International Journal of Social Discussion
Volume 3, No. 1, 2026 - ISSN: 3063-3036
Website: http://ijsd.seevalue.org/index.php/ijsd/index

Analysis of Dwelling Time and Strategies to Improve Logistics Efficiency at Belawan Port Using a Swot Approach

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Keywords:
Dwelling Time,
Logistics Efficiency,
Belawan Port,
SWOT Analysis
Strategy Development

Abstract

Ports play a strategic role in supporting the efficiency of global supply chains, particularly in international trade. This study aims to analyze the factors contributing to the prolonged dwelling time at Belawan Port and to develop acceleration strategies using a SWOT approach. The research employs quantitative and qualitative descriptive methods, with data collected through observations, semi-structured interviews, and documentation studies from 2021 to 2023. The findings reveal that although there has been a downward trend in customs clearance duration over the past three years, the average dwelling time in 2023 (3.80 days) still exceeds the national standard (3 days). The post-clearance stage is the slowest phase, caused by delays in cargo retrieval, limited operational hours of container yards, and suboptimal digitalization of documentation. SWOT analysis indicates that efficiency improvements can be achieved through investments in digital technology, enhanced inter-agency collaboration, and the implementation of real-time performance evaluation systems. On the other hand, service fluctuations and failure to meet time standards pose serious threats to national logistics competitiveness. The study concludes that accelerating dwelling time requires a systemic approach through institutional reform, technological infrastructure strengthening, and regulatory alignment. Implementing evidence-based and measurable strategies will enhance port efficiency, reduce logistics costs, and strengthen Belawan Port's position as a competitive regional logistics hub.

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INTRODUCTION

Ports are highly strategic as central nodes in the global supply chain. According to data from the United Nations Conference on Trade and Development (UNCTAD, 2023), more than 80% of international trade volume is carried out via maritime routes. This fact positions ports as vital infrastructure in facilitating the flow of goods between countries. Alongside the increase in container traffic, the transformation of global logistics systems has shown a significant shift from bulk cargo transportation to a more efficient and standardized containerization system (Laurentia & Chintuwa, 2022). Pereira et al. (2024) also noted that the proportion of container usage in global maritime transport rose from 10.5% to over 17% in the past decade.

Regionally, Asia has become the center of global port activities, with over 70% of global container traffic managed by major ports in the region. (World Bank, 2019). Countries like China, Japan, Singapore, and South Korea lead in cargo volume and service efficiency. This phenomenon indicates that ports are not merely logistics nodes, but also reflect a country's capacity to manage international trade effectively (Verschuur et al., 2022). In Indonesia, the increase in cargo volume through ports aligns with national economic growth and industrial expansion (Yudhistira & Sofiyandi, 2018). The government, through the National Port Master Plan (RIPN) and the National Logistics System (Sislognas), has prioritized the strengthening of port infrastructure as a strategic agenda (Sarfina & Sari, 2025).

Nevertheless, substantial challenges remain regarding port operational efficiency, particularly container waiting or dwelling time. Dwelling time is a crucial indicator that reflects the effectiveness of port logistics systems, as it directly affects distribution costs, service speed, and national export competitiveness (Wardana et al., 2024). While in developed countries, dwelling time typically ranges from 1–2 days, in Indonesia, it remains around 4–7 days, depending on the port (Gunawan et al., 2020). This contributes to Indonesia's low ranking in the 2023 Logistics Performance Index (LPI), where it ranked 61st out of 139 countries, far below Singapore (1st), Malaysia (26th), and Thailand (34th) (World Bank, 2023).

The main factors contributing to high dwelling time in Indonesia include the lack of digitalization in port services, limited supporting infrastructure, and weak coordination among institutions such as port authorities, customs, and logistics operators (Dewi, 2023). A study by Hwang & Huang, (2025) also shows that similar issues are present in some Southeast Asian ports. However, countries like Singapore and Malaysia have successfully reduced dwelling time by implementing integrated digital systems like the Port Community System (PCS) and Internet of Things (IoT) technologies in logistics monitoring (Nguyen et al., 2020).

In response to these issues, the Indonesian government merged four state-owned port enterprises into PT Pelindo (Persero) in 2021 to improve service integration and operational efficiency. PT Pelindo now manages over 90 ports and is leading the transformation toward smart logistics ports (Pelindo, 2016). However, this transformation's effectiveness remains limited in practice. It has yet to address technical issues such as dwelling time comprehensively.

