Sinergi International Journal of Logistics
E-ISSN: 2988-6244
Volume. 3, Issue 4, November 2025
Page No: 233-250

Understanding Port Operators' Perceptions of Operational Efficiency: A Qualitative Study of Indonesian Container Ports

Untung Lestari Nur Wibowo
Akademi Penerbang Indonesia Banyuwangi, Indonesia
Correspondent: untung.apib2020@gmail.com

Received : August 30, 2025
Accepted : November 11, 2025
Published : November 30, 2025

Citation: Wibowo, U.L.N., (2025). Understanding Port Operators' Perceptions of Operational Efficiency: A Qualitative Study of Indonesian Container Ports. Sinergi International Journal of Logistics, 3(4), 233-250.

https://doi.org/10.61194/sijl.v3i4.1134

ABSTRACT: Container ports are strategically vital to international trade and national logistics, making operational efficiency essential for competitiveness. While prior research has largely measured efficiency through quantitative methods, limited attention has been given to how frontline practitioners perceive and achieve efficiency in daily operations. This study explores port operators' perceptions of operational efficiency, its facilitating factors, barriers, and improvement strategies in Indonesian container ports. A qualitative interpretivist approach was used, involving semi-structured interviews with twelve experienced port operators selected purposively and analyzed through thematic analysis. Findings show operational efficiency is perceived as a multidimensional capability involving vessel services, resource utilization, berth/yard management, equipment reliability, stakeholder coordination, and digital systems. Key drivers include cross-agency coordination, skilled human resources, accurate planning, and digital technologies (Port Community Systems, Terminal Operating Systems, Smart Port initiatives). Barriers include yard congestion, limited berth capacity, equipment failures, and fragmented digital platforms. The study concludes that sustainable efficiency requires integrated coordination, governance, digital integration, and stakeholder collaboration, offering practical insights for Smart Port implementation.

Keywords: Operational Efficiency, Container Ports, Port Operators, Smart Port, Digital Transformation, Thematic Analysis, Indonesia.

INTRODUCTION

Seaports are fundamental components of global supply chains because they facilitate the movement of goods between maritime and inland transportation networks while supporting international trade and economic development. As international trade continues to expand, container ports are experiencing increasing pressure to improve operational performance, reduce logistics costs, and provide reliable services to shipping lines, cargo owners, and logistics providers. Efficient port operations not only accelerate cargo movement but also strengthen national logistics systems and improve the competitiveness of countries participating in global markets. Consequently, operational efficiency has become one of the most widely discussed themes in

maritime transport and port management research. Previous studies commonly define operational efficiency through dimensions such as container throughput, vessel productivity, berth productivity, yard operations, dwell time, berth utilization, container cycle time, and overall terminal productivity (Kishore et al., 2024; Pratama & Wiguna, 2023; Saha et al., 2024). These dimensions demonstrate that operational efficiency extends beyond technical productivity to encompass the effective utilization of physical resources, operational processes, and service quality.

The growing importance of operational efficiency is closely associated with its contribution to port competitiveness and national logistics performance. Efficient ports reduce vessel turnaround time, minimize cargo delays, improve schedule reliability, and decrease logistics costs throughout the supply chain. These improvements enhance the attractiveness of ports to shipping companies and logistics providers while strengthening hinterland connectivity and overall supply chain resilience. The literature consistently argues that operational efficiency is a major determinant of port competitiveness because it directly influences cost efficiency, service reliability, customer satisfaction, and national logistics performance (Agha & Warsi, 2020; Castellanos et al., 2024; Merk et al., 2022; Notteboom & Rodrigue, 2008). Furthermore, efficient port operations contribute to improvements in national logistics systems by facilitating smoother intermodal transport, increasing supply chain responsiveness, and supporting higher logistics performance at the national level.

Alongside the increasing demand for efficient port operations, digital transformation has fundamentally changed the way ports manage operational activities (Baptista et al., 2020). The adoption of Port Community Systems, Terminal Operating Systems, automation technologies, Internet of Things applications, artificial intelligence, cloud computing, and Smart Port initiatives has significantly improved operational visibility, information exchange, and decision-making processes. Contemporary studies suggest that operational efficiency should no longer be interpreted solely as the efficient movement of ships and cargo but also as the capability to coordinate information accurately and in real time across multiple stakeholders within the port ecosystem (Caldeirinha et al., 2022; Dalaklis et al., 2021; Hirata et al., 2022; Iman et al., 2022; Othman et al., 2022). Digital platforms improve transparency, automate routine operational activities, and enable predictive planning that enhances both terminal productivity and service reliability.

Despite these technological advancements, container ports continue to face numerous operational challenges that constrain efficiency. Yard congestion, prolonged dwelling time, limited berth capacity, fluctuating vessel arrival schedules, equipment failures, road congestion, and fragmented stakeholder coordination remain persistent operational problems in many ports. Studies further indicate that inefficiencies are often propagated through interactions between ports and their hinterland transport systems, where road congestion, rail limitations, and inadequate intermodal integration reduce the effectiveness of terminal operations (Wiedmer et al., 2023). In addition, slow digital adoption, limited interoperability among information systems, and regulatory complexity frequently prevent ports from realizing the full benefits of technological investments (Calatayud et al., 2020). These challenges demonstrate that improving operational efficiency requires simultaneous attention to infrastructure, governance, organizational coordination, and digital integration.

