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IMPACT OF PORT FACILITIES AND LOADING-UNLOADING ON DWELL TIME AT TANJUNG PRIOK PORT

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Abstract: This study investigates the impact of port facilities and loading and unloading processes on dwelling time at Tanjung Priok Port, Indonesia's primary trade gateway. Dwelling time, a critical factor in port efficiency, directly influences logistics costs and the competitiveness of the national economy. The research method uses a quantitative approach where data is collected through surveys and statistical analysis, with data sourced from three major companies operating at Tanjung Priok Port and analyzed using Structural Equation Modeling (SEM) with SmartPLS 4. The findings reveal that while port facilities significantly enhance the efficiency of loading and unloading operations, their direct impact on dwelling time is less pronounced. However, when the influence of port facilities is mediated through loading and unloading processes, a notable reduction in dwelling time is observed. This highlights the importance of an integrated approach to port management, where infrastructure development is closely aligned with operational improvements. The study's limitations, including its focus on a limited set of variables and a single port, suggest the need for further research to explore additional factors affecting dwelling time and to validate the findings across different ports. The results underscore the necessity for port authorities to prioritize investments in modernizing infrastructure and optimizing operational processes to reduce dwelling time and enhance overall port efficiency.
Keywords: *Port Facilities, Loading Unloading, Dwelling Time, Port Efficiency, Sea Transport*

1. INTRODUCTION

The expansion of the world economy has an impact on international trade, with ports serving as crucial entry points for this trade. In the rapidly expanding global competitive market, ports are viewed as a vital accelerator of local economic development in many countries by F Suprata et al (2020).The availability of ports plays a crucial role in the success of trade, serving as a vital mechanism for swiftly and securely transporting goods to the hinterland by Yau et al. (2020). The efficiency of logistics services at ports directly impacts the competitiveness of products and the overall industrial and trade standing of a nation. Utilizing containerized shipping, which is the most effective method, becomes the optimal choice for import and export activities by Miller & Hyodo (2022). However, Malisan et al., (2023) demonstrate that a number of obstacles still stand in the way of the Indonesian transportation service sector's ability to fully realize the logistics system's potential.

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Several factors contribute to dwelling time, notably the quality of port facilities and the effectiveness of loading and unloading processes. Modern and well-maintained port facilities are vital for the smooth operation of port activities by Ricardianto et al. (2022). Adequate infrastructure helps expedite the transfer of goods, reduces vessel turnaround times, and ensures that cargo handling is conducted seamlessly.The loading and unloading processes are equally crucial. Efficient operations in these areas rely on the availability of advanced handling equipment, skilled personnel, and streamlined procedures by Carlan et al. (2023). Inefficiencies or bottlenecks in these processes can significantly increase dwelling time, leading to delays and higher costs for both imports and exports. Indonesia's busiest and most critical trade gateway, these factors are particularly significant at Tanjung Priok Port by Gunawan et al. (2020). The port's performance in managing dwelling time affects not only the efficiency of trade but also the broader industrial and economic landscape of the nation. This journal explores how port facilities and loading and unloading processes impact dwelling time at Tanjung Priok Port, aiming to identify key challenges and opportunities for improvement. By addressing these factors, we can enhance port operations and contribute to Indonesia's economic growth and trade competitiveness.

2. LITERATURE REVIEW

Yousefi, (2021) mentioned that within the realm of marine transport, loading and unloading refers to the activities that take place within the port area, specifically from the ship to the warehouse. Furthermore, the enhancement of work safety standards and advancements in automation technology have emerged as significant focal points in endeavors to enhance the efficiency of loading and unloading operations, particularly in minimizing human mistakes and expediting work procedures at ports. The majority of loading and unloading operations are carried out using human workers, a process that is both time-consuming and susceptible to mistakes, damages, and accidents. Given the rising hourly wage and the scarcity of truck drivers, it is evident that there is a pressing need to enhance these operations by Carlan et al. (2023). Vicrihadi & Sembiring , (2020) mentioned that the efficiency of ship operations is significantly impacted by the productivity of loading and unloading containers, which in turn influences the duration of the ship's stay in port. As the duration of the ship's stay at the port increases, the expenses and inefficiency of ship operations also increase. The primary function of a container terminal is to facilitate the transit of commodities. This involves providing services for loading and unloading containers from ships to land or vice versa, as well as offering storage facilities for container stacking. During the loading and unloading process, various obstacles often arise, such as errors in the TOS system, human error, natural factors, and equipment damage. These factors can impede the productivity of container loading and unloading activities. According to Ricardianto et al., (2022) port is a defined area, either on land or sea, where government and business activities take place. It serves as a location for ships to dock, passengers to embark and disembark, and cargo to be loaded and unloaded. This is often done at designated terminals and ship berths. Studies by Yau et al., (2020) mentioned that the smart port, as a component of port infrastructure, seeks to leverage technological

