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Improving Container Terminal Productivity Through Strategic Port Management: A Case Study of Port of Belawan, Indonesia

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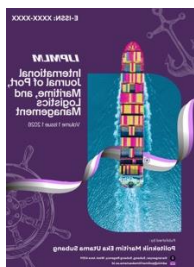
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ABSTRACT

Container terminals play a critical role in supporting maritime logistics and global trade by ensuring efficient cargo handling and port operations. Improving container terminal productivity has become an important priority for port authorities in order to enhance operational efficiency and maintain competitiveness in the global maritime transport network. This study aims to examine how strategic port management contributes to improving container terminal productivity at the Port of Belawan, Indonesia. The research employs a qualitative case study approach using data collected through semi-structured interviews, document analysis, and field observations involving key stakeholders in port operations. The findings indicate that strategic port management practices, including improved operational coordination, efficient infrastructure utilization, and the adoption of digital port management systems, significantly contribute to enhancing container handling performance and operational efficiency. The study also identifies several challenges affecting terminal productivity, such as infrastructure capacity limitations, coordination issues among port stakeholders, and human resource capability gaps. The results highlight the importance of integrating strategic management practices with technological innovation and stakeholder collaboration to improve port performance. This study provides practical insights for port authorities and policymakers in developing effective management strategies to enhance container terminal productivity and strengthen maritime logistics systems in developing maritime economies.

Keywords: Container Terminal Productivity; Strategic Port Management; Maritime Logistics; Port Operations; Belawan Port; Indonesia

ABSTRAK

Terminal peti kemas memiliki peran penting dalam mendukung logistik maritim dan perdagangan global dengan memastikan efisiensi dalam proses penanganan kargo dan operasional pelabuhan. Peningkatan produktivitas terminal peti kemas menjadi prioritas penting bagi otoritas pelabuhan untuk meningkatkan efisiensi operasional serta menjaga daya saing dalam jaringan transportasi maritim global. Penelitian ini bertujuan untuk menganalisis bagaimana manajemen pelabuhan strategis berkontribusi dalam meningkatkan produktivitas terminal peti kemas di Pelabuhan Belawan, Indonesia. Penelitian ini menggunakan pendekatan studi kasus kualitatif dengan pengumpulan data melalui wawancara semi-terstruktur, analisis dokumen, dan observasi lapangan yang melibatkan berbagai pemangku kepentingan dalam operasional pelabuhan. Hasil penelitian menunjukkan bahwa praktik manajemen pelabuhan strategis, seperti peningkatan koordinasi operasional, pemanfaatan infrastruktur yang efisien, serta penerapan sistem manajemen pelabuhan berbasis digital, berkontribusi signifikan terhadap peningkatan kinerja penanganan peti kemas dan efisiensi operasional. Penelitian ini juga mengidentifikasi beberapa tantangan yang memengaruhi produktivitas terminal, seperti keterbatasan kapasitas infrastruktur, permasalahan koordinasi antar pemangku kepentingan pelabuhan, serta kesenjangan kapasitas sumber daya manusia. Hasil penelitian ini memberikan wawasan praktis bagi otoritas pelabuhan dan pembuat kebijakan dalam merumuskan strategi manajemen yang efektif untuk meningkatkan produktivitas terminal peti kemas serta memperkuat sistem logistik maritim di negara berkembang.

Kata Kunci : Produktivitas Terminal Peti Kemas; Manajemen Pelabuhan Strategis; Logistik Maritim; Operasional Pelabuhan; Pelabuhan Belawan; Indonesia

A. INTRODUCTION

Seaports play a critical role in facilitating international trade and global supply chains, serving as key gateways for the movement of goods between countries. In the context of maritime logistics, container terminals represent one of the most strategic components of port operations because they directly influence the efficiency and reliability of cargo handling processes. Container terminals function as operational hubs where containers are loaded, unloaded, stored, and transferred between vessels and land transportation systems. As global trade continues to expand and vessel sizes increase, ports are required to improve operational performance in order to maintain competitiveness and ensure smooth logistics flows (Zhou & Suh, 2024). The growing complexity of maritime transport systems has also intensified competition among ports worldwide, making operational efficiency and service quality increasingly important in determining a port's attractiveness to shipping lines and logistics companies.