One of the ports facing significant challenges is Belawan Port in North Sumatra. As a major international port in western Indonesia, Belawan supports regional export-import activities. (Batubara, Septiana et al., 2024). Despite handling more than 6 million tons of goods annually, the port still records high dwell times, which hampers regional logistics performance (Asbullah et al., 2024). Previous studies by Sudarsono (2022) and Putra (2024) Also noted is that the prolonged waiting times are caused by slow inspection processes, document delays, limited container yard (TPS) capacity, and a lack of transparency and utilization of information technology.

Furthermore, a study by Holguin-Veras et al. (2021) Emphasizes that port efficiency is not solely determined by infrastructure, but also by institutional governance and stakeholder synergy. In international practice, efficiency strategies such as the digital twin system in Rotterdam (van der Horst et al., 2019) and AI-based port control in Shanghai (Zhou et al., 2020) demonstrate how technology can accelerate logistics processes. Indonesia has initiated similar efforts through the National Logistics Ecosystem (NLE), but its implementation in Belawan remains suboptimal. (Safuan, 2023).

Therefore, despite several initiatives, no comprehensive study has specifically analyzed the dynamics of dwelling time at Belawan Port using multi-year historical data while proposing acceleration strategies based on a SWOT analysis approach. This represents a research gap in existing studies, which generally focus on major ports such as Tanjung Priok or are descriptive without data-based strategic formulations.

This research aims to fill that gap by systematically analyzing the internal and external factors affecting dwelling time at Belawan Port and formulating practical and innovative strategies to improve logistics efficiency. The

SWOT approach, by examining the strengths, weaknesses, opportunities, and threats, offers a comprehensive analytical framework to identify strategic leverage points and actionable recommendations that align with the goals of Indonesia's port modernization agenda.

METHOD

This research was conducted at Belawan Port in Medan Belawan District, Medan City, North Sumatra Province, in November 2023. The study's main objective is to analyze the causes of prolonged dwelling time and formulate relevant acceleration strategies to support international trade efficiency. The research employs a combined quantitative and qualitative descriptive approach, integrating direct observation methods, semi-structured interviews with port stakeholders, and documentation studies of operational reports and dwelling time data from 2021 to 2023.

Primary data were collected through interviews with Customs officers, terminal operators, and logistics business actors to understand the customs clearance process at the port. Meanwhile, secondary data were obtained from internal reports by Pelindo, dwelling time reports from the Ministry of Transportation, and relevant regulatory documents such as the Regulation of the Minister of Transportation No. PM 117 of 2015.

1. Quantitative Analysis Dwelling Time Calculation

   Quantitative analysis was conducted by calculating the Import Cargo Dwelling Time (DT) as the main indicator of port efficiency. The dwelling time calculation refers to the World Bank standard formula:

   DT = TP + TCC + TPC

   Explanation:

   - DT = Import Cargo Dwelling Time
   - TP = Pre-Clearance Time
   - TCC = Customs Clearance Time
   - TPC = Post-Clearance Time

   Time data for each stage were averaged monthly from January 2021 to October 2023.

2. Qualitative Analysis SWOT Analysis

   The qualitative approach was carried out through SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) to identify the internal and external factors affecting dwelling time. Internal factors include the strengths and weaknesses in the port service system, while external factors refer to technological opportunities and threats from regulatory or market fluctuations. This method is used to formulate strategies based on the operational realities of the port and to allow for the development of applicable policy recommendations. A triangulation technique was applied to ensure the validity of the data from various information sources. (Kania & Rusindiyanto, 2025).

RESULT AND DISCUSSION

Stages and Data of Dwelling Time

The port dwelling time process consists of three main stages: pre-clearance, customs clearance, and post-clearance. These stages are key indicators in assessing port services' efficiency and stakeholder coordination's effectiveness within the logistics system. This study uses time-series data from Belawan Port spanning the 2021–2023 period to analyze the duration dynamics at each stage.

