



A Literature Review on Optimizing Port Operations to Reduce Dwelling Time: Implications for Maritime Logistics Sustainability

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Abstract. The maritime industry plays a vital role in global trade, with ports serving as crucial hubs of activity. The operational efficiency of ports, particularly in terms of dwelling time, directly impacts the smooth flow of maritime logistics. Dwelling time, which refers to the duration cargo spends in port, is critical for reducing costs, improving competitiveness, and enhancing customer satisfaction. Factors such as document inspection processes, delays in loading and unloading, and container yard capacity influence dwelling time. Strategies to reduce dwelling time include implementing fines, expediting permit procedures, and improving warehousing facilities. These measures are expected to enhance logistics efficiency, improve customer satisfaction, and support economic growth and global port competitiveness.

Keywords: Maritime logistic, Dwelling Time, Strategies

1. Introduction

The maritime industry serves as the backbone of global trade, facilitating the movement of goods across vast distances and connecting markets worldwide[1]. At the heart of this industry are ports, which act as crucial nodes in the complex network of international commerce. The efficiency of port operations is paramount to the smooth functioning of maritime logistics, as it directly impacts the speed and cost of cargo movement. One of the key performance indicators for port efficiency is dwelling time. According to the World Bank (2011), dwelling time is defined as the time calculated from when cargo or containers are unloaded from a ship until they exit the terminal through the main gate[2]. This metric is critical for several reasons, including cost implications, port capacity, supply chain efficiency, economic impact, and environmental concerns. The importance of reducing dwelling time cannot be overstated, as it has wide-ranging implications for the sustainability of maritime logistics. Prolonged dwelling times can lead to increased storage costs, higher risks of cargo damage, and reduced cargo turnover rates. These issues not only affect the immediate stakeholders in the maritime industry but also have broader economic and environmental implications. Despite the recognized importance of minimizing dwelling time, many ports worldwide continue to struggle with this issue. In Indonesia, for instance, the port of Tanjung Priok has reported dwelling times as long as 6.7 days, significantly higher than the 1.1 days reported in Singapore's ports[3]. This discrepancy highlights the need for a comprehensive understanding of the factors contributing to extended dwelling times and the development of effective strategies to address them.

Given this context, this study aims to address several key research questions: What are the key factors influencing dwelling time in ports? What methods can be employed to improve port operational efficiency and reduce dwelling time? What are the effects of reducing dwelling time on the sustainability of maritime logistics? This research is significant for several reasons. By identifying ways to reduce dwelling time, this study can contribute to enhancing the competitiveness of ports and, by extension, national economies. The findings can guide port authorities and operators in implementing more efficient processes and technologies. Reducing dwelling time can lead to decreased emissions from port operations, contributing to environmental sustainability goals. The results of this study can inform policymakers in developing regulations and incentives to improve port efficiency. Furthermore, the comparative analysis of dwelling times across different ports can serve as a benchmark for the industry, driving continuous improvement.

2. Method

The research method employed in this study is a comprehensive literature review. According to Kitchenham (2004), a literature review is a research method of identifying, evaluating, and interpreting all relevant research results related to certain research questions, topics, or phenomena of concern. While individual studies form the basis of primary research, a literature review serves as a secondary study, synthesizing and analyzing existing research findings.

The literature review process for this study followed these steps: 1). Identification of Research Questions: The research questions outlined in the introduction were formulated to guide the literature search and analysis. 2). Search Strategy: A systematic search was conducted using academic databases such as Google Scholar, Science Direct, and IEEE Xplore. Key search terms included "Port Dwelling Time," "Maritime Logistics Efficiency," "Port Operations Optimization," and "Sustainable Port Management." 3). Selection Criteria: Studies were selected based on their relevance to the research questions, publication date (prioritizing recent publications within the last 10 years), and the credibility of the source. Both empirical studies and theoretical papers were included to provide a comprehensive view of the topic. 4). Synthesis and Analysis: The extracted data was synthesized to identify common themes, trends, and gaps in the existing literature. This process involved comparing and contrasting findings from different studies to draw meaningful conclusions.

This methodological approach allows for a comprehensive and balanced presentation of the current state of knowledge regarding dwelling time in ports and its implications for maritime logistics sustainability. By synthesizing various relevant research results, the facts presented to policymakers and industry stakeholders become more comprehensive and balanced, providing a solid foundation for decision-making and future research directions.