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advancements to enhance port operations and services, while also contributing to the socio-economic development of cities and regions by improving their international trade competitiveness. The intelligent port ecosystem reduces energy usage and traffic. Port productivity is a metric used to assess the quality of service and the effectiveness of port infrastructure for consumers. A high level of port productivity signifies that the port has delivered excellent service, According to Ana et al., (2020) . Dwelling time refers to the duration measured from when the goods are unloaded from the ship till they are taken out of the port, as defined by Gunawan et al., (2020). The efficiency of port services is quantified by the duration it takes to offload a container from ships till the container departs the port terminal via the primary exit, also referred to as Dwelling Time. The Dwelling Time problem is a complex issue that necessitates the collaboration of multiple agencies and entities to provide a comprehensive resolution, according to Sirajuddin, (2020). This collaboration entails the harmonization of efforts among the government, port operators, and port service users to establish a more transparent and efficient procedure, with the ultimate goal of minimizing dwelling time. The duration of time that cargo spends at a port, known as dwelling time, has a direct impact on the productivity and efficiency of the port. Therefore, by minimizing the amount of time cargo spends at the port, we may enhance port productivity. Port productivity is a commonly used metric to assess and compare a company's output-to-input ratio, whereas port efficiency evaluates a port's capacity to achieve the highest possible outcome with a given level of input Miller & Hyodo, (2022). The assessment also serves as the foundation for decision-making in port infrastructure investment, since enhancements in productivity and efficiency can lead to increased economic advantages for both the port and the overall logistics ecosystem.

Table and Figures

Tables are presented in the following:

Table 1

Measurement of variables

Variable	Operational Definition	Indicator	Source
Port Facility	Effective port operations rely on the crucial management of port facilities. Efficiently managed port facilities have the potential to enhance production and operational efficiency, thereby ensuring the	1. Port Usability 2. Berth Operation Rate 3. Berth Number and Length 4. Berth Capacity and Utilization 5. Ship Average Amount	(Wahyuni et al., 2024) (Xie et al., 2017)

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	long-term sustainability of port operations.		
Loading Unloading	Loading and unloading are integral commercial operations involved in the transfer of commodities to and from ships at ports. These activities encompass stevedoring, cargodoring, and receiving/delivery tasks.	1. Labor Group 2. Loading Unloading Equipment 3. Full Empty Ratio 4. Container Weight 5. Loading Unloading Process Time	(Chumaida, 2019) (Marzuki et al., 2021)
Dwelling Time	Dwelling time refers to the duration it takes for containers to be unloaded from a vessel (unloading), transferred to the container yard (cargodoring), and finally exiting the port via the main door (distribution).	1. Shipping Companies and Ship Agent 2. Port Authorities 3. Ship Owners	(De Wibowo Muhammad Sidik et al., 2020) (Nwokedi et al., 2022)

Figures are presented as follows:

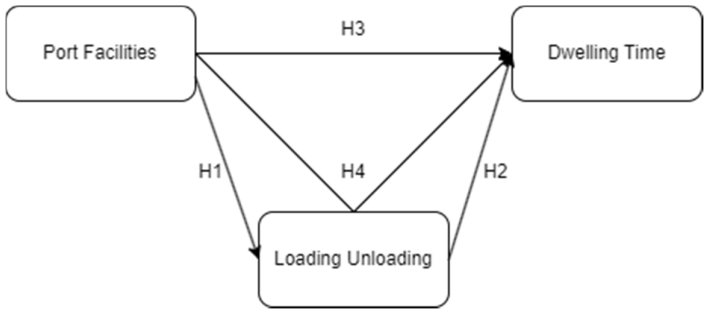

Fig. 1. Research model

Hypothesis

1. Hypothesis 1: There is significant effect between Port Facilities and Loading unloading H1: Ezzahra et al., (2023) Mentioned that ships may have delays in finding a place to dock, which leads to periods of inactivity and decreased efficiency. Inefficient allocation of container handling equipment, such as cranes, can result in downtime and lower throughput, leading to extended dwelling time at the port.

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2. Hypothesis 2: There is significant effect between Loading Unloading and Dwelling Time
   H2: Wardana and Dharmakarja, (2024) Said in order to accommodate the growing volume of exports and imports in Indonesia, it is imperative for port facilities to be provided with adequate port facilities to expedite the transit of commodities. By understanding the impact of dwelling time, governments can establish customs laws that expedite services through streamlined and efficient procedures

3. Hypothesis 3: There is significant effect between Port Facilities and Dwelling Time
   H3: Sirajuddin, (2020) found that factor causing the significance of service quality from the port facility perspective is the capability of equipment modernization from port operators, which is still not maximized, and the low productivity of loading and unloading equipment, which causes the target of loading and unloading operations cannot be achieved. Wagner et al., (2022) Also mentioned that Port infrastructure and facilities are essential assets that significantly impact the appeal of a port. These resources are essential for conducting both port and value-added logistics activities.

4. Hypothesis 4: There is significant effect between Port Facilities and Dwelling Time through Loading Unloading
   H4: Studies by Andromeda & Purwantini, (2021) shown that the presence of transportation for the movement of products, as well as the coordination of loading and unloading operations, is a key aspect in the handling of commodities during these processes. These activities frequently encounter delays in document completion, damage to commodities, shortages of goods, limited equipment, and a lack of experience in operating loading and unloading equipment. Consequently, the extended duration of ships at the port will lead to financial expenses for shipping corporations. The delay problem highlights the significance of implementing a strategy to assess and enhance port performance in order to attain high levels of success in both domestic and international supply chains.

3. RESEARCH METHOD

3.1. Research Design

This study uses a quantitative research design to analyze the relationship between the variables studied. The quantitative approach was chosen because it allows the collection and analysis of numerical data that can be processed statistically, so that the research results can be measured objectively and can be tested for validity and reliability. The data in this study were collected through surveys distributed to respondents, and

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analyzed using relevant statistical techniques to test the hypotheses that have been formulated.

3.2. Population and Sample

This study uses (Hair, 2006) method. More acceptable sample size would have a 10:1 ratio for each indicator to determine the number of representative samples. The data in this study were taken from three companies operating in Tanjung Priok Port, namely PT Pelabuhan Indonesia (Pelindo), Jakarta International Container Terminal (JICT), and New Priok Container Terminal 1 (NPCT 1). Based on calculations using the Joseph F. Hair method, the number of respondents taken in this study was 130 people.

3.3. Data Analysis Tools

In this study, the authors analyzed the data using StructuraL Equation Modelling (SEM) – SmartPLS 4 software in managing the results of the survey to conclude the results of the study

4. RESULT AND DISCUSSION

4.1 Respondent Characteristics

This research presents an examination of respondent data categorized by specified demographic groupings, along with the findings from the analysis of the researched variables. An analysis of these data will enhance comprehension of the links among the researched variables. Respondent demographics were categorized into numerous groups, specifically gender, age, and company name. The researchers have summarized the data as follows:

TABLE 1

Demographics of Respondents Based on Gender

Gender	Amount	Percentage
Male	102	78,5%
Female	28	21,5%
Total	130	100%

In this study, the number of respondents was dominated by men at 78,5%, while the number of female respondents in this study was only 21,5%

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TABLE 2

Demographics of Respondents Based on Age

Ages	Amount (People)	Percentage
17 -20 years old	3	2,3%
21 – 25 years old	17	13%
26 – 30 years old	27	20,8%
31 – 35 years old	29	22,4%
36 – 40 years old	23	17,7%
> 40 years old	31	23,8%
Total	130	100%