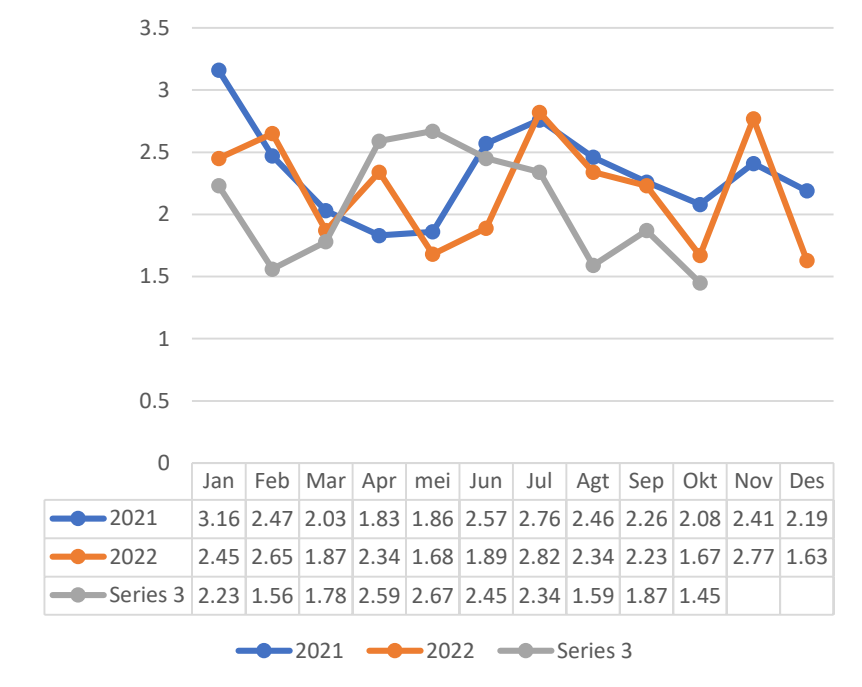
1. Pre-Clearance

The pre-clearance stage refers to the initial process before customs clearance begins. This stage is measured from the vessel's arrival until the importer submits the Import Declaration (PIB) to the Directorate General of Customs and Excise. The monthly average duration of pre-clearance from 2021 to 2023 is presented in Table 1.

Table 1. Pre Clearance Duration 2021-2023

No	Month	Pre Clearance (Days)		
		2021	**2022**	**2023**
1	January	3,16	2,45	2,23
2	February	2,47	2,65	1,56
3	March	2,03	1,87	1,78
4	April	1,83	2,34	2,59
5	May	1,86	1,68	2,67
6	June	2,57	1,89	2,45
7	July	2,76	2,82	2,34
8	August	2,46	2,34	1,59
9	September	2,26	2,23	1,87
10	October	2,08	1,67	1,45
11	November	2,41	2,77	-
12	December	2,19	1,63	-
	Average	2,34	2,19	2,05

From the data above, it can be observed that from 2021 to 2023, pre-clearance experienced minor fluctuations without significant changes. The trend in pre-clearance development is illustrated in Figure 1.



	Jan	Feb	Mar	Apr	mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
2021	3.16	2.47	2.03	1.83	1.86	2.57	2.76	2.46	2.26	2.08	2.41	2.19
2022	2.45	2.65	1.87	2.34	1.68	1.89	2.82	2.34	2.23	1.67	2.77	1.63
Series 3	2.23	1.56	1.78	2.59	2.67	2.45	2.34	1.59	1.87	1.45		

Generally, the pre-clearance time has shown a moderate downward trend from year to year. In 2023, the average duration required was 2.05 days. However, monthly fluctuations still occurred, particularly in May and June, where the average time exceeded 2.5 days. This phenomenon is primarily caused by the obligation to obtain import permits from technical agencies and inspect restricted and prohibited goods (Lartas). Chaniago et al. (2023) Noted that prolonged waiting times during the initial customs process are often due to fragmented licensing regulations across agencies and limitations in digital systems that are not yet fully integrated.

