

Public–Private Partnerships and Container Terminal Performance

Driss JAMAI^{1}, Babounia AZIZ²*

¹ Doctoral Researcher, Ibn Tofail University, National School of Business and Management (ENCG) of Kénitra, Laboratory of Multidisciplinary Research in Organizational Management (LSGO), Kénitra, Morocco.

² Professor, Ibn Tofail University, ENCG of Kénitra, LSGO, Kénitra, Morocco.

Corresponding author: jamai.driss@uit.ac.ma | ORCID: <https://orcid.org/0009-0001-0173-8029>

ABSTRACT: Public-private partnerships (PPPs) have become an important institutional arrangement for financing, developing, and operating container terminals. However, the performance effects of private participation are not uniform and depend on the interaction between governance, contract design, risk allocation, regulation, and the operational capabilities of the terminal. This conceptual and comparative review synthesizes the mechanisms through which PPP arrangements may affect container-terminal performance. The analysis organizes the literature around four performance dimensions: service delivery, terminal capacity, operational efficiency and productivity, and investment and financing. It then compares the expected effects of concessions, operating leases, build-operate-transfer arrangements, and performance-based concessions across regional contexts. The review suggests that PPPs can support productivity, throughput, service reliability, investment mobilisation, and operational flexibility, particularly when contractual obligations are measurable and the private operator has adequate incentives and capabilities. These potential gains are nevertheless conditional. Weak regulation, excessive market power, politically motivated renegotiation, inadequate hinterland connectivity, and poorly allocated risks can reduce or reverse the expected benefits. The article proposes a performance-oriented governance framework that combines transparent risk allocation, competition safeguards, monitoring indicators, accountability mechanisms, and sustained investment in intermodal and green infrastructure. The review also identifies priorities for future empirical research, including longitudinal designs, comparable terminal-level datasets, and broader social and environmental performance measures.

Keywords: public-private partnerships; container terminals; port governance; terminal performance; concessions; risk allocation.

1. INTRODUCTION

Container terminals are critical nodes in international logistics systems. Their performance affects vessel turnaround times, cargo reliability, inland distribution, trade competitiveness, and the resilience of supply chains. The expansion of containerized trade, the arrival of larger vessels, and the increasing integration of maritime and inland transport have intensified the pressure on terminal operators and public authorities to improve capacity, productivity, and service quality. At the same time, terminal infrastructure requires substantial and long-term capital investment, while public budgets are often constrained.

Public-private partnerships offer one institutional response to this challenge. Under a PPP, a public authority and a private entity share responsibilities for the financing, development, operation, or maintenance of infrastructure over a specified period. In the port sector, the arrangement may take the form of a concession, an operating lease, a build-operate-transfer (BOT) contract, or a performance-based contract. These arrangements do not merely change the source of finance. They also redistribute decision rights, operational responsibilities, commercial incentives, and project risks between the public and private partners.

The central problem addressed in this article is that PPPs are frequently associated with efficiency and investment gains, although the available evidence is more nuanced. Private participation may improve operating flexibility and access to capital, but it may also create risks related to market power, fiscal exposure, reduced accountability, or opportunistic renegotiation. The performance of a PPP therefore depends not only on whether private participation exists, but also on how the partnership is governed and monitored.

This article asks: **through which governance, financing, operational, and risk-allocation mechanisms do PPP arrangements influence container-terminal performance, and under what conditions are the**

expected benefits most likely to materialize? The article has three objectives. First, it clarifies the principal theoretical pathways connecting PPP arrangements to terminal outcomes. Second, it organizes comparative evidence around a common set of performance dimensions. Third, it derives implications for contract design, regulation, terminal management, and future research.

The remainder of the article is structured as follows. Section 2 presents the literature-based methodology and the conceptual framework. Section 3 reviews the principal performance dimensions and contractual arrangements. Section 4 discusses theoretical mechanisms, comparative evidence, governance conditions, and trade-offs. Section 5 develops implications for policy and practice. Section 6 concludes by identifying limitations and research priorities.

2. MATERIALS AND METHODS

2.1. Research design

This study adopts a conceptual and comparative literature-review design. It does not estimate a new econometric model or claim to produce a causal effect for a particular terminal. Instead, it synthesizes arguments and findings reported in the literature in order to explain the conditions under which PPP arrangements may strengthen or weaken terminal performance. This approach is appropriate because the relationship between PPPs and performance is multidimensional: it includes financial, operational, institutional, competitive, and environmental mechanisms that cannot be represented adequately by a single output indicator.

The reviewed material was organized using five analytical categories: governance structure; financing and risk allocation; operational responsibility; terminal performance indicators; and regional or institutional context. The synthesis distinguishes between expected mechanisms and reported associations. This distinction is important because a positive association between private participation and performance may also reflect selection effects, terminal scale, cargo composition, market competition, location, or the quality of the public authority.