Previous research has predominantly investigated operational efficiency using quantitative methodologies. Data Envelopment Analysis and Stochastic Frontier Analysis remain the most widely adopted approaches for evaluating port efficiency by comparing multiple operational inputs and outputs across ports or terminals (Kishore et al., 2024). Other studies employ productivity indices, benchmarking techniques, and mathematical optimization models to measure operational performance. These approaches have substantially advanced the understanding of port productivity by providing objective efficiency scores and comparative performance evaluations. However, quantitative indicators primarily reveal what level of efficiency has been achieved rather than explaining how efficiency is understood, interpreted, and implemented by operational practitioners responsible for managing daily port activities.

Increasingly, scholars have argued that qualitative approaches are necessary to complement quantitative efficiency assessments because they capture organizational routines, operational decision-making processes, stakeholder relationships, governance practices, and contextual factors that cannot be fully explained through numerical indicators alone(Trapp et al., 2020). Interpretivist research provides valuable insights into how frontline practitioners perceive operational challenges, coordinate with multiple stakeholders, and implement improvement initiatives within complex port environments. Such perspectives are particularly important in container ports where operational performance depends on continuous interaction among terminal operators, shipping lines, customs authorities, logistics companies, and inland transport providers.

Although qualitative logistics research has expanded in recent years, a significant research gap remains within the literature on port operational efficiency. Most existing studies continue to emphasize technical performance measurement, operational benchmarking, or digital technology adoption, while comparatively little attention has been devoted to understanding the lived experiences and perceptions of port operators. This limitation is especially evident in the Indonesian context, where qualitative investigations into operational efficiency remain scarce despite the country's strategic dependence on maritime transport and ongoing efforts to modernize national port infrastructure. Consequently, current knowledge provides only a partial understanding of operational efficiency because the perspectives of practitioners responsible for executing daily operations remain underrepresented.

This study addresses this gap by exploring how Indonesian port operators perceive operational efficiency, identifying the organizational and technological factors that facilitate efficiency improvement, examining the operational barriers that continue to hinder performance, and understanding the strategies practitioners employ to enhance operational efficiency. Unlike previous studies that primarily evaluate efficiency using quantitative indicators, this research adopts a qualitative interpretivist approach to capture the experiences of frontline operators directly involved in container terminal operations. By integrating practitioner perspectives with contemporary literature on port efficiency and digital transformation, the study contributes to extending theoretical understanding of operational efficiency beyond traditional productivity measures while providing practical recommendations for terminal operators, port authorities, and policymakers supporting Smart Port development and national logistics modernization.

METHOD

Research Design

This study adopted a qualitative research approach grounded in the interpretivist paradigm to explore how port operators perceive operational efficiency within Indonesian container ports. The qualitative design was selected because the study sought to understand participants' experiences, interpretations, and operational practices rather than to measure predefined variables or test causal relationships statistically. Operational efficiency is shaped not only by measurable performance indicators but also by organizational routines, decision-making processes, coordination mechanisms, and contextual factors that are best understood through direct engagement with practitioners. Consequently, an interpretivist approach provides an appropriate framework for examining the meanings that port operators assign to operational efficiency in their everyday work.

The study was guided by four research questions addressing operators' perceptions of operational efficiency, the factors facilitating efficiency improvements, operational barriers, and strategies for enhancing operational performance. These questions required detailed descriptions of operational experiences and interactions among multiple stakeholders, making qualitative inquiry particularly suitable. Previous maritime logistics research similarly argues that qualitative methods provide deeper insights into organizational practices, governance structures, and inter-organizational relationships that cannot be adequately explained through quantitative indicators alone (Heikkilä et al., 2024; Lin et al., 2021; Vukić et al., 2020).

Research Setting

The research was conducted within Indonesian container port operations, where increasing cargo volumes, digital transformation initiatives, and national logistics reforms have intensified the importance of operational efficiency. Indonesian container terminals operate within complex organizational environments involving terminal operators, shipping lines, customs authorities, logistics companies, trucking firms, and port authorities. Daily operational performance therefore depends on continuous coordination among multiple organizations while simultaneously responding to changing vessel schedules, cargo demand, infrastructure constraints, and regulatory requirements.

The Indonesian context provides an appropriate setting because the country continues to modernize its port infrastructure through digitalization initiatives, including the implementation of Port Community Systems, terminal operating systems, electronic customs services, and Smart Port programs. Despite these developments, operational challenges such as yard congestion, berth utilization, road access, and inter-agency coordination remain significant. Understanding how operators experience these conditions provides valuable empirical evidence for improving operational efficiency.

Participant Selection

Purposive sampling was employed to recruit participants possessing substantial operational knowledge and direct involvement in container terminal activities. This sampling strategy is widely recommended for qualitative research because it enables researchers to select information-rich participants capable of providing detailed accounts of the phenomenon under investigation (Reinecke et al., 2023).

Twelve port operators participated in the study. Each participant was actively engaged in daily operational activities related to vessel services, container handling, terminal planning, yard management, equipment utilization, operational coordination, or administrative processes. Their diverse operational responsibilities allowed the study to capture multiple perspectives regarding operational efficiency across different functional areas within the container terminal.

Participant recruitment continued until sufficient informational richness and thematic saturation were achieved. During the later interviews, no substantially new concepts emerged beyond those already identified in previous interviews, indicating that the collected data adequately represented the operational experiences relevant to the research objectives.

Data Collection

Primary data were collected through semi-structured interviews conducted with the twelve participants. Semi-structured interviews were selected because they provide sufficient flexibility to explore participants' experiences while maintaining consistency across interviews through a common interview guide. Unlike structured questionnaires, semi-structured interviews allow respondents to elaborate on operational routines, decision-making processes, and contextual factors influencing operational efficiency (Dovbischuk, 2021).