3. Result and Discussion

3.1. Factors Affecting Dwelling Time at the Port

Dwelling time refers to the length of time containers are kept in temporary storage at the port, from the time they are unloaded from the ship until they are discharged [4]. It is an important factor in measuring the efficiency of cargo flow and logistics costs. Dwelling Time is also a benchmark for a port to improve the quality of consumer services. There are several factors that affect Dwelling Time at the Port: 1). The length of the document examination process by the relevant agencies, the process that determines the length of dwelling time at the port, broadly speaking, goes through the following stages: pre-clearance, custom clearance and post-clearance, as can be seen in the chart below (Nuyanto, 2018):



Fig. 1 Dwelling time process at the port (Hanafi, 2018)

Pre-Customs Clearance is the time required from the time the container is removed from the ship until the importer sends the administration of the Notice of Import of Goods (PIB) to Customs. Customs Clearance is the time required from the time the PIB is received until Customs issues the Goods Release Approval Letter (SPPB). Pre-Customs Clearance is the time required from the time the SPPB is issued until the imported goods can be released [2].

The previous pattern shows an inefficient and ineffective process. Therefore, logistics costs in Indonesia are higher compared to other countries. If logistics costs remain high, investors will prefer to go to neighboring countries such as Malaysia and Singapore as their logistics costs are lower. Both countries also have a very low cost of living compared to Indonesia. 2). Slow Loading and Unloading Process, delay in loading and unloading process is another factor that affects dwelling time at the port. These delays can be caused by various technical issues, such as a lack of adequate loading and unloading equipment, a lack of trained workers, or even bad weather. All of these can impede the flow of goods at the port, causing a buildup of cargo and extending the dwelling time of goods at the port before they reach their final destination (Ahmad et al., 2020). 3). Container Yard Capacity, the capacity of the stacking yard is very important for dwelling time at the port. Stacking occurs when the stacking field cannot accommodate a larger volume of goods (Susanto et al., 2019). If this happens, the loading and unloading process and distribution will be hampered. Lack of storage space can lead to longer dwelling time at the port, delays in moving goods from ships to storage warehouses, and longer dwelling time overall. Therefore, increasing the capacity of stacking yards is an important step to improve port operational efficiency and reduce dwelling time.

3.2. Strategies Used to Reduce Dwelling Time to Improve Port Operational Efficiency

The impact of the length of dwelling time will affect the efficiency of port operations, so a strategy is needed to improve or reduce this impact. To improve dwelling time, for example, Tanjung Priok Port has the longest dwelling time with 6.7 days, while Singapore has the fastest dwelling time of only 1.1 days [5].

Table 1. list dwelling time (Journal Indonesia Infrastructure Initiative)

Country/port	Dwell (in day)	Remarks
Singapore	1,1	Excellent/fast
Hong Kong, China	2	Very good/fast
France	3	Good/fair
Australia, New Zealand	3	Good/fair
United Kingdom, Los Angeles (USA)	4	Moderate/average
Port Klang (Malaysia)	4	Moderate/average
Thailand	5	Not good/slow
Tanjung Priok (Indonesia)	6,7	Very slow

This significant difference indicates a great opportunity for improvement in Indonesian ports. To enhance this, there needs to be integration and synchronization between parties involving various institutions and eliminating failures. Better coordination among customs, port operators, shipping companies, and cargo owners is crucial to streamline the process. Here are some strategies to reduce dwelling time in order to improve supply chain efficiency, among others: imposing progressive fines for goods idling at the port; speeding up goods clearance procedures through automation and digitalization of documents; eliminating unnecessary additional regulations; establishing appropriate service cooperation with international companies for technology transfer; improving warehousing facilities and costs; building special warehouses in areas/regions supporting the port; adding supporting facilities for the loading and unloading process; and applying modern technology such as integrated port management systems and IoT for real-time container tracking [3]. With this strategy, it can certainly reduce the length of dwelling time in the stacking field. This can increase the productivity and effectiveness of the logistics process, reduce operational costs, speed up the flow of goods, and increase customer satisfaction. Moreover, improvements in dwelling time can also enhance the competitiveness of Indonesian ports at regional and global

levels, attract more international cargo traffic, and ultimately contribute to national economic growth through increased trade efficiency.