The table presents data on the distribution of individuals by age groups, detailing the number of persons and their respective percentages within a sample size of 130 individuals. The predominant demographic consists of individuals aged over 40, accounting for 23.8% (31 individuals), followed by the 31–35 age cohort at 22.4% (29 individuals) and the 26–30 age bracket at 20.8% (27 individuals). Individuals aged 36–40 comprise 17.7% (23 individuals), whilst those aged 21–25 constitute 13% (17 individuals). The 17–20 age range constitutes the smallest group, representing about 2.3% (3 individuals). This presents a demographic analysis of individuals categorized by age, including both numerical and percentage representations.

TABLE 3

Demographics of Respondents Based on Company

Company	Amount (People)	Percentage
NPCT 1	37	28,4%
JICT	24	18,4%
Pelindo	33	25,3%
Others	36	27,9%
Total	130	100%

The table delineates the distribution of individuals employed by various companies within a sample size of 130 individuals. The largest group, representing 28.4% (37

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people), is employed by NPCT 1, followed by 27.9% (36 people) who work for companies categorized as "Others." Pelindo employs 25.3% (33 people), and JICT employs the smallest proportion, accounting for 18.4% (24 people). This table summarizes the distribution of employees across four company categories, highlighting NPCT 1 as the largest employer in the sample.

4.2 Validity Test

TABLE 4
Validitas Konvergen

	Code	Outer Loading	VIF
Port Facility	PF 1	0,746	2,468
	PF 2	0,844	3,048
	PF 3	0,805	2,142
	PF 4	0,834	2,153
	PF 5	0,782	1,821
Loading Unloading	LU 1	0,805	1,826
	LU 2	0,823	2,096
	LU 3	0,768	1,955
	LU 4	0,859	2,570
	LU 5	0,855	2,316
Dwelling Time	DT 1	0,865	1,894
	DT 2	0,885	2,040
	DT 3	0,836	1,779

Source : Sem PLS (v.4.1.0.6)

In summary, the table demonstrates that all the indicators utilized in this model exhibit substantial outer loadings, suggesting that they effectively represent their corresponding latent components. While there are a few VIF values that are slightly higher (such as PF 2), none of them above the crucial threshold (typically VIF > 10), suggesting that multicollinearity is not a serious problem in this model. The indicators possess validity and reliability when measuring the specified latent constructs.

Table 5
Discriminant Validity- Heterotrait- Monotrait Ratio of Correlations (HTMT)

	DT	LU	PF
DT			
LU	0,626		
PF	0,581	0,872	

Source : Sem PLS (v.4.1.0.6)

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In summary, the table indicates a significant positive association between the three latent variables, particularly between Port Facility and Loading Unloading. These findings suggest that enhancing port infrastructure is highly likely to directly enhance the efficiency of the loading and unloading operations. The association between Dwelling Time and the other two dimensions is positive, although it is not as robust as the correlation between PF and LU. This suggests that although Dwelling Time is influenced by these parameters, there are more variables that also have a significant impact on determining the duration of dwelling time.

Table 6
Cross Loadings

	PF	LU	DT
PF 1	0,746	0,551	0,325
PF 2	0,844	0,650	0,336
PF 3	0,805	0,539	0,335
PF 4	0,834	0,613	0,388
PF 5	0,782	0,748	0,591
LU 1	0,754	0,805	0,487
LU 2	0,636	0,823	0,377
LU 3	0,499	0,768	0,387
LU 4	0,611	0,859	0,486
LU 5	0,693	0,855	0,473
DT 1	0,463	0,467	0,865
DT 2	0,432	0,518	0,885
DT 3	0,427	0,411	0,836

Source : Sem PLS (v.4.1.0.6)

Discriminant Validity: The table 3 demonstrates that each indicator exhibits the maximum loading value on the construct it is intended to measure, in comparison to other constructs. This indicates that the model has strong discriminant validity, implying that distinct underlying constructs are accurately represented by their respective indicators.
Indicator Relevance: Greater values in the column of each concept suggest that the indicators accurately represent their underlying constructs. For instance, the indication PF 2 is of great significance for Port Facility, but LU 4 is of great significance for Loading Unloading.