The interview protocol was organized around four principal research questions addressing perceptions of operational efficiency, operational drivers, operational barriers, and improvement strategies. Additional probing questions were used whenever clarification or further explanation was required. This flexible interviewing strategy enabled participants to describe how operational activities were performed in practice, including coordination among stakeholders, utilization of digital technologies, infrastructure constraints, and responses to operational disruptions.

The use of semi-structured interviews is consistent with previous qualitative studies in maritime logistics that investigate governance, collaboration, trust, and organizational dynamics within port ecosystems (Heikkilä et al., 2024). Furthermore, this approach is particularly appropriate in digitally enabled port environments because it allows researchers to explore how Port Community Systems, Terminal Operating Systems, electronic documentation, and other digital platforms are actually utilized by operational personnel rather than merely examining their technical characteristics (Abushaikha et al., 2023).

All interviews were conducted individually using the same interview guide while allowing sufficient flexibility for participants to discuss issues they considered operationally significant. Interview

responses were recorded with participants' consent and subsequently transcribed verbatim to preserve the authenticity and completeness of the collected data.

Data Analysis

The interview transcripts were analyzed using thematic analysis to identify recurring patterns, concepts, and relationships across participants. Thematic analysis was selected because it provides a systematic yet flexible approach for interpreting qualitative data and has been widely applied in logistics and maritime management research.

The analytical process consisted of five sequential stages. First, all interview recordings were transcribed verbatim to produce accurate textual data for analysis. Second, open coding was conducted to identify meaningful statements describing operational efficiency, operational practices, coordination mechanisms, digital technologies, infrastructure issues, and organizational challenges. Third, related codes were grouped through axial coding into broader conceptual categories. Fourth, categories were integrated into higher-order themes corresponding to the study's research questions. Finally, cross-case comparison was undertaken to identify similarities and differences among participants while refining the thematic structure.

This iterative analytical process enabled the researchers to move from individual operational experiences toward broader conceptual interpretations while maintaining close connections with the original interview data. Continuous comparison between emerging themes and interview transcripts enhanced analytical consistency and ensured that interpretations accurately reflected participants' perspectives.

Trustworthiness

The study adopted established qualitative criteria to ensure methodological rigor, including credibility, transferability, dependability, and confirmability (Salleh et al., 2021; Vukić et al., 2020). Credibility was strengthened through purposive sampling of experienced practitioners, prolonged engagement with the interview data, iterative questioning during interviews, and continuous comparison among participant responses.

Transferability was supported by providing detailed descriptions of the research setting, participant characteristics, interview procedures, and analytical processes, enabling readers to evaluate the applicability of the findings in comparable operational contexts. Dependability was enhanced through transparent documentation of each stage of data collection and analysis, including the interview protocol, coding procedures, category development, and theme generation.

Confirmability was promoted by maintaining a systematic audit trail throughout the research process and ensuring that interpretations remained grounded in participants' accounts rather than researcher assumptions. Reflexive interpretation and constant comparison were employed to minimize potential bias during coding and theme development. Consistent with methodological recommendations for qualitative maritime research, trustworthiness was further strengthened

through triangulation across interview participants and transparent reporting of the analytical procedures (Vukić et al., 2020).

Ethical Considerations

Participation in this study was voluntary, and informed consent was obtained from all participants prior to the interviews. Participants were informed of the study objectives, confidentiality procedures, and their right to withdraw at any stage without consequence. To protect anonymity, respondents were identified using coded labels (I1–I12), and no personally identifiable information was reported. Interview data were used solely for academic research purposes and stored securely throughout the research process.

Overall, the qualitative interpretivist design, purposive participant selection, semi-structured interviews, systematic thematic analysis, and rigorous trustworthiness procedures provided a robust methodological framework for exploring port operators' perceptions of operational efficiency. This approach enabled the study to generate rich empirical insights into the organizational, technological, and operational factors shaping efficiency within Indonesian container ports while complementing the predominantly quantitative evidence reported in the existing literature.

RESULT AND DISCUSSION

Overview of the Findings

The thematic analysis of interviews with twelve port operators identified four principal themes related to operational efficiency in Indonesian container ports (Braun & Clarke, 2023): operators' perceptions of operational efficiency, factors facilitating efficiency, operational barriers, and strategies for operational improvement. These themes demonstrate that efficiency is not understood solely as a technical measure of throughput or equipment productivity. Instead, participants perceived it as the outcome of interconnected physical, organizational, technological, and informational processes.

Across the interviews, participants consistently emphasized timely vessel and cargo services, optimal use of resources, effective berth and yard management, reliable equipment, efficient documentation, and coordinated information exchange. Their responses further showed that digital technologies increasingly shape daily operational practices by improving visibility, monitoring, scheduling, and decision-making. However, the benefits of digitalization remained constrained by congestion, infrastructure limitations, equipment failures, regulatory complexity, and incomplete system integration. The findings are derived from the consolidated interview matrix covering respondents I1–I12.

Port Operators' Perceptions of Operational Efficiency

Efficiency as Timely and Reliable Service

Participants commonly defined operational efficiency as the ability to complete vessel and cargo services according to schedule while minimizing waiting time and delays. I1 described efficiency as a condition in which ship and cargo services were completed on time through optimal resource use. Similarly, I2 associated efficiency with achieving loading and unloading targets without creating vessel queues. I4 emphasized that effective vessel planning reduced berth waiting time, while I8 linked schedule accuracy to customer trust.