2. Custom Clearance

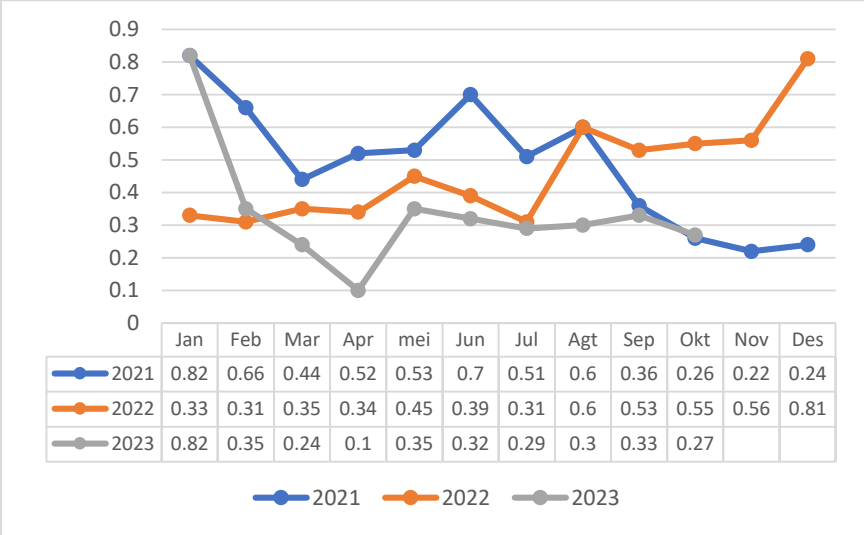
The customs clearance stage spans from receiving PIB documents by Customs until issuing the Customs Release Approval Letter (SPPB). This stage has shown efficiency improvements, as presented in Table 2.

Table 2. Custom Clearance Duration 2021-2023

No	Month	Custom Clearance (Days)		
		2021	**2022**	**2023**
1	January	0,82	0,33	0,82
2	February	0,66	0,31	0,35
3	March	0,44	0,35	0,24
4	April	0,52	0,34	0,10
5	May	0,53	0,45	0,35
6	June	0,70	0,39	0,32
7	July	0,51	0,31	0,29
8	August	0,60	0,60	0,30
9	September	0,36	0,53	0,33
10	October	0,26	0,55	0,27
11	November	0,22	0,56	-

12	December	0,24	0,81	-
	Average	0,49	0,46	0,33

From the data above, it can be seen that post-clearance performance has shown a downward trend from 2021 to October 2023. The trend in post-clearance performance is illustrated in Figure 2.



	Jan	Feb	Mar	Apr	mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
2021	0.82	0.66	0.44	0.52	0.53	0.7	0.51	0.6	0.36	0.26	0.22	0.24
2022	0.33	0.31	0.35	0.34	0.45	0.39	0.31	0.6	0.53	0.55	0.56	0.81
2023	0.82	0.35	0.24	0.1	0.35	0.32	0.29	0.3	0.33	0.27		

The average customs clearance time in 2023 decreased to 0.33 days. However, significant challenges remain due to the unpreparedness in transferring containers from the temporary storage area (TPS) to the physical inspection site and the limited speed of application networks. According to Orłowska & Chackiewicz (2024), customs efficiency is highly influenced by system interoperability, human resource readiness, and inter-agency digital integration. Therefore, strengthening the integrated logistics information system between Pelindo and Customs has become urgent.

3. Post Clearance

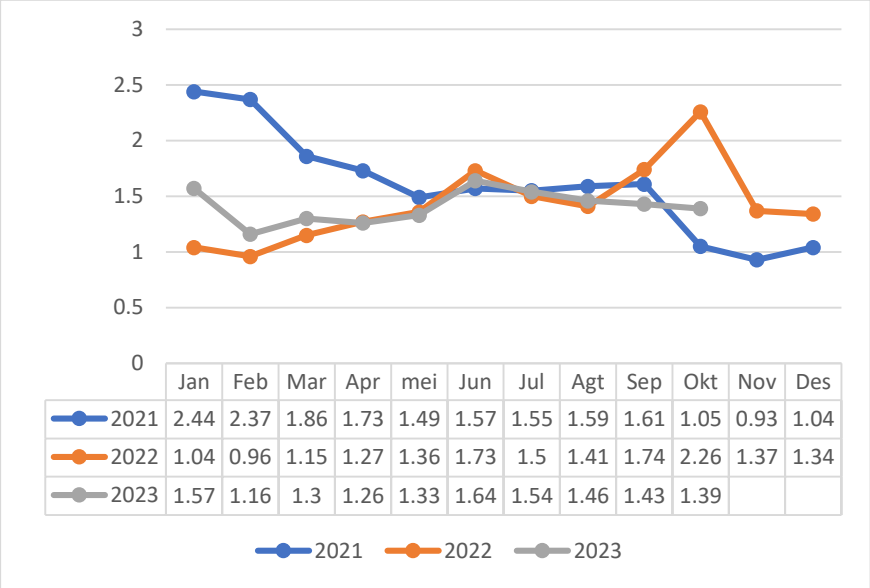
The post-clearance stage begins after the issuance of the SPPB and continues until goods are released from TPS. Table 3 shows that this stage takes longer than the previous two stages.