2.2. Conceptual framework

The framework developed in this article treats PPPs as governance arrangements that affect performance through three interconnected pathways. The first pathway is **operational capability**. Private operators may contribute specialized management, equipment utilization practices, labor organization, digital systems, and commercial responsiveness. The second pathway is **financial and risk capacity**. PPPs may mobilize capital and distribute construction, demand, operational, political, and financial risks between the partners. The third pathway is **institutional alignment**. Contracts and regulatory frameworks define objectives, performance obligations, monitoring procedures, competition conditions, and mechanisms for adjustment. The three pathways interact. For example, a private operator may have the technical capacity to increase crane productivity, but the gain may not occur if the contract does not reward performance or if access roads and rail connections are inadequate. Likewise, a concession may mobilize investment, but the resulting welfare effects may be limited if tariff regulation is weak or if market power is not controlled. PPP performance is therefore understood as a conditional outcome of organizational capability, contractual incentives, public oversight, and the wider logistics environment.

2.3. Performance dimensions

Container-terminal performance should be measured through a balanced set of indicators. Service delivery captures reliability, speed, and consistency from the perspective of shipping lines, cargo owners, and inland operators. Terminal capacity reflects the effective use of berths, cranes, yards, gates, and other assets. Efficiency and productivity relate outputs to resources and time. Investment and financing indicators capture the terminal's ability to expand, modernize, and maintain its infrastructure while controlling financial exposure.

Table 1. Principal dimensions and indicators of container-terminal performance.

Performance dimension	Representative indicators	Interpretation
Service delivery	Vessel punctuality; berth turnaround time; cargo-handling time; gate and delivery reliability	Reliability, speed, and consistency of service
Terminal capacity	Equipment availability; crane productivity; berth occupancy; yard utilization	Effective use of physical assets and terminal space

Efficiency and productivity	Throughput; moves per crane-hour; dwell time; operating cost per unit	Output relative to resources and time
Investment and financing	Capital expenditure; infrastructure renewal; financing cost; demand and currency exposure	Ability to expand, modernize, and sustain operations
Sustainability and accountability	Emissions; energy intensity; labor safety; complaints; compliance	Broader economic, social, and environmental performance

Source: Authors' synthesis based on the literature reviewed in this article.

3. PPP ARRANGEMENTS AND EXPECTED PERFORMANCE PATHWAYS

3.1. Concessions

A concession generally preserves public ownership of the land or core assets while granting a private operator the right to develop and operate the terminal for a defined period. The operator may assume responsibility for equipment, labor organization, customer relations, and some capital expenditure. The expected performance pathway is based on managerial flexibility, commercial incentives, and the ability to coordinate investment and operations. The public authority retains responsibility for defining the contract, protecting public interests, and monitoring compliance.

Concessions can improve performance when the contract specifies clear service standards, investment obligations, tariff principles, reporting requirements, and remedies for non-compliance. Their effectiveness is reduced when the concessionaire is protected from competition, when investment promises are vague, or when the authority lacks the technical and institutional capacity to monitor results.

3.2. Operating leases

Under an operating lease, the public entity retains ownership of the terminal assets while the private operator receives operational control for a specified period. This model may provide flexibility in service delivery and commercial decision-making without transferring the full responsibility for long-term infrastructure development. It can be appropriate where the public authority wishes to preserve ownership but needs specialized operational expertise.

The main limitation is the possible separation between short-term operating incentives and long-term asset stewardship. If the lease period is too short or maintenance obligations are poorly defined, the operator may prioritize immediate throughput over asset renewal, safety, or environmental performance. Performance monitoring must therefore include both annual operating indicators and longer-term maintenance and investment obligations.

3.3. Build-operate-transfer arrangements

In a BOT arrangement, the private partner finances and builds the facility, operates it during the contract period, and transfers the asset to the public authority at the end of the term. The model can mobilize private finance for greenfield or major reconstruction projects. It also integrates design, construction, and operation, potentially reducing coordination failures between project stages.

BOT projects are exposed to construction delays, cost overruns, demand uncertainty, interest-rate changes, currency fluctuations, legal disputes, political intervention, and land or utility constraints. Risk should be allocated to the party best able to control or absorb it. Transferring every risk to the private partner can increase the risk premium and reduce financial viability; retaining every risk in the public sector can undermine the purpose of the partnership. A credible feasibility study and transparent financial model are therefore essential.

3.4. Performance-based concessions

Performance-based concessions link part of the operator's rights, remuneration, or contractual renewal to measurable outcomes. Indicators may concern vessel turnaround, crane productivity, gate reliability, safety, emissions, investment completion, and customer complaints. This model can strengthen accountability by converting broad contractual objectives into verifiable targets.