Container terminal productivity has become a crucial indicator of port performance. High productivity levels enable ports to reduce vessel turnaround time, minimize congestion, and improve overall supply chain efficiency. When terminal operations are well managed, containers can be handled more quickly and accurately, allowing shipping schedules to be maintained and reducing operational disruptions. Conversely, inefficient terminal operations may lead to longer waiting times, higher logistics costs, and reduced port competitiveness in the global maritime network. Previous studies indicate that the productivity of container terminals is influenced by several interrelated factors, including port infrastructure, cargo handling equipment, human resource capability, and operational management systems (Ahmad et al., 2024). These elements must work together in an integrated manner to support efficient container handling operations and maintain optimal service levels.

In recent years, many ports around the world have adopted strategic management approaches to enhance terminal productivity. Strategic port management involves long-term planning, efficient resource allocation, and the implementation of operational strategies that improve port performance. These strategies include improvements in terminal operational planning, consolidation of container terminal operations, digitalization of port systems, and the integration of advanced technologies such as automation and terminal operating systems (TOS). Effective port management strategies have been shown to significantly reduce vessel waiting times, improve berth utilization, and optimize the use of terminal resources, thereby enhancing overall operational performance (Kim & Park, 2022). In addition, strategic coordination among port authorities, terminal operators, shipping lines, and logistics providers is essential in ensuring smooth and efficient container flows.

Technological innovation also plays an increasingly important role in enhancing container terminal productivity. The adoption of automation technologies, digital platforms, and real-time operational monitoring systems has enabled ports to streamline container handling processes and improve operational efficiency. Modern container terminals increasingly rely on advanced technologies such as automated stacking cranes, automated guided vehicles (AGVs), and integrated port community systems to facilitate faster and more accurate container movements. Research indicates that the implementation of automation and digital technologies in container terminals can significantly improve productivity, operational safety, and service reliability within port operations (Tsagkaris & Moschovou, 2025). Furthermore, digital transformation in port operations allows for better data integration, improved decision-making, and more transparent communication among stakeholders involved in the logistics chain.

Despite these developments, many container ports in developing countries still face operational challenges related to infrastructure limitations, management inefficiencies, and fragmented operational systems. Limited investment in modern port equipment, inadequate infrastructure capacity, and insufficient coordination among port stakeholders often create bottlenecks in terminal operations. These challenges can lead to suboptimal terminal productivity, longer cargo handling times, and higher logistics costs. Studies on port efficiency also highlight that productivity levels among container terminals can vary significantly depending on management practices, resource allocation, technological adoption, and the economic hinterland of the port (Danladi et al., 2025). Addressing these challenges requires not only infrastructure development but also improvements in strategic port management and operational planning.

In Indonesia, seaports play a vital role in supporting national logistics systems and international trade. As an archipelagic country with extensive maritime transportation networks, Indonesia depends heavily on efficient port operations to facilitate the movement of goods between islands and to connect domestic markets with global trade routes. One of the important ports in Indonesia is the Port of Belawan, which serves as a major maritime gateway

for trade activities in the western region of Indonesia, particularly in North Sumatra. The port handles a significant volume of containerized cargo and plays a strategic role in supporting regional economic activities. As trade volumes continue to grow, improving container terminal productivity at the Port of Belawan has become increasingly important to ensure efficient cargo handling and to strengthen the competitiveness of Indonesia's maritime logistics sector.

Therefore, this study aims to examine how strategic port management can improve container terminal productivity at the Port of Belawan. By analyzing operational management practices, infrastructure utilization, technological adoption, and supporting systems within the port, this research seeks to provide insights into effective management strategies that can enhance terminal productivity and operational efficiency. In addition, the study will explore how improvements in port management can contribute to reducing operational bottlenecks and optimizing resource utilization. The findings of this study are expected to contribute to the development of more efficient port management practices, provide recommendations for port authorities and terminal operators, and support the improvement of maritime logistics performance in Indonesia.

B. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Port Management

Port management refers to the strategic and operational processes involved in planning, organizing, directing, and controlling port activities in order to ensure efficient and effective maritime operations. Effective port management plays a crucial role in facilitating international trade by ensuring smooth cargo handling, efficient vessel services, and optimal utilization of port infrastructure and resources (Notteboom, Pallis, & Rodrigue, 2021).

In modern maritime logistics systems, ports are no longer viewed solely as cargo transshipment points but also as integrated logistics hubs that connect global supply chains. Consequently, port authorities and terminal operators must adopt strategic management approaches to enhance operational performance, improve service quality, and strengthen competitiveness in the global maritime market (Lam & Yap, 2021).