Table 3. Post Clearance Duration 2021-2023

No	Month	Post Clearance (Days)		
		2021	**2022**	**2023**
1	January	2,44	1,04	1,57
2	February	2,37	0,96	1,16
3	March	1,86	1,15	1,30
4	April	1,73	1,27	1,26
5	May	1,49	1,36	1,33
6	June	1,57	1,73	1,64

7	July	1,55	1,50	1,54
8	August	1,59	1,41	1,46
9	September	1,61	1,74	1,43
10	October	1,05	2,26	1,39
11	November	0,93	1,37	-
12	December	1,04	1,34	-
	Average	1,60	1,43	1,41

The data above show that the post-clearance stage showed a downward trend from 2021 to October 2023. The post-clearance trend development is illustrated in Figure 3.



The average duration of post-clearance in 2023 was 1.41 days. The leading causes were delays by importers in collecting goods, limited TPS (Temporary Storage Facility) services outside working hours, and slow administrative processing of release documents. Field findings indicate that many importers intentionally delay the release of goods due to considerations of storage costs and their own internal logistics efficiency. According to Notteboom et al. (2024), the final stage of the customs process is highly vulnerable to behavioral obstacles from actors, especially at ports in developing countries.

4. Dwelling Time

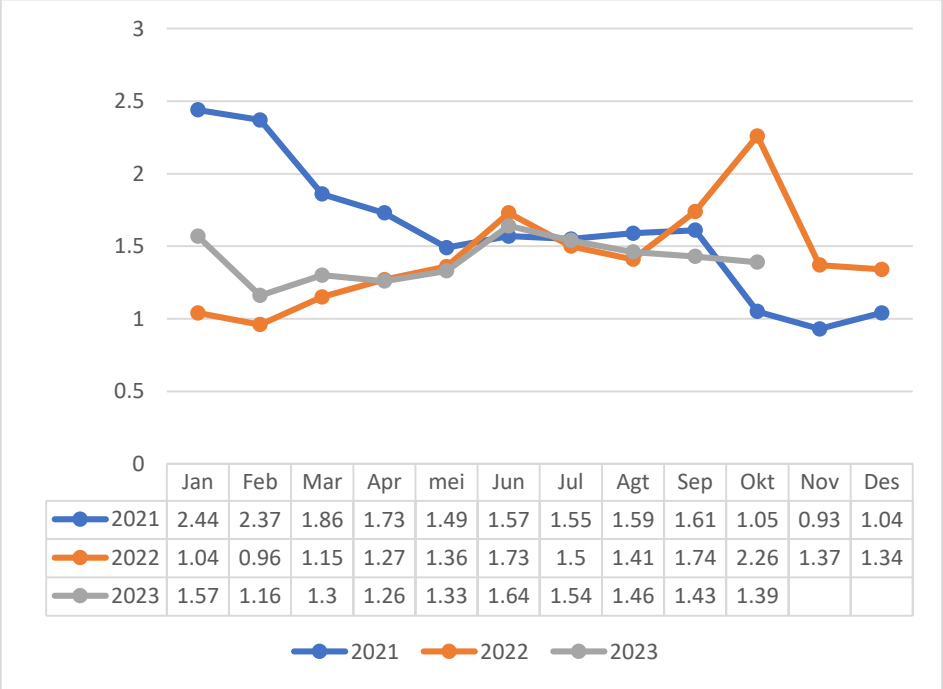
Dwelling time is calculated from when goods are unloaded from the ship until they exit the port. Table 4 presents the aggregated dwelling time duration over the past three years.

Table 4. Dwelling Time 2021-2023

No	Month	Dwelling Time (Days)		
		2021	**2022**	**2023**
1	January	4,8	3,82	4,62

2	February	3,79	3,92	3,07
3	March	2,91	3,37	3,32
4	April	2,87	3,95	3,95
5	May	2,92	3,49	4,35
6	June	3,97	4,01	4,41
7	July	3,78	4,63	4,17
8	August	3,66	4,35	3,35
9	September	2,98	4,5	3,63
10	October	2,6	4,48	3,11
11	November	2,85	4,7	-
12	December	2,67	3,78	-
	Average	3,32	4,08	3,80

Based on the data above, it can be observed that from 2021 to October 2023, dwelling time has shown a declining trend. The progression of this trend is illustrated in Figure 4.