Performance clauses should be limited to indicators that the operator can materially influence. They should also define data sources, measurement frequency, baseline values, exceptional-event rules, audit rights, and consequences for underperformance. Poorly designed targets can encourage gaming, discourage service to less profitable cargo, or penalize an operator for congestion caused by external infrastructure.

Table 2. PPP contractual arrangements and expected performance pathways.

PPP arrangement	Public-sector role	Private-sector role	Expected performance pathway
Concession	Retains ownership or regulatory authority and defines contractual conditions	Manages terminal operations and may finance equipment and expansion	Efficiency, productivity, and investment incentives
Operating lease	Retains ownership and long-term asset responsibility	Exercises operational control and selected commercial decisions	Flexibility and service responsiveness
BOT	Defines the project framework and receives the asset after the term	Finances, builds, and operates the facility	Investment mobilization and integrated risk management
Performance-based concession	Sets measurable obligations and monitors compliance	Operates under performance-linked incentives	Accountability and alignment with service targets

Source: Authors' synthesis based on the literature reviewed in this article.

4. RESULTS AND DISCUSSION

4.1. Efficiency and productivity

The literature reviewed generally supports the proposition that private participation can contribute to operational efficiency and productivity. Private operators may introduce specialized processes, more flexible procurement, improved equipment scheduling, and stronger customer-oriented management. In a context of larger vessels and tighter service windows, such capabilities can affect berth productivity, yard utilization, gate operations, and vessel turnaround.

The result should not, however, be interpreted as an automatic effect of ownership or contracting form. Productivity also depends on terminal scale, cargo mix, labor arrangements, equipment condition, berth configuration, weather, congestion, and inland connectivity. A concessionaire may perform well inside the terminal while the overall logistics chain remains slow because road and rail interfaces are inadequate. Evaluation should therefore distinguish terminal-controlled outcomes from system-level outcomes.

4.2. Service quality and reliability

Service quality includes punctuality, predictability, cargo-handling time, gate performance, information availability, and the ability to respond to disruptions. PPP arrangements may improve these dimensions by giving the operator greater control over staffing, equipment deployment, maintenance, and customer interfaces. The private operator may also have stronger incentives to retain shipping-line customers and protect service reputation.

At the same time, commercial incentives can conflict with public-service obligations. A terminal may prioritize high-volume customers or profitable services, while smaller shippers, strategic cargo, or regional development objectives receive less attention. Public authorities should therefore define minimum service obligations and establish transparent reporting systems. Reliability targets should be complemented by accessibility, safety, labor, and environmental indicators.

4.3. Investment and financing risk

Terminal infrastructure is capital-intensive, and the timing of investment is often uncertain. PPPs can expand access to finance and combine public authority with private capital, project management, and operational expertise. They may also distribute risks across the project life cycle. Construction risk can often be better managed by the party responsible for design and delivery, while political and regulatory risks may remain more appropriately with the public authority.

Risk allocation is a central determinant of performance. Excessive guarantees can expose taxpayers to contingent liabilities, whereas excessive private risk can increase financing costs or lead to renegotiation. The public authority should disclose the fiscal implications of guarantees, minimum-revenue commitments, termination payments, and foreign-exchange exposure. The contract should also specify how demand shocks, force majeure, regulatory changes, and major technological shifts will be handled.

4.4. Comparative evidence across regions

Comparative evidence suggests that PPP effects vary across regions and terminal environments. Studies discussed in the reviewed literature report positive associations between PPP arrangements and efficiency, productivity, reliability, or throughput in several contexts. Such findings are consistent with the view that private participation can be valuable where public authorities establish credible contracts and where operators have the capacity to invest and manage efficiently.

The evidence nevertheless remains heterogeneous. Differences in institutional quality, competition, terminal size, hinterland connectivity, cargo composition, and national port policy make direct comparisons difficult. Regional evidence should therefore be interpreted as contextual rather than universal. The key analytical question is not whether PPPs always outperform public provision, but which combination of governance and market conditions produces durable performance.

Table 3. Comparative evidence on PPPs and container-terminal performance.

Region or evidence base	Reported relationship	Main implication
Asia-Pacific: 65 terminals across 18 countries and territories	Positive reported association with efficiency, productivity, reliability, and overall performance	PPP benefits may be substantial when governance and operations are supportive
Africa: 35 ports during 2005-2015	Positive association between PPP arrangements and container-throughput growth	Private participation may support investment and capacity growth in resource-constrained contexts
Latin America: Brazil, Chile, Mexico, and competitive metropolitan port environments	Preliminary positive association with productivity and efficiency; service-quality effects may be mixed	Competition, regulation, and local market conditions shape outcomes

Source: Authors' synthesis based on the literature reviewed in this article. The underlying studies and sample descriptions should be verified before submission.