These findings indicate that timeliness is not viewed only as a performance indicator but also as a measure of service reliability. Vessel turnaround time, loading and unloading speed, and schedule adherence were therefore central to participants' interpretations. This perspective corresponds with previous studies that position throughput, vessel productivity, berth productivity, and turnaround time as central dimensions of terminal efficiency (Agha & Warsi, 2020; Notteboom & Rodrigue, 2008; Saha et al., 2024). However, the interview evidence extends this understanding by showing that operators also associate timeliness with customer confidence and operational predictability.

Efficiency as Optimal Resource and Infrastructure Utilization

Participants also understood efficiency in terms of how effectively ports utilize available resources. I3 emphasized smooth yard movement without container congestion, whereas I5 identified optimal berth utilization as a primary indicator. I6 highlighted high crane productivity with minimal downtime. I10 viewed the smooth movement of trucks through terminal gates as another expression of operational efficiency.

These responses reveal that efficiency is perceived as a multi-resource construct involving labor, handling equipment, berth space, yard capacity, terminal gates, and information systems. Resource utilization is therefore not limited to maximizing output but includes maintaining flow continuity across operational areas. This finding aligns with literature that identifies berth utilization, yard performance, container cycle time, and terminal productivity as recurring dimensions of operational efficiency (Agha & Warsi, 2020; Iman et al., 2022; Saha et al., 2024).

Efficiency as Coordination and Information Integration

Several participants described efficiency as dependent on coordination among operational units and external stakeholders. I7 stated that inter-unit coordination determined the smoothness of the entire logistics chain. I9 emphasized the importance of rapid administrative processes, while I11 associated document clearance with broader national efficiency. I12 described digital system integration as a mechanism that made operations faster and more transparent.

These responses demonstrate that operational efficiency is not perceived as an isolated terminal function. Instead, it depends on the synchronization of terminal operators, customs authorities,

shipping lines, trucking firms, and other logistics actors. This interpretation supports the literature describing efficiency as a multi-actor and network-based construct shaped by organizational routines, information exchange, and governance processes (Agha & Warsi, 2020; Calatayud et al., 2020). It also reflects studies that identify Port Community Systems and terminal information ecosystems as essential enablers of operational coordination (Caldeirinha et al., 2022; Dalaklis et al., 2021; Hirata et al., 2022; Othman et al., 2022).

Current Conditions of Port Operational Efficiency

Perceived Improvements

Most participants believed that operational efficiency had improved compared with previous years. I2 reported higher productivity following the adoption of digital systems. I4 observed greater stability in vessel schedules, while I7 indicated that communication among stakeholders had improved. I9 and I11 noted that administrative and customs processes had become faster and simpler. I12 emphasized that real-time digital monitoring had improved managerial control.

The perceived improvements were therefore associated primarily with digitalization, administrative simplification, better communication, and more stable planning. These outcomes support studies showing that digital platforms improve visibility, reduce paperwork, accelerate decision-making, and facilitate more reliable scheduling (Caldeirinha et al., 2022; Dalaklis et al., 2021; Hirata et al., 2022; Othman et al., 2022).

Persistent Bottlenecks

Despite these improvements, participants identified continuing operational bottlenecks. I1 stated that efficiency had improved but that several bottlenecks remained. I3 reported recurring yard congestion during peak periods. I5 noted high berth occupancy, while I6 indicated that crane performance remained vulnerable to weather conditions. I8 identified delays affecting certain vessels, and I10 emphasized continuing road congestion around port access routes.

These responses show that digital progress has not eliminated physical capacity constraints. Improvements in information systems may increase planning accuracy, but insufficient yard space, berth limitations, equipment vulnerability, and external traffic congestion continue to restrict operational performance. The findings correspond with previous studies identifying yard congestion, dwell time, berth pressure, and hinterland bottlenecks as persistent causes of inefficiency (Agha & Warsi, 2020; Merk et al., 2022; Saha et al., 2024; Wiedmer et al., 2023).

Factors Facilitating Operational Efficiency

Organizational and Human Resource Factors

Participants identified coordination, communication, and workforce competence as major facilitators. I1 emphasized cross-agency coordination, I2 highlighted competent human resources, and I7 identified real-time communication. I9 stressed collaboration across the logistics chain, while I8 emphasized schedule certainty.

These findings suggest that operational efficiency depends on organizational capacity as much as technological or physical resources. Competent personnel are required to interpret operational information, respond to disruptions, and coordinate decisions. Similarly, cross-agency collaboration reduces fragmentation and accelerates problem-solving. This evidence supports qualitative studies emphasizing governance, trust, relational norms, and inter-organizational dynamics as important determinants of efficiency (Lin et al., 2021; Saha et al., 2024).

Operational Planning and Infrastructure Management

Other participants emphasized accurate vessel planning, yard management, berth allocation, modern equipment, and transport access. I3 identified effective yard management, I4 emphasized accurate vessel planning, I5 highlighted optimized berth scheduling, and I6 pointed to modern equipment. I10 added that smooth road access was essential for maintaining cargo flow.

These responses illustrate that operational efficiency depends on the alignment of seaside, terminal, and landside activities. Berth planning without sufficient yard capacity may transfer congestion inland, while effective terminal operations may still be undermined by road bottlenecks. The findings therefore support a systemic interpretation of efficiency in which berth, yard, gate, and hinterland operations are interdependent (Merk et al., 2022; Wiedmer et al., 2023).

Digital Technologies as Efficiency Enablers

Participants consistently described digital technology as a major facilitator of operational efficiency. I1 stated that digital systems accelerated decision-making. I3 noted that automated container tracking improved yard visibility. I4 and I5 associated digital tools with more accurate ship planning and berth scheduling. I6 emphasized crane monitoring, I9 referred to electronic documentation, I10 identified gate automation, I11 highlighted single-submission customs procedures, and I12 emphasized real-time operational dashboards.