In 2023, the average total dwelling time was 3.80 days, exceeding the national standard of 3 days as stipulated in the Regulation of the Minister of Transportation of the Republic of Indonesia No. PM 117 of 2015. Although there has been a decline compared to 2022, the efficiency target has not yet been fully achieved. According to Zhou et al. (2020) and van der Horst et al. (2019), cross-agency digital integration systems and process automation based on AI and IoT support the success of international ports such as Shanghai and Rotterdam in significantly reducing dwell time. Without the implementation of such technologies, improvements in dwelling time tend to stagnate or remain marginal.

SWOT Analysis

1. Strengths

Several performance improvement indicators reflect the main strengths in the customs clearance process at Belawan Port. Specifically, the clearance time has shown a downward trend year-on-year, indicating a commitment to enhancing system efficiency and service responsiveness. The overall reduction in dwelling time also signifies improvements in the logistics flow from cargo unloading to cargo release from the port. Additionally, the implementation of government regulations that set a maximum dwelling time of three days, as outlined in Regulation of the Minister of Transportation No. PM 117 of 2015 demonstrates the state's commitment to promoting national logistics efficiency. These components form a strategic foundation for reforming the customs system toward greater efficiency and measurability. This aligns with the view of Gonzalez & Quesada (2024), who assert that performance measurability is a cornerstone of globally competitive ports.

2. Weaknesses

Despite notable progress, the customs clearance process still faces several structural and operational weaknesses. First, significant monthly fluctuations in clearance time indicate instability in field systems and procedures. This instability can trigger supply chain uncertainty and disrupt business distribution planning. Second, the post-clearance stage tends to take longer than other phases. Contributing factors include delays in cargo collection by importers, slow administrative processes, and limited facilities and human resources at temporary storage facilities (TPS). These weaknesses are critical because they directly affect cargo release times and incur additional logistics costs. As emphasized by Sahu et al. (2022) inefficiencies in last-mile customs handling are a significant source of port system inefficiencies in developing countries.

3. Opportunities

A significant opportunity exists to improve dwelling time efficiency by adopting digital technologies and institutional synergy. Using integrated information technologies such as electronic-based customs management systems and single window systems has strong potential to accelerate clearance processes and reduce dependency on manual systems. Moreover, adopting IoT-based devices and data analytics can enhance oversight and support data-driven decision-making. On another front, opportunities arise through multi-stakeholder collaboration between port operators, customs authorities, technical agencies, and logistics actors. As noted by de Oliveira et al. (2021), ports that develop collaborative governance models demonstrate more adaptive performance in the face of operational fluctuations. Therefore, improving communication among actors and establishing regular coordination forums are vital to fully leveraging the potential of logistics transformation.

4. Threats

The primary threat in managing dwelling time is the inability to meet the government-mandated time standard. Failure to achieve the standard may lead to penalties, economic losses, and the port's reputational decline nationally and internationally. Furthermore, uncontrolled fluctuations in service time generate uncertainty in business planning, inventory management, and overall supply chain efficiency. This could increase logistics costs and reduce investor confidence in the national port system. Wendler-Bosco & Nicholson (2020) emphasize that instability in port service times directly affects supply chain resilience and strategic decision-making among industrial stakeholders.

Policies and Strategies

Based on the SWOT analysis of the customs clearance performance at Belawan Port, several strategic findings were identified that can serve as the foundation for formulating policies and strategies to improve dwelling time efficiency. These findings indicate that efforts to accelerate dwelling time cannot be approached in a sectoral or isolated manner; instead, they require a systemic approach through institutional reform, technological investment, human resource capacity building, and cross-sectoral coordination.

This aligns with the perspective of Christoper (2015), the theory of logistics system integration emphasizes that logistics efficiency can only be achieved when regulations, infrastructure, technology, and the behavior of actors within the supply chain are harmonized. Accordingly, the following policies and strategies are structured around three key dimensions: institutional reform, technological upgrading, and stakeholder alignment.