Strategic port management involves various aspects such as infrastructure development, investment in cargo handling equipment, operational planning, and institutional coordination among stakeholders. According to recent studies, effective management practices in ports can significantly improve operational efficiency and reduce vessel turnaround time, thereby contributing to higher port productivity (Nguyen & Park, 2023).

Furthermore, port governance and management structures influence decision-making processes and operational performance. Ports that adopt flexible and market-oriented management systems tend to demonstrate better operational efficiency and higher service quality compared to those operating under rigid bureaucratic structures (Pallis & Vaggelas, 2022).

Container Terminal Productivity

Container terminal productivity is one of the most important indicators of port operational performance. It reflects the ability of a container terminal to efficiently handle cargo using available resources such as cranes, yard equipment, labor, and terminal space. High productivity levels allow ports to reduce vessel turnaround time, improve berth utilization, and increase overall throughput capacity (Zhang & Lam, 2020).

The productivity of container terminals is commonly measured through indicators such as crane productivity, berth productivity, container handling rate, and terminal throughput. These indicators help evaluate the operational performance of terminals and identify areas for improvement in terminal operations (Chen, Lee, & Huang, 2022).

Several factors influence container terminal productivity. These include the availability of modern cargo handling equipment, effective yard management systems, skilled human resources, and efficient operational planning. In addition, the adoption of digital technologies and terminal operating systems (TOS) has been shown to improve coordination among operational units and enhance container handling efficiency (Heilig & Voß, 2021).

Previous studies also highlight that container terminal productivity is closely related to the level of technological adoption within port operations. Automation technologies such as automated stacking cranes, real-time monitoring systems, and digital logistics platforms enable ports to improve operational accuracy, reduce human errors, and enhance service reliability (Tsagkaris & Moschovou, 2025).

Strategic Port Management and Terminal Productivity

Strategic port management plays a key role in improving container terminal productivity by ensuring effective resource allocation, operational coordination, and infrastructure utilization. Ports that implement strategic planning and integrated management systems tend to achieve higher levels of operational efficiency and service performance (Yap & Lam, 2021).

One important element of strategic port management is the integration of operational planning with technological innovation. The implementation of smart port technologies, data analytics, and digital platforms enables port managers to monitor operational activities in real time and optimize terminal operations. These technologies help improve decision-making processes and enhance the overall efficiency of container handling activities (Heilig, Schwarze, & Voß, 2020).

In addition, collaboration among port stakeholders—including terminal operators, shipping lines, logistics providers, and government authorities—also contributes to improved terminal productivity. Effective coordination among these stakeholders helps streamline operational processes and minimize inefficiencies within the port system (Notteboom & Haralambides, 2020).

However, despite the growing importance of strategic port management, many ports in developing countries still face challenges related to infrastructure limitations, management inefficiencies, and technological gaps. These challenges often hinder the improvement of container terminal productivity and reduce the competitiveness of ports in the global maritime logistics network (Nguyen & Park, 2023).

C. RESEARCH METHODOLOGY

This study employed a qualitative case study approach to analyze how strategic port management contributes to improving container terminal productivity at the Port of Belawan, Indonesia. The case study method was selected because it enables an in-depth examination of operational management practices within a specific institutional and operational context (Yin, 2020). Data were collected through a combination of semi-structured interviews, document analysis, and field observations. Interviews were conducted with key stakeholders involved in port operations, including port authority officials, terminal operators, logistics service providers, and operational managers responsible for container handling activities. In addition, secondary data were obtained from official port reports, government publications, and maritime logistics statistics to provide supporting empirical evidence. The collected data were analyzed using a descriptive and thematic analysis approach, which involved identifying key patterns related to port management strategies, operational coordination, infrastructure utilization, and technological adoption that influence container terminal productivity. This analytical approach allows the study to systematically interpret how management practices affect operational efficiency and container handling performance at the Port of Belawan while providing contextual insights relevant to port management in developing maritime economies

D. RESULT AND DISCUSSION

Strategic Port Management Practices at the Port of Belawan

The findings indicate that strategic port management plays a significant role in improving container terminal productivity at the Port of Belawan. Port management has implemented several operational strategies aimed at optimizing terminal operations, including improved berth allocation, enhanced coordination between terminal operators and shipping lines, and the optimization of cargo handling equipment. These strategies are designed to reduce vessel waiting time, improve berth utilization, and enhance the efficiency of container handling processes within the terminal. As a result, vessel turnaround time can be minimized, allowing shipping lines to operate more efficiently and maintain their schedules. Effective operational coordination among port stakeholders has also contributed to smoother logistics flows and improved port service performance. This coordination allows for better synchronization between vessel arrival schedules, terminal operations, and hinterland transportation activities. Similar findings have been reported in previous studies which suggest that strategic port management is essential in enhancing operational efficiency and strengthening port competitiveness in the global maritime logistics network (Notteboom & Haralambides, 2020).