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4.3 Reliability Test

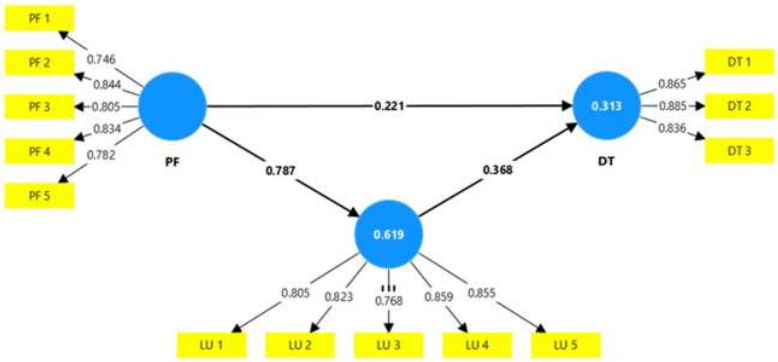
Table 7
Reliability Result

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
DT	0,828	0,833	0,897	0,744
LU	0,881	0,888	0,913	0,677
PF	0,863	0,876	0,901	0,645

Source : Sem PLS (v.4.1.0.6)

The table demonstrates that all latent constructs (DT, LU, and PF) exhibit exceptional internal reliability, as evidenced by their high Cronbach's alpha and composite reliability values. Furthermore, the convergent validity of all constructs is satisfactory, as evidenced by the AVE values, all of which above 0.5. Put simply, the constructs are consistently evaluated using suitable indicators, which effectively capture a significant portion of the relevant variability. Therefore, these findings suggest that the utilized model exhibits high measurement quality.

4.4 Inner Model



Source : Sem PLS (v.4.1.0.6)

Table 8
R-Square Table

	R-square
DT	0,313
LU	0,619

Source : Sem PLS (v.4.1.0.6)

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The model's R-square value of 0.313 indicates a modest level of explanatory power in relation to differences in Dwelling Time. This implies that there may be more significant variables that were not taken into account in the model, which have an impact on Dwelling Time. The Loading Unloading (LU) model has a fairly effective explanatory power, as indicated by an R-square value of 0.619. The variables incorporated in the model make a substantial contribution to our comprehension of the fluctuations in this procedure.

Table 9
F-Square Table

	DT	LU	PF
DT			
LU	0,075		
PF	0,027	1,626	

Source : Sem PLS (v.4.1.0.6)

The latent variable (LU) has a minor impact on the determinant 1 (DT) with a F^2 value of 0.075. This suggests that the contribution of LU to DT is not particularly important and may have a limited impact on changes in DT in the model.
The Performance Factor (PF) has a minor impact on DT, as indicated by a F^2 value of 0.027. Similar to LU, the impact of PF on DT is similarly relatively minor, suggesting that alterations in PF have an insignificant effect on DT.
The influence of PF on LU is significant, as indicated by a F^2 value of 1.626. This suggests that PF has a significant role in determining LU, making it an essential variable in the link between PF and LU.

4.5 Hypothesis Result

Table 10
Direct and Inderect Hypothesis Result

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
PF -> LU	0,787	0,794	0,039	20,009	0,000
LU -> DT	0,368	0,375	0,165	2,230	0,013
PF -> DT	0,221	0,224	0,156	1,416	0,078
PF -> LU ->DT	0,290	0,297	0,133	2,182	0,015

Source : Sem PLS (v.4.1.0.6)

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The coefficient of 0.787 and p-value of 0.000 indicate that PF has a powerful and meaningful impact on LU. This link is extremely significant and may be considered with practically perfect confidence.
The variable LU has a substantial and direct impact on the variable DT, with a coefficient of 0.368 and a p-value of 0.013. The data suggests that LU has a substantial and direct influence on DT, with a high level of confidence at 98.7%.
The coefficient of 0.221 and the p-value of 0.078 indicate that PF does not have a substantial direct impact on DT. Furthermore, the p-value above the significance threshold of 0.05. This suggests that the correlation between PF and DT is not statistically significant.
The impact of PF on DT is mediated indirectly through LU, with a coefficient of 0.290 and a p-value of 0.015. This suggests that while PF does not have a direct impact on DT, its influence on DT becomes noteworthy when mediated by LU.