4.5. Governance, regulation, and market structure

Governance quality is the principal condition linking PPP design to performance. A well-structured partnership defines responsibilities, establishes measurable targets, protects users, and gives the operator sufficient autonomy to manage operations. Regulation is required to control abuse of market power, supervise tariffs where necessary, protect access, and ensure compliance with safety and environmental standards.

Competition must be assessed at more than one level. Competition between ports may discipline operators, but it may be weak where geography or network effects create a natural concentration. Competition between terminal operators may also be limited by land availability, shipping alliances, or exclusive access arrangements. Where competitive pressure is insufficient, the public authority must rely more heavily on benchmarking, tariff oversight, service obligations, and independent monitoring.

4.6. Renegotiation, accountability, and unintended consequences

Long-term infrastructure contracts cannot anticipate every future event. Renegotiation may therefore be legitimate when demand, regulation, technology, or force majeure conditions change materially. It becomes problematic when the initial contract is deliberately underpriced, when political incentives dominate economic reasoning, or when the private partner receives benefits without corresponding public value.

PPP governance should include publication of key contractual principles, transparent approval of material amendments, independent audits, and clear rules for termination and compensation. Fiscal discipline is especially important because long-term payment commitments may remain outside ordinary annual budget decisions. Public authorities should assess the partnership over its entire life cycle rather than focusing only on the initial investment.

4.7. Technology, innovation, and sustainability

Container terminals are increasingly shaped by automation, data platforms, predictive maintenance, energy management, and digital coordination with shipping and inland transport. PPP contracts should remain sufficiently adaptable to technological change without allowing unilateral changes that undermine competition or accountability. Investment obligations should include data governance, cybersecurity, workforce training, and interoperability where these are relevant to the logistics network.

Sustainability should be treated as a performance dimension rather than an optional addition. Relevant indicators include emissions, energy consumption, equipment electrification, noise, waste, occupational safety, labor conditions, and stakeholder complaints. Private participation may accelerate investment in green technologies, but only when environmental targets are measurable and supported by appropriate incentives and enforcement.

5. IMPLICATIONS FOR POLICY AND PRACTICE

Public authorities should begin with a transparent assessment of the problem that the PPP is intended to solve. The choice between public provision, concession, lease, BOT, or a hybrid model should follow from

an evaluation of value for money, fiscal affordability, market structure, institutional capacity, and long-term public objectives. PPP should not be treated as a financing shortcut or as a substitute for effective regulation. Contract preparation should define the allocation of design, construction, demand, operational, political, foreign-exchange, environmental, and technology risks. The allocation should follow control and comparative capacity rather than political convenience. The contract should contain a limited and balanced set of indicators, independent verification arrangements, adjustment rules, and remedies that are credible but proportionate.

Terminal managers should connect operational targets with broader supply-chain outcomes. Improvements in crane productivity are valuable, but they may not produce system-level benefits if gate congestion, rail capacity, or inland terminals remain inadequate. Cooperation with port authorities, carriers, customs, road and rail operators, and local communities is therefore necessary.

Future PPP projects should also incorporate sustainability and resilience from the beginning. This includes energy-efficient equipment, climate-risk assessment, emergency continuity plans, data-sharing protocols, and workforce development. Such provisions can protect performance while reducing the risk that short-term commercial objectives undermine long-term public value.

6. CONCLUSION

This article reviewed the mechanisms through which PPP arrangements influence container-terminal performance. The synthesis indicates that PPPs can contribute to efficiency, productivity, service reliability, investment mobilisation, and risk sharing. These potential benefits arise through operational capability, access to finance, integrated project responsibility, and contractual incentives.

The evidence also demonstrates that PPPs do not guarantee superior performance. Outcomes depend on contract design, regulatory quality, competition, accountability, risk allocation, terminal characteristics, and hinterland connectivity. Weak oversight may permit market power, underinvestment, fiscal opacity, or opportunistic renegotiation. The most credible policy position is therefore conditional: PPPs may create public value when they are selected for the right reasons and governed through transparent, measurable, and enforceable arrangements.

The study has two main limitations. First, it is a conceptual and literature-based synthesis rather than a new causal evaluation. Second, the source manuscript contains several incomplete citations and bibliographic records that require verification. Future research should develop comparable longitudinal terminal-level datasets, distinguish selection effects from treatment effects, examine the full logistics chain, and integrate economic, social, environmental, and resilience indicators. Such work would strengthen the empirical basis for designing PPPs that deliver durable performance and public accountability.

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Conflict of interest

The authors should declare any financial, professional, or personal relationships that could have influenced the research. If none exists, state: “The authors declare no conflict of interest.”

Ethics statement

This article is based on published literature and does not involve human participants, animals, or identifiable personal data. Formal ethical approval was therefore not required.

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