These findings show that digitalization improves efficiency through several mechanisms: faster information exchange, improved visibility, automated monitoring, reduced paperwork, and more accurate scheduling. This evidence is consistent with literature on Port Community Systems, Terminal Operating Systems, automation, and Smart Port technologies (Caldeirinha et al., 2022; Dalaklis et al., 2021; Dey et al., 2025; Hirata et al., 2022; Makkawan & Muangpan, 2023). However, participants' responses also imply that technology creates value only when it is integrated into operational routines and shared across stakeholder boundaries.

Operational Barriers

Coordination and Information Barriers

I1 reported that stakeholder coordination was not always synchronized. I7 identified delayed information, while I12 stated that system integration across institutions remained incomplete. I9 noted that incomplete customer documentation caused delays, and I11 observed that some regulations still required manual processes.

These findings indicate that information fragmentation continues to undermine operational performance. Delayed, incomplete, or incompatible information disrupts planning and slows decision-making. This supports previous studies identifying interoperability, data quality, governance, and stakeholder trust as critical conditions for successful digital transformation (Divatia & Jagasia, 2025; Makkawan & Muangpan, 2023; Othman et al., 2022).

Capacity and Infrastructure Barriers

Participants also identified physical constraints. I3 reported yard congestion during periods of high volume. I5 referred to limited berth length, while I10 emphasized congestion on roads leading to the port. I6 identified equipment failure as an operational risk. These constraints reduced container flow, increased waiting time, and limited operational flexibility.

The findings reinforce the view that port efficiency is shaped by the weakest interface within the logistics chain. Increasing terminal productivity alone may not generate end-to-end improvements when yard, berth, equipment, or hinterland capacity remains insufficient. This systemic pattern is consistent with earlier findings on congestion spillovers and port–hinterland interdependence (Agha & Warsi, 2020; Merk et al., 2022; Wiedmer et al., 2023).

Effects of Increasing Container Volume

All participants indicated that increasing container volumes intensified operational pressure. Reported consequences included higher workloads, faster yard saturation, denser vessel schedules, greater berth occupancy, longer crane operating hours, increased truck traffic, higher customs workloads, and greater demand for digital infrastructure.

The responses demonstrate that volume growth increases not only physical workload but also informational and coordination complexity. I12 specifically noted the need to improve server and network capacity, indicating that digital infrastructure must scale alongside physical capacity. Thus, efficiency challenges associated with growth involve simultaneous pressure on personnel, equipment, infrastructure, and information systems.

Strategies for Improving Operational Efficiency

Immediate Operational Strategies

Participants reported several strategies already used in daily operations. These included cross-agency coordination, routine staff training, optimized container placement, data-driven vessel planning, dynamic berth allocation, preventive equipment maintenance, daily coordination meetings, vessel schedule synchronization, digital document exchange, truck scheduling, and customs simplification.

These strategies reflect a combination of process improvement and organizational adaptation. Preventive maintenance reduces equipment downtime, while data-driven planning improves berth and vessel allocation. Daily coordination meetings and digital document exchange strengthen operational synchronization. The range of strategies indicates that efficiency improvement requires coordinated interventions rather than isolated technical solutions.

Long-Term Strategic Recommendations

Participants' future recommendations focused on integrated digital platforms, human resource investment, yard expansion, artificial intelligence-based vessel prediction, additional berths, equipment modernization, schedule transparency, regulatory harmonization, improved road infrastructure, and comprehensive implementation.

The strongest shared recommendation was the integration of stakeholders through a unified digital platform. However, participants also recognized that digital transformation must be accompanied by infrastructure development, workforce capability, and regulatory alignment. Their recommendations therefore support an ecosystem-based model of port modernization in which technology, governance, human resources, and physical capacity develop together.

Overall, the results demonstrate that port operators perceive operational efficiency as a multidimensional and relational capability. Efficient operations depend on timely service, effective resource use, coordinated decision-making, integrated information systems, reliable infrastructure, and the ability to adapt to increasing cargo volumes. Digitalization has improved monitoring and coordination, but its benefits remain conditional on interoperability, institutional collaboration, infrastructure adequacy, and workforce competence.

The findings indicate that operational efficiency in Indonesian container ports is understood by practitioners as a multidimensional capability rather than as a single technical performance ratio. Participants associated efficiency with timely vessel handling, effective resource utilization, coordinated yard and berth operations, reliable equipment, rapid documentation, and integrated information flows. This broader interpretation complements conventional quantitative approaches, particularly Data Envelopment Analysis and Stochastic Frontier Analysis, which estimate relative efficiency from combinations of inputs and outputs. Although such techniques are useful for comparing ports and terminals, they do not fully explain the organizational mechanisms that produce observed performance. The qualitative evidence therefore adds

explanatory depth by revealing how governance, communication, routines, and operational decision-making influence the efficiency represented by numerical indicators (Vukić et al., 2020).

The interview results show that throughput and turnaround time remain central to practitioners' assessments of efficiency, but these outcomes are inseparable from the quality of coordination among port actors. Participants repeatedly emphasized cross-agency collaboration, schedule synchronization, timely information exchange, and the competence of operational personnel. These findings suggest that an efficient terminal cannot be created solely through equipment investment or capacity expansion. Instead, operational performance emerges from the interaction of technical resources with institutional arrangements and inter-organizational behavior. This interpretation is consistent with studies arguing that Port Community Systems and Port Community Ecosystems generate value only when information-sharing norms, governance structures, and stakeholder incentives are sufficiently aligned (Caldeirinha et al., 2022; Iman et al., 2022; Othman et al., 2022).