3.3. Effects of Dwelling Time Reduction on Maritime Logistics Sustainability

The reduction of dwelling time in ports has profound and far-reaching implications for the sustainability of maritime logistics, encompassing economic, environmental, operational, and social dimensions. From an economic perspective, shorter dwelling times significantly enhance a port's competitiveness both regionally and globally. Ports that efficiently manage cargo throughput attract more shipping lines and larger cargo volumes, potentially increasing their market share in international trade. This improved efficiency acts as a magnet for foreign direct investment, not only in port infrastructure but also in related industries, fostering economic growth in the surrounding region. Moreover, the reduction in operational costs resulting from lower dwelling times – including decreased labor costs, equipment usage, and energy consumption per unit of cargo handled – translates into more competitive pricing for port services. This cost-effectiveness ripples through the entire supply chain, reducing inventory carrying costs for businesses and supporting just-in-time manufacturing practices, which in turn enhances the overall competitiveness of a country's exports in the global marketplace.

The environmental benefits of reduced dwelling time are equally significant. Shorter port stays for vessels result in substantial reductions in emissions of greenhouse gases and pollutants such as sulfur oxides (SOx) and nitrogen oxides (NOx). This improvement in air quality extends beyond the immediate port area, as more efficient port operations lead to better coordination with land-side logistics, reducing truck idling and congestion around ports [6]. The push for efficiency often drives the adoption of greener technologies in ports, such as electric or hydrogen-powered equipment, further minimizing the environmental footprint of port operations. Additionally, by increasing throughput without the need for physical expansion, ports can handle more cargo while preserving coastal ecosystems and valuable urban spaces. This more efficient use of existing infrastructure aligns well with principles of sustainable development and resource conservation.

From an operational standpoint, the reduction in dwelling time offers numerous advantages that contribute to long-term sustainability. Ports can significantly increase their handling capacity without major infrastructure expansions, maximizing the use of existing resources. This improved efficiency helps ports better manage seasonal fluctuations in cargo volumes and respond more effectively to supply chain disruptions, enhancing overall resilience. The drive for efficiency often leads to better data integration and analysis, paving the way for more informed operational decisions and increased automation. These advancements not only improve current operations but also position ports to adapt more easily to future changes in trade patterns and shipping technologies.

4. Conclusion

Based on this comprehensive literature review, it can be concluded that dwelling time is a critical factor in port operations that has broad implications for the sustainability of maritime logistics. Dwelling time is influenced by a variety of interrelated factors, including document processing efficiency, loading and unloading operations, and container yard capacity. The significant variation in dwelling time between ports worldwide, ranging from 1.1 days in Singapore to 6.7 days in Tanjung Priok, Indonesia, indicates both challenges and significant opportunities for improving port efficiency. The study identified several effective strategies to reduce dwelling time, including the implementation of progressive fines, streamlining clearance procedures through automation and digitalization, upgrading infrastructure and technology, and improving coordination between stakeholders. Comprehensive implementation of these strategies has been shown to result in significant reductions in dwelling time. Reducing dwelling time not only improves operational efficiency and reduces costs, but also enhances port competitiveness, contributes to environmental sustainability through reduced emissions, and supports broader economic growth by facilitating smoother international trade.

The adoption of advanced technologies, including automation, IoT, AI, and blockchain, has emerged as a crucial factor in optimizing port operations and reducing dwelling time. Ports that have adopted these technologies have shown substantial improvements in efficiency [7]. However, it is important to note that effective dwelling time reduction requires coordinated efforts from multiple stakeholders, including port authorities, customs agents, shipping lines, and cargo

In terms of implementation, it is recommended that port authorities and relevant stakeholders adopt a phased approach in implementing dwelling time reduction strategies. This can start with relatively easy-to-implement process improvements, such as optimizing documentation procedures, before moving on to larger technology investments. In addition, international cooperation and knowledge exchange between ports should be encouraged to accelerate the adoption of best practices. Finally, it is important to ensure that dwelling time reduction efforts are aligned with broader sustainability objectives, including reducing emissions and improving energy efficiency at ports. By implementing these strategies and continuing research and innovation in port management, the maritime industry can move towards more efficient, sustainable and globally competitive operations. Reducing dwelling time is not just a matter of operational efficiency, but also a critical step towards a more resilient and sustainable maritime logistics system in the future.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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