrangement becomes problematic when cooperation restricts rivalry through price coordination, market allocation, exclusionary practices, or other anti-competitive conduct. Transparent governance, independent oversight, competition-law compliance, and measurable public or system-level objectives are therefore essential design conditions for port coopetition.

6. Conclusions

This study develops a domain-specific interpretation of coopetition for ports, container terminals, maritime logistics networks, and port competitiveness. By combining insights from coopetition theory, port competition, governance, and maritime logistics, it constructs an integrated framework explaining how selective collaboration can coexist with commercial rivalry in complex port ecosystems.

The synthesis indicates that coopetition is most defensible where competitors confront shared system constraints but still require market-based incentives. Relevant domains include capacity management,

hinterland integration, digital information exchange, sustainability infrastructure, safety and security, and resilience. At the same time, collaboration may create opportunism, information leakage, bargaining asymmetry, governance complexity, strategic dependency, and regulatory uncertainty. These risks make transparent allocation rules, data governance, legal safeguards, accountability arrangements, and performance monitoring integral to the design of coopetitive initiatives.

The principal theoretical contribution is to convert coopetition from a broad inter-organizational strategy into a structured framework tailored to the infrastructural, operational, and governance realities of port systems. From a practical perspective, the framework provides a decision-oriented basis for identifying where collaboration among rivals may improve system performance and how such cooperation can be bounded without undermining fair competition. Empirical validation should now examine the propositions across regional port systems and container-terminal ecosystems using surveys, comparative case studies, network analysis, game-theoretic modelling, multi-criteria decision-making, and other operations-oriented methods capable of evaluating competitiveness, resilience, and resource-use consequences.

6.1. Practical Implications

Table 5. Practical implications for port stakeholders

Stakeholder	Decision implication
Port authorities	Establish clear boundaries between cooperative infrastructure planning and competitive service provision and provide neutral coordination for port-community initiatives.
Terminal operators	Use coopetition selectively for interoperable data, congestion management, contingency capacity, and environmental initiatives while protecting commercial differentiation.
Shipping lines	Coordinate transparently where schedule reliability and capacity planning require joint action without compromising independent market competition.
Regulators	Clarify acceptable forms of collaboration among competitors, particularly in sustainability, resilience, safety, and digital infrastructure.
Technology providers	Develop interoperable architectures with role-based access, cybersecurity safeguards, and neutral mechanisms for data governance.
Researchers	Empirically validate the framework and develop robust measures of coopetition intensity, governance quality, system performance, and competitiveness outcomes.

6.2. Limitations and Future Research

The study is conceptual and relies on an integrative synthesis of existing literature; accordingly, it does not estimate causal effects, quantify effect sizes, or rank individual ports. Future research should test the proposed constructs and relationships using empirical evidence from port authorities, container terminals, shipping lines, logistics firms, and regulatory institutions. Survey-based studies can develop and validate measurement scales and examine structural relationships, while comparative case studies can investigate how coopetition is governed under different institutional arrangements. Further work could integrate game theory, network analysis, simulation, optimization, and multi-criteria decision-making to assess how alternative coopetition designs influence capacity utilization, reliability, competitiveness, resilience, and sustainability across different market and regulatory scenarios.

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