Digital transformation emerged as one of the most influential changes affecting operational practices. Participants described digital systems as improving vessel planning, berth allocation, yard visibility, container tracking, gate automation, customs processing, and managerial monitoring. These applications reduce paperwork, increase transparency, and support faster decisions. The findings are consistent with literature demonstrating that Port Community Systems, Terminal Operating Systems, and related platforms improve information exchange across terminal and hinterland operations (Agha & Warsi, 2020; Caldeirinha et al., 2022). They also support the broader Smart Port literature, which links automation, Internet of Things applications, artificial intelligence, digital twins, and real-time analytics with improved asset utilization, schedule reliability, and predictive maintenance (Hirata et al., 2022; Makkawan & Muangpan, 2023).

Nevertheless, the findings demonstrate that technology adoption does not automatically generate operational efficiency. Participants identified incomplete integration among institutional systems, delayed information, manual procedures, inadequate network capacity, and uneven digital readiness as continuing barriers. These observations reinforce the argument that the benefits of digitalization depend on interoperability, data quality, user capability, and stakeholder trust. Ports may adopt multiple digital applications while continuing to experience fragmented processes when those applications are not integrated into a coherent operational ecosystem. Therefore, the relevant managerial objective is not merely to increase the number of digital tools but to ensure that technologies are interoperable, supported by appropriate governance, and embedded in shared operational routines (Agha & Warsi, 2020; Makkawan & Muangpan, 2023; Othman et al., 2022).

The continued presence of yard congestion, berth limitations, equipment failures, and road congestion further demonstrates that digital improvements must be matched by physical and organizational capacity. Increasing container volumes placed simultaneous pressure on yards, berths, cranes, gates, personnel, customs services, and information infrastructure. This result highlights the systemic nature of operational efficiency. An improvement in one area may transfer congestion to another if capacity is not developed across the entire port–hinterland network. For example, faster ship handling may intensify yard congestion, while efficient terminal operations may be undermined by inadequate road access. Sustainable improvement therefore requires

integrated planning across maritime, terminal, and inland logistics interfaces rather than isolated terminal optimization.

The findings also identify several organizational capabilities that are essential for sustainable operational efficiency. First, collaborative governance is necessary to align the activities of terminal operators, port authorities, shipping lines, customs agencies, trucking companies, and cargo owners. Second, information-sharing capability is required to ensure that operational decisions are based on timely and reliable data. Third, workforce competence is essential because digital technologies and automated systems depend on operators who can interpret information and respond to disruptions. Fourth, adaptive planning is necessary to manage changes in cargo volumes, vessel schedules, weather conditions, and equipment availability. These capabilities correspond with previous studies emphasizing relational norms, collaborative governance, standardized procedures, and coordinated policy as important foundations for port efficiency (Calatayud et al., 2020; Vukić et al., 2020).

Leadership and change management are particularly important because Smart Port implementation requires organizational transformation rather than simple technological procurement. Port leaders must establish a shared digital vision, create incentives for collaboration, support workforce development, and ensure that innovations are incorporated into daily operational processes. Without effective leadership, technology projects may remain fragmented or fail to achieve widespread adoption. This interpretation is consistent with research showing that leadership decisions shape governance reform, digital readiness, and the success of smart port initiatives (Beifert et al., 2020; Salleh et al., 2021).

For developing countries, including Indonesia, the findings imply that Smart Port policies should combine institutional reform, infrastructure investment, and capacity development. Governments and port authorities should establish clear data-sharing standards, interoperability requirements, cybersecurity arrangements, and regulatory responsibilities. Regulatory sandboxes may also allow ports to test artificial intelligence, automation, and digital documentation systems before full implementation. Such measures can reduce uncertainty and improve coordination across public and private actors (Abushaikha et al., 2023; Merk et al., 2022).

Financial support is also necessary because the transition toward integrated digital ports may require substantial investment in equipment, platforms, networks, and workforce training. Targeted subsidies, public–private partnerships, and phased investment programs can help ports overcome capital constraints while prioritizing technologies with clear operational value (Tang & Wen, 2022). In parallel, knowledge-transfer partnerships with more technologically advanced ports can accelerate learning through joint training, pilot projects, technical assistance, and shared implementation experience (Klar et al., 2023).

Overall, this study demonstrates that operational efficiency is produced through the interaction of infrastructure, technology, governance, human resources, and inter-organizational coordination. Its principal theoretical contribution lies in explaining the processes behind measured performance, while its practical contribution lies in identifying the organizational and policy conditions required for sustainable Smart Port transformation.

CONCLUSION

This study explored port operators' perceptions of operational efficiency in Indonesian container ports using a qualitative interpretivist approach. By examining the experiences of twelve operational practitioners through semi-structured interviews and thematic analysis, the research provides a practitioner-centered understanding of how operational efficiency is conceptualized, implemented, and improved within contemporary container terminal operations.

The findings demonstrate that operational efficiency is perceived as a multidimensional organizational capability rather than merely a measure of technical productivity or throughput. Participants consistently associated efficient operations with timely vessel turnaround, effective utilization of labor and infrastructure, optimal berth and yard management, reliable equipment performance, efficient administrative procedures, and coordinated information exchange among stakeholders. These dimensions indicate that operational efficiency depends on the integration of physical resources, organizational processes, and digital information systems operating across the broader port ecosystem.

