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Research Article

Determining the Performance of Sea Tolls in Indonesia : Analysis of Port Infrastructure, Logistics Connectivity, and Fleet Capacity

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Abstract: This study aims to analyze the influence of port infrastructure, logistics connectivity, and fleet capacity on the performance of sea tolls in Indonesia. The approach used in this literature review study is descriptive qualitative. The data collection technique used is a literature study or review of relevant previous articles published between 2021 and 2026. The technique used in this literature review is comparative analysis. The data used in this descriptive qualitative approach came from previous studies relevant to this study and sourced from academic online media such as Thomson Reuters Journal, Springer, Taylor & Francis, Scopus Q2-Q4 Emerald, Elsevier, Sage, Web of Science, Sinta 2-5 Journal, DOAJ, EBSCO, Google Scholar, Copernicus, and digital reference books. The results of the study show that: 1) Port infrastructure affects sea toll performance; 2) Logistics connectivity affects sea toll performance; 3) Fleet capacity affects sea toll performance.

Keywords: Fleet Capacity; Logistics Connectivity; Maritime Transport; Port Infrastructure; Sea Toll Performance.

1. Introduction

The global supply chain is a complex network that integrates the flow of goods, information, and capital across countries to ensure the efficient fulfillment of global market needs. In this ecosystem, sea transportation plays a vital role as the backbone of international logistics due to its ability to transport large volumes of cargo at a relatively low cost (Nofrialdi et al., 2023).

One crucial initiative that supports the reliability of this supply chain at the domestic level is the Sea Toll program. Sea Toll is a concept of regular and scheduled sea transportation (scheduled liner) that connects major ports to remote areas, aiming to ensure the availability of goods and minimize price disparities of basic commodities throughout the country. The performance of the Sea Toll can be seen, among other things, through the realization of the number of sea freight shipments in TEUs or ton (Susanto et al., 2021).

In countries that rely on maritime routes, the number and effectiveness of Sea Toll routes are key indicators of their national logistics strength (Triantoro, 2020). For example, in archipelagic countries or countries with long coastlines, this system is designed to eliminate distribution barriers that often cause high inflation in isolated areas. The success of this system is highly dependent on the synchronization between a modern fleet of ships, deep ports, and an integrated logistics information system (Wijaya, 2025).

In Indonesia, the performance of sea tolls can be seen through the data on sea vessel cargo during a certain period below:

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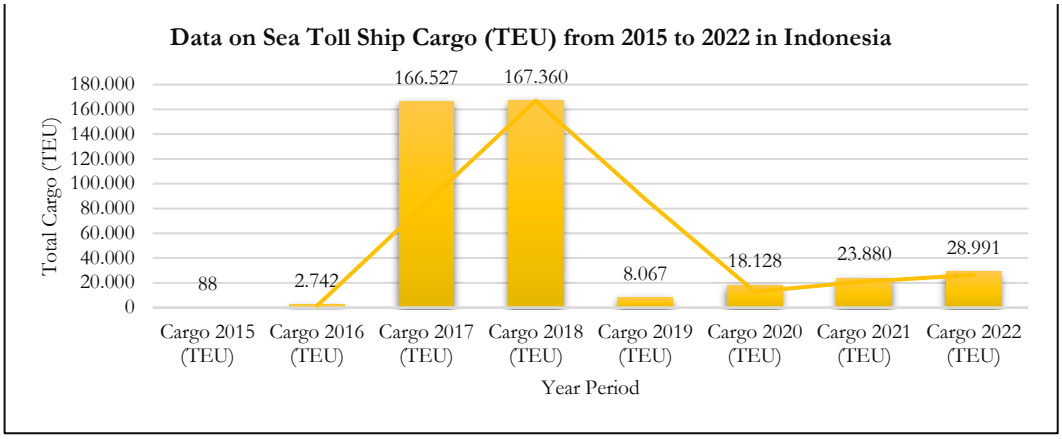

Figure 1. Sea Toll Ship Cargo Data (TEU/Twenty-foot Equivalent Unit) for 2015-2022 in Indonesia. Source: (Ministry of Transportation of the Republic of Indonesia, 2023)

Figure 1 shows the development of Sea Toll ship cargo in Indonesia measured in TEU (Twenty-foot Equivalent Unit) during the period 2015–2022, where in general there is a fluctuating pattern with a significant downward trend in certain periods. In the early phase of the Sea Toll program implementation (2015–2017), cargo volume experienced a relatively positive increase, reflecting the commencement of Sea Toll routes as a national logistics distribution instrument and increased utilization of subsidized sea transportation services to disadvantaged, remote, outermost, and border areas (Ministry of Transportation of the Republic of Indonesia, 2023).

However, from 2018 to 2019, there was a significant decline in cargo volume, indicating structural problems in the implementation of the Sea Toll. This decline can be attributed to several factors, including the suboptimal readiness of port infrastructure at ports of call, low backhaul, an imbalance in the flow of goods between regions, and the limited integration of the Sea Toll with land logistics networks and other modes of transportation. These conditions have led to a decline in vessel utilization rates and the Sea Toll's operational efficiency has not been maximized (Gultom et al., 2022).