In addition, the management of terminal infrastructure and cargo handling equipment has been identified as a key factor influencing container terminal productivity. The availability and proper utilization of quay cranes, yard equipment, and container yard facilities significantly affect the speed and efficiency of container handling operations. Modern container terminals rely heavily on the performance of these operational resources to ensure smooth container movement between vessels, storage yards, and land transport systems. Ports that effectively manage these resources are able to increase throughput capacity while minimizing operational delays and equipment idle time. Efficient infrastructure utilization also allows terminal operators to handle larger volumes of cargo without requiring significant expansion of physical facilities.

Furthermore, proper maintenance and scheduling of cargo handling equipment play an important role in maintaining operational reliability. Regular equipment maintenance helps prevent unexpected breakdowns that may disrupt terminal operations and cause delays in vessel servicing. In addition, effective planning in the allocation of equipment and workforce allows ports to maximize operational productivity during peak cargo handling periods. Studies in port operations management also emphasize that the integration of infrastructure management with operational planning can significantly improve terminal performance and service reliability.

Overall, the results of this study demonstrate that the combination of effective strategic management, efficient infrastructure utilization, and strong operational coordination can significantly enhance container terminal productivity. These findings highlight the importance of integrated port management approaches in improving operational performance and ensuring that ports remain competitive in the increasingly complex global maritime logistics environment.

The Role of Technology in Improving Terminal Productivity

Another important finding of this study is the role of technological adoption in improving terminal productivity at the Port of Belawan. The implementation of digital port management systems and terminal operating systems (TOS) has significantly enhanced operational coordination, data sharing, and the monitoring of container movements within the terminal. Through these systems, port operators are able to track container positions, schedule equipment usage, and manage vessel handling operations in a more integrated and systematic manner. As a result, the flow of information among port stakeholders becomes more transparent and efficient, enabling better synchronization between vessel operations, yard management, and land transportation activities. These improvements contribute to the reduction of operational bottlenecks and delays that often occur in conventional port management systems.

The use of digital technologies also enables real-time monitoring of terminal activities, allowing port managers to make faster and more accurate operational decisions. Real-time operational data provides valuable insights into container movement patterns, equipment utilization, and terminal congestion levels, which allows port managers to adjust operational strategies when necessary. This capability is particularly important in busy container terminals where operational efficiency must be maintained despite fluctuating cargo volumes and vessel arrival schedules. In addition, digital platforms support better communication between terminal operators, shipping lines, and logistics service providers, thereby improving the overall coordination of maritime logistics operations.

Previous studies highlight that the adoption of smart port technologies can significantly improve operational performance, reduce human errors, and enhance service reliability in container terminal operations (Heilig & Voß, 2021). Smart port systems integrate digital technologies such as data analytics, automated monitoring systems, and information-sharing platforms to support more efficient port operations. These technologies not only improve the accuracy of operational processes but also help ports respond more effectively to operational disruptions and changes in cargo demand. Therefore, the increasing adoption of digital technologies in port operations represents an important step toward building more efficient, resilient, and competitive container terminal systems.

Operational Challenges Affecting Terminal Productivity

Despite these improvements, several operational challenges still affect container terminal productivity at the Port of Belawan. One of the main challenges is related to infrastructure capacity limitations, particularly during peak cargo periods when container volumes increase significantly. Limited container yard space, combined with growing trade activities, can create congestion within the terminal area. This congestion may slow down container stacking, retrieval, and transportation processes within the terminal, ultimately affecting the overall efficiency of cargo handling operations. When yard capacity is constrained, container movements become more complex and require additional operational coordination, which can reduce terminal productivity and increase vessel turnaround time.