The study further identified several factors that facilitate operational efficiency, including effective inter-agency coordination, competent human resources, accurate operational planning, modern cargo-handling equipment, integrated digital platforms, and continuous communication among port stakeholders. At the same time, persistent barriers continue to constrain operational performance. These include yard congestion, limited berth capacity, equipment failures, road access congestion, fragmented information systems, regulatory complexity, and incomplete interoperability among digital platforms. The findings suggest that technological advancement alone is insufficient to achieve sustainable operational improvements without complementary investments in infrastructure, governance, workforce capability, and institutional collaboration.

Digital transformation emerged as one of the most influential drivers of operational improvement. Participants emphasized that Port Community Systems, Terminal Operating Systems, electronic documentation, real-time monitoring, and Smart Port technologies have improved operational visibility, planning accuracy, scheduling reliability, and coordination across organizations. Nevertheless, the benefits of digitalization depend on high-quality data, system interoperability, organizational readiness, stakeholder trust, and effective governance. Consequently, successful Smart Port implementation requires an integrated approach that combines technological innovation with organizational change and collaborative management.

The principal contribution of this research is its extension of the existing port efficiency literature beyond conventional quantitative performance measurement. While previous studies have predominantly evaluated operational efficiency using approaches such as Data Envelopment Analysis and Stochastic Frontier Analysis, this study explains the organizational, managerial, and behavioral mechanisms that underlie measured performance. By incorporating the perspectives of frontline practitioners, the research provides richer insight into how operational efficiency is created, maintained, and constrained within daily container terminal operations.

From a practical perspective, the findings provide several recommendations for port authorities, terminal operators, and policymakers. Future Smart Port initiatives should prioritize integrated

digital ecosystems, standardized information-sharing protocols, workforce development, preventive maintenance programs, coordinated governance, and strategic investments in berth, yard, and hinterland infrastructure. Policies that strengthen collaboration among public and private stakeholders while supporting digital interoperability will contribute to more resilient and competitive port operations.

Although this study offers important qualitative insights, several limitations should be acknowledged. The research focuses on a limited number of participants within the Indonesian container port context and therefore reflects context-specific operational experiences. Future studies may extend this work by incorporating larger samples, comparative analyses across multiple ports or countries, and mixed-methods approaches that integrate qualitative findings with quantitative operational performance indicators. Longitudinal research may also examine how digital transformation, Smart Port implementation, and organizational change influence operational efficiency over time.

Overall, this study demonstrates that sustainable operational efficiency is achieved through the interaction of infrastructure, technology, governance, human resources, and inter-organizational collaboration. By integrating practitioner perspectives with contemporary theories of port management and digital transformation, the research contributes to a more comprehensive understanding of operational efficiency and offers actionable guidance for enhancing the competitiveness, resilience, and sustainability of container ports in developing maritime economies.

REFERENCES

Abushaikha, I., Albahsh, R., Alsayes, M., & Al-Anaswah, M. F. (2023). Toward a Model to Enhance the Applicability of Blockchain in Maritime Shipping: A Qualitative Study from the Middle East. *Measuring Business Excellence*, *28*(1), 69–83. https://doi.org/10.1108/MBE-07-2023-0100

Agha, M. H., & Warsi, S. S. (2020). Case Study on the Competitiveness Comparisons of Karachi Port with the Neighbouring Emerging Ports in Persian Gulf and Indian Ocean. *NUST Business Review*, *2*(1), 12–32. https://doi.org/10.37435/NBR-20-0014

Baptista, J., Stein, M.-K., Klein, S., Watson-Manheim, M. B., & Lee, J. (2020). Digital work and organisational transformation: Emergent Digital/Human work configurations in modern organisations. *Journal of Strategic Information Systems*, *29*(2). https://doi.org/10.1016/j.jsis.2020.101618

Beifert, A., Prause, G., & Shcherbanin, Y. (2020). Integration Perspectives of Eurasian Land-Based Transport Corridors: Empirical Evidence from the OBOR and Rail Baltica Initiatives. *TalTech Journal of European Studies*, *10*(3), 3–25. https://doi.org/10.1515/bjes-2020-0019

Braun, V., & Clarke, V. (2023). *Thematic Analysis: A Practical Guide* (2nd ed.). SAGE. https://doi.org/10.1037/0000319-004

Calatayud, A., Monsreal, M., Mangan, J., & Villa, J. C. (2020). Benefits of Technology Adoption for Enhanced Integration of Port-Hinterland Operations. *Transportation Research Record: Journal of the Transportation Research Board*, *2674*(11), 606–615. https://doi.org/10.1177/0361198120949251

Caldeirinha, V., Nabais, J. L., & Pinto, C. J. (2022). Port Community Systems: Accelerating the Transition of Seaports toward the Physical Internet — The Portuguese Case. *Journal of Marine Science and Engineering*, *10*(2), 152. https://doi.org/10.3390/jmse10020152

Castellanos, J. D. G., Castaño, T., López, V., Velásquez, P., & González, J. (2024). Utilidad de las Tecnologías de las Industria 4.0 en los Smart Ports. *Ingeniería y Competitividad*, *26*(1). https://doi.org/10.25100/iyc.v26i1.12814

Dalaklis, D., Christodoulou, A., Ölcer, A. I., Ballini, F., Dalaklis, A., & Lagdami, K. (2021). The Port of Gothenburg Under the Influence of the Fourth Stage of the Industrial Revolution: Implementing a Wide Portfolio of Digital Tools to Optimize the Conduct of Operations. *Maritime Technology and Research*, *4*(3), 253844. https://doi.org/10.33175/mtr.2022.253844