Furthermore, in the 2020–2022 period, data shows that Sea Toll ship cargo tends to be stagnant without significant increases. This stagnation was not only influenced by external factors such as the slowdown in economic activity and supply chain disruptions during the COVID-19 pandemic, but also reflected the fact that fundamental improvements in the Sea Toll system particularly in terms of logistics connectivity and fleet capacity had not been fully realized. Thus, Figure 1 confirms that even though the Sea Toll has been operating for more than a decade, the challenges in increasing cargo volume and ship loading factors remain crucial issues that require serious attention from the government and relevant stakeholders.

Overall, the trend in Figure 1 reinforces the argument that the performance of Sea Toll in Indonesia cannot be measured solely in terms of operational sustainability, but also in terms of the system's ability to consistently increase ship utilization and cargo volume, which ultimately contributes to reducing price disparities and equalizing the distribution of goods between regions.

Based on the above background, the research questions for this study are as follows: 1) Does port infrastructure affect the performance of the Sea Toll?; 2) Does logistics connectivity affect the performance of the Sea Toll?; 3) Does fleet capacity affect the performance of the Sea Toll?.

2. Preliminaries or Related Work or Literature Review

Based on the background and problem formulation above, the literature review for this study is as follows:

Sea Toll Performance

Sea toll performance is a variable that measures the effectiveness and efficiency of government strategic programs in ensuring the availability of goods and price disparities in Disadvantaged, Remote, Outermost, and Border (3TP) areas. Conceptually, this performance is not only viewed from the technical aspects of shipping, but also from its socio-economic

impact on communities in the target areas of(Dewantara & Saputro, 2022) (Dewantara & Saputro, 2022).

The indicators included in the performance of the sea toll are: 1) Price Disparity: Measures the price difference of basic necessities between the base area (producer) and the 3TP (Underdeveloped, Remote, Outermost, and Border) areas. Performance success is seen from the decline in prices in the destination area; 2) Timeliness: Measures the accuracy of ship arrival and departure schedules in accordance with the predetermined route (*liner* schedule); 3) Load Factor: The percentage of ship space occupancy, both for outgoing and return cargo. This indicator shows the efficiency of cargo space utilization; 4) Goods Availability: Ensuring the consistency of stocks of essential commodities in target areas to prevent seasonal shortages (TAHARUDDIN et al., 2021).

The performance variables of sea tolls are relevant to previous studies conducted by: (Arif et al., 2025), (Al-Faruqi & Perbani, 2023), (Erlangga et al., 2024).

Port Infrastructure

Port infrastructure consists of all physical facilities and support systems in a port that facilitate the movement of goods and passengers between sea and land transportation modes. This variable covers two main categories, namely *hard infrastructure* and *soft infrastructure*. Hard infrastructure includes adequate shipping channel depth, pier length, availability of container yards, and mechanical loading and unloading equipment such as Ship-to-Shore Cranes or Rubber Tyred Gantries. The quality of this infrastructure greatly determines port productivity; the more modern the facilities, the faster the berthing time and dwelling time, which directly reduces logistics costs per unit of(Husen & Baranyanan, 2021) (Husen & Baranyanan, 2021).

Indicators found in port infrastructure include: 1) Port Channel and Basin Depth: Determines the size of ships that can dock. The deeper the channel, the larger the ships that can enter, which has an impact on economies of scale; 2) Pier Length and Capacity: Measures the port's ability to accommodate the number of ships docking simultaneously without causing long queues; 3) Availability of Loading and Unloading Equipment: The quality and quantity of mechanical equipment (such as container cranes) that determines the speed of container transfer per hour (box per hour); 4) Storage Yard Area: The temporary storage capacity for goods or containers within the port area before they are unloaded or loaded onto ships (Triantoro, 2020).

Port infrastructure variables are relevant to previous studies conducted by: (Apriyanto et al., 2025), (Irawan et al., 2025), (Purnama, 2022).

Logistics Connectivity

Logistics connectivity refers to the degree of interconnection and ease of accessibility between logistics nodes in a distribution network. This variable is not only about physical distance, but more about the smooth flow of goods, information, and finance from the point of origin to the destination. In the context of an archipelagic country, strong logistics connectivity means the seamless integration of sea, land, and air transportation. This includes the availability of regular transportation schedules, high frequency of ship visits, and the connectivity of ports with hinterland areas (industrial or agricultural areas) through a network of toll roads or logistics railways (Susanto et al., 2021).

The indicators of logistics connectivity include: 1) Ship Visit Frequency: The number of regular voyages within a certain period connecting one port to another; 2) Hinterland Accessibility: The quality of connections between ports and supporting areas on land (toll roads, railways, or industrial centers); 3) Transit Time: The total time required for goods to move from the point of origin to the final destination; 4) Multimodal Integration Index: The extent to which goods can be easily transferred between modes of transportation (sea to land) without bureaucratic or physical barriers (Nugraha & Santoso, 2025).

Logistics connectivity variables are relevant to previous studies conducted by: (Wardiningsih & Mokodompit, 2025), (Setiawan, 2025), (Mokodompit, 2025).

Fleet Capacity

Fleet capacity is a variable that measures the total cargo space and availability of ships in a maritime transportation system to serve the volume of cargo demand. This definition includes the quantity of ships (number of units), the quality of ships (technical age and specifications), and the total carrying capacity, which is usually expressed in Deadweight Tonnage (DWT) or Twenty-foot Equivalent Units (