Another challenge concerns the coordination among multiple stakeholders involved in port operations. Container terminal productivity is influenced not only by terminal operators but also by shipping lines, trucking companies, customs authorities, freight forwarders, and other logistics service providers. Each stakeholder plays a different role in the cargo handling and clearance process, and any inefficiency in coordination among them may lead to operational delays. For instance, delays in customs clearance procedures or trucking availability can slow down container delivery and pickup processes, which in turn affects the flow of containers within the terminal. Therefore, improving communication and coordination mechanisms among port stakeholders is essential to ensure smoother logistics flows and minimize operational disruptions.

Human resource capacity is also an important factor affecting operational efficiency at container terminals. Skilled and well-trained personnel are essential for operating cargo handling equipment, managing terminal operations, and ensuring the safety and reliability of port activities. Modern container terminals require operators who are capable of handling increasingly complex technologies and operational systems, including automated equipment and digital management platforms. Without adequate training and technical expertise, operational errors and inefficiencies may occur, which can negatively impact terminal productivity. Therefore, continuous training programs, professional development initiatives, and workforce capacity building are necessary to improve employee competence and support more efficient terminal operations.

Overall, addressing these operational challenges requires a comprehensive approach that combines infrastructure improvement, better stakeholder coordination, and human resource development. By strengthening these aspects, ports can enhance operational efficiency and ensure that container terminal productivity continues to improve in line with growing trade demands.

Implications for Port Management

The results of this study suggest that improving container terminal productivity requires a comprehensive port management strategy that integrates infrastructure development, operational efficiency, and technological innovation. An integrated approach to port management allows terminal operators and port authorities to optimize the utilization of available resources while simultaneously improving the efficiency of operational processes. Strategic management practices that emphasize effective coordination among stakeholders, efficient allocation of operational resources, and the implementation of digital technologies can significantly enhance port operational performance. By adopting such strategies, ports are better positioned to reduce operational bottlenecks, improve service reliability, and handle increasing cargo volumes more efficiently.

Furthermore, the findings highlight the importance of aligning port management strategies with the evolving demands of global maritime trade. Container terminals today operate in a highly competitive environment where shipping lines prefer ports that offer faster turnaround times, reliable services, and efficient logistics connectivity. Therefore, ports must continuously improve their operational systems and management practices to remain attractive within the global shipping network. The integration of infrastructure development with modern management approaches can contribute to improving terminal throughput capacity and ensuring sustainable port operations in the long term.

For the Port of Belawan, strengthening technological adoption and improving coordination among port stakeholders will be crucial in supporting future growth in container traffic. The implementation of more advanced digital systems, integrated information platforms, and real-time operational monitoring can help improve transparency and coordination across the port logistics chain. In addition, stronger collaboration between port authorities, terminal operators, shipping companies, customs agencies, and logistics service providers can facilitate smoother cargo flows and reduce operational delays.

As global maritime trade continues to expand, ports must continuously adapt their management strategies in order to remain competitive within the international maritime logistics network. Continuous investment in infrastructure, technological innovation, and human resource development will be essential to support the long-term sustainability of port operations. By implementing comprehensive and forward-looking management strategies, the Port of Belawan can strengthen its role as a key maritime gateway in western Indonesia and contribute to the improvement of national logistics efficiency.

E. CONCLUSION AND SUGGESTION

This study examined the role of strategic port management in improving container terminal productivity at the Port of Belawan, Indonesia. The findings indicate that effective port management plays a crucial role in enhancing operational efficiency and container handling performance. Strategic management practices such as improved operational coordination, efficient infrastructure utilization, and the adoption of digital port systems contribute significantly to increasing terminal productivity and reducing operational delays.

The study also highlights the importance of technological adoption in modern port operations. The implementation of digital management systems and terminal operating systems has enabled better monitoring of container flows, improved data sharing among stakeholders, and enhanced operational decision-making. These technological improvements help streamline container handling activities and increase overall terminal efficiency.

However, the results also reveal several operational challenges that still affect terminal productivity at the Port of Belawan. Infrastructure capacity limitations, coordination issues among port stakeholders, and human resource capability gaps remain key obstacles in achieving optimal operational performance. Addressing these challenges requires continuous improvements in port infrastructure, enhanced collaboration among maritime logistics stakeholders, and the development of skilled human resources.

Overall, this study contributes to the understanding of how strategic port management can enhance container terminal productivity in developing maritime economies. The findings provide practical insights for port authorities, terminal operators, and policymakers in designing effective management strategies to improve port operational performance. Future research is recommended to explore quantitative approaches and comparative analyses among multiple ports in order to further examine the relationship between strategic port management and terminal productivity in different maritime contexts.

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