Dey, S., Mishra, R., & Mukherjee, S. (2025). Supply Chain Resilience and Sustainable Digital Transformation with Next-Generation Connectivity in a Smart Port. *Communications of the Association for Information Systems*, *57*. https://www.scopus.com/inward/record.uri?eid=2-s2.0-105016363436&partnerID=40&md5=1f67baa1d6155a213aecfc09f3fd5269

Divatia, A. S., & Jagasia, J. (2025). Enterprise Architecture and Data Management for Digital Transformation-A Higher Education Institute (HEI) Case. *Communications of the Association for Information Systems*, *57*. https://doi.org/10.17705/1cais.05740

Dovbischuk, I. (2021). Sustainable Firm Performance of Logistics Service Providers along Maritime Supply Chain. *Sustainability*, *13*(14), 8040. https://doi.org/10.3390/su13148040

Heikkilä, M., Himmanen, H., Soininen, O., Sonninen, S., & Heikkilä, J. (2024). Navigating the Future: Developing Smart Fairways for Enhanced Maritime Safety and Efficiency. *Journal of Marine Science and Engineering*, *12*(2), 324. https://doi.org/10.3390/jmse12020324

Hirata, E., Watanabe, D., & Lambrou, M. (2022). *Shipping Digitalization and Automation for the Smart Port*. https://doi.org/10.5772/intechopen.102015

Iman, N., Amanda, M. T., & Angela, J. (2022). Digital Transformation for Maritime Logistics Capabilities Improvement: Cases in Indonesia. *Marine Economics and Management*, *5*(2), 188–212. https://doi.org/10.1108/MAEM-01-2022-0002

Kishore, L., Pai, Y. P., Ghosh, B. K., & Pakkan, S. (2024). Maritime Shipping Ports Performance: A Systematic Literature Review. *Discover Sustainability*, *5*(1). https://doi.org/10.1007/s43621-024-00299-y

Klar, R., Fredriksson, A., & Angelakis, V. (2023). *Digital Twins for Ports: Derived from Smart City and Supply Chain Twinning Experience*. https://doi.org/10.1109/ACCESS.2023.3295495

Lin, M. S., Potter, A., & Pettit, S. (2021). Relationship Heterogeneity in Taiwanese Maritime Logistics Service Supply Chains. *Supply Chain Management: An International Journal*, *26*(3), 385–401. https://doi.org/10.1108/SCM-03-2019-0116

Makkawan, K., & Muangpan, T. (2023). Developing Smart Port with Crucial Domains and Indicators in the Thai Port Case: A Confirmatory Factor Analysis. *Transactions on Maritime Science*, *12*(1). https://doi.org/10.7225/toms.v12.n01.w03

Merk, O., Hoffmann, J., & Haralambides, H. (2022). Post-COVID-19 Scenarios for the Governance of Maritime Transport and Ports. *Maritime Economics & Logistics*, *24*(4), 673–685. https://doi.org/10.1057/s41278-022-00228-8

Notteboom, T., & Rodrigue, J. (2008). Containerisation, Box Logistics and Global Supply Chains: The Integration of Ports and Liner Shipping Networks. *Maritime Economics & Logistics*, *10*(1–2), 152–174. https://doi.org/10.1057/palgrave.mel.9100196

Othman, A., Elgazzar, S., & Knez, M. (2022). A Framework for Adopting a Sustainable Smart Sea Port Index. *Sustainability*, *14*(8), 4551. https://doi.org/10.3390/su14084551

Pratama, I. G. A., & Wiguna, I. M. O. (2023). Capital Adequacy and Operational Efficiency. *Asian Journal of Accounting Research*, *8*(1), 45–58.

Reinecke, P. C., Wrona, T., Rückert, N., & Fischer, K. (2023). A Typology of the Collaboration Willingness of Carriers in Hinterland Logistics. *International Journal of Physical Distribution & Logistics Management*, *53*(9), 967–984. https://doi.org/10.1108/IJPDLM-07-2022-0216

Saha, R. C., Sabur, H. M. A., & Saif, T. M. R. (2024). An Integrated Intermodal Freight Transportation System to Avoid Container Supply Chain Disruptions in Chattogram Port of Bangladesh. *Maritime Technology and Research*, *6*(4), 269380. https://doi.org/10.33175/mtr.2024.269380

Salleh, N. H. M., Selvaduray, M., Jeevan, J., Ngah, A. H., & Zailani, S. (2021). Adaptation of Industrial Revolution 4.0 in a Seaport System. *Sustainability*, *13*(19), 10667. https://doi.org/10.3390/su131910667

Tang, L., & Wen, Q. (2022). Connotation, Composition, and Characteristics of Location Value of Free Trade Port — An Empirical Study of Ningbo Zhoushan Port. *American Journal of Industrial and Business Management*, *12*(12), 1804–1830. https://doi.org/10.4236/ajibm.2022.1212099

Trapp, A. C., Harris, I., Rodrigues, V. S., & Sarkis, J. (2020). Maritime Container Shipping: Does Coopetition Improve Cost and Environmental Efficiencies? *Transportation Research Part D: Transport and Environment*, *87*, 102507. https://doi.org/10.1016/j.trd.2020.102507

Vukić, L., Jugović, T. P., Guidi, G., & Oblak, R. (2020). Model of Determining the Optimal, Green Transport Route Among Alternatives: Data Envelopment Analysis Settings. *Journal of Marine Science and Engineering*, *8*(10), 735. https://doi.org/10.3390/jmse8100735

Wiedmer, R., Polyviou, M., & Paraskevas, J. (2023). Does Global Supply Chain Integration Payoff? The Case of Maritime Shipping Firms. *Journal of Business Logistics*, *45*(1). https://doi.org/10.1111/jbl.12350