4.6 Discussion

Hypothesis 1: Port Facilities and Loading Unloading (H1)

The analysis indicates a significant positive relationship between port facilities and loading and unloading processes. The port facilities are crucial in determining the efficiency of loading and unloading operations. This is consistent with previous studies Ezzahra et al., (2023) that suggest that well-developed port infrastructure, such as cranes, berths, and storage areas, can directly enhance the throughput of loading and unloading activities. The findings imply that improvements in port facilities are likely to lead to more efficient loading and unloading operations, thereby reducing operational bottlenecks and contributing to smoother port operations.

Hypothesis 2: Loading Unloading and Dwelling Time (H2)

The results confirm that there is a significant impact of loading and unloading processes on dwelling time. Efficient loading and unloading operations reduce the time cargo spends at the port, which in turn decreases dwelling time. The study supports the idea of author Wardana and Dharmakarja, (2024) that operational delays during the loading and unloading stages can extend dwelling time, which is a critical factor in port efficiency. Therefore, optimizing these processes is essential to minimize delays and enhance overall port performance.

Hypothesis 3: Port Facilities and Dwelling Time (H3)

The relationship between port facilities and dwelling time was found to be positive but not as strong as expected. This suggests that while port facilities are essential, their direct impact on dwelling time might be less pronounced compared to their influence on loading and unloading operations. The study highlights that simply improving port infrastructure may not be sufficient to reduce dwelling time unless these improvements also lead to more efficient loading and unloading processes.

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Hypothesis 4: Port Facilities and Dwelling Time through Loading Unloading (H4)

The mediation analysis reveals that the impact of port facilities on dwelling time is significant when mediated by the efficiency of loading and unloading operations. This finding underscores research from previous researchers Andromeda & Purwantini, (2021) the importance of an integrated approach where enhancements in port infrastructure are closely aligned with operational improvements. The indirect effect suggests that investments in port facilities should be coupled with strategies to optimize loading and unloading processes to achieve meaningful reductions in dwelling time.

4.7 Conclusion

This study determines that port facilities play a crucial role in ensuring the efficient functioning of port activities. However, their influence on the time it takes for cargo to be loaded and unloaded is greatly influenced by the effectiveness of these processes. Implementing direct enhancements to these operational procedures can result in a prompt decrease in dwelling time, which in turn leads to reduced logistical costs and improved port efficiency. The significance of an integrated approach to port management is underscored by the indirect impact of port facilities on enhanced loading and unloading operations. This approach emphasizes the close alignment between infrastructure development and process improvement.

4.8 Implications

This study has two main implications. Initially, it is crucial for port authorities and stakeholders to give priority to investments in the modernization and maintenance of port infrastructure, guaranteeing that they have the capacity to facilitate effective loading and unloading operations. Furthermore, it is imperative to consistently enhance the operational processes, specifically in the domain of cargo handling, in order to immediately minimize the amount of time spent waiting. When formulating plans for port growth, policymakers should take into account these findings. They should ensure that expenditures in infrastructure are accompanied by efforts to enhance operating efficiency. Moreover, the model's limited ability to explain recommends that future studies and policy formulations should take into account a wider variety of characteristics to effectively tackle the difficulties related to residence time at ports.

5. RESEARCH LIMITATION

This study, although it offers useful insights into the effect of port infrastructure and loading and unloading operations on dwelling time at Tanjung Priok Port, is restricted by its narrow emphasis on a specific collection of variables, its limitation to only one port, and its reliance on a quantitative methodology. These limitations may not comprehensively encompass the wider array of elements that impact living time, such as customs protocols, external logistics, and seasonal fluctuations. In addition, relying solely on survey data may fail to consider

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qualitative factors such as managerial practices and organizational culture, which can have a substantial influence on port operations. Future study should adopt a more extensive strategy, using several ports, a wider range of variables, and a mixed-methods design to gain a more comprehensive understanding of the factors that impact port efficiency.

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