Policy Recommendations

1. Enhancing investment in logistics technology

   The government and port authorities must promote sustained investment in digital technologies and customs process automation. Implementing integrated information management systems, single window systems, and Internet of Things (IoT) based technologies can accelerate data exchange and minimize waiting times. According to Dinh et al. (2024), ports that adopt AI-based digital systems and cross-agency platform integration have shown an average reduction in dwelling time of up to 30%.

2. Regulatory refinement and establishment of customs time standards

   Policy efforts should focus on developing regulations that are adaptive to the dynamics of the logistics market and technological advancements. Alignment between technical rules issued by ministries/agencies and port authorities is essential to avoid redundancy in the clearance process. In addition, the consistent enforcement of penalties and incentives for achieving the dwelling time standard (≤ 3 days), as stipulated in Regulation PM 117/2015, is crucial. Notteboom et al. (2024) emphasize that regulatory consistency is a key factor in the success of a national logistics system.

Implementation Strategies

1. Strengthening collaboration and coordination among stakeholders

   A collaborative strategy is needed among Pelindo, Customs, technical agencies (for example, Kementerian Perdagangan, Karantina), container yard operators, and logistics business associations. Periodic coordination forums and the formulation of joint Standard Operating Procedures (SOPs) will enhance the system's responsiveness to operational dynamics. Mustafa et al. (2021) This indicates that ports applying a collaborative governance approach exhibit more adaptive and stable logistics performance.

2. Improving training and awareness among logistics actors

   Efficiency improvement strategies must also include capacity-building for port service users, such as importers and freight forwarders. Regular training on the latest customs procedures and the importance of compliance with operational timelines will accelerate the post-clearance process. This education initiative can also help reduce delays caused by documentation and payment issues.

3. Implementing a real-time dwelling time monitoring and evaluation system

It is essential to develop a digital dashboard to transparently monitor the performance of each stage of dwelling time (pre-, customs-, and post-clearance) in real time. Periodic evaluation of key performance indicators (KPIs) should be conducted to assess the effectiveness of implemented strategies and quickly identify operational bottlenecks. Holguin-Veras et al. (2021) emphasize that real-time, data-driven performance evaluation systems can improve port operational efficiency by up to 20%.

4. Optimizing the post-clearance stage as a primary focus

Given that the post-clearance stage contributes the most to total dwelling time, specific strategies must focus on enhancing storage facilities, digitizing cargo release documentation, and providing 24-hour service at container yards. Operational adjustments in line with importers' and carriers' schedules are critical to preventing cargo accumulation at the port.

CONCLUSION

This study highlights the dynamics of dwelling time as a key indicator of logistics efficiency at Belawan Port within the context of international trade. Time-series data analysis reveals that, although there has been a moderate decline across all stages of the customs process, pre-clearance, customs clearance, and post-clearance, the average total dwelling time in 2023 still exceeds the national standard of three days. Monthly fluctuations, particularly in the post-clearance stage, indicate systemic instability that remains a significant challenge in improving overall port performance.

Through SWOT analysis, the study identifies key strengths, including the consistent reduction in clearance time and implementing government regulations that promote logistics efficiency. However, notable weaknesses persist, especially irregular service times and delays in cargo retrieval by importers, which prolong the post-clearance process. Strategic opportunities lie in the adoption of digital technologies, the integration of inter-agency information systems, and the strengthening of collaborative governance among stakeholders. Conversely, threats emerge from the inability to consistently meet the dwelling time standard, potentially undermining the port's competitiveness and credibility in global logistics networks.

Based on these findings, the study concludes that accelerating dwelling time at Belawan Port cannot be achieved through isolated efforts but requires a systemic approach. Institutional reform, investment in IoT- and AI-based technologies, enhanced inter-agency collaboration, and ongoing education for logistics actors are fundamental components that must be integrated. The success of international ports such as Rotterdam and Shanghai demonstrates that dwelling time efficiency depends heavily on the system's capacity to adapt to global logistics complexity through technological innovation and institutional synergy.

Therefore, implementing strategies derived from SWOT analysis holds strong potential to streamline customs processes, reduce dwell time, and enhance national logistics competitiveness. As the western gateway of Indonesia's trade network, Belawan Port has a significant opportunity to become a model for national logistics transformation provided that strategic steps are executed consistently, measurably, and based on empirical evidence. Further research is recommended to evaluate the effectiveness of digital interventions and to develop real-time monitoring systems for dwelling time performance across Indonesia's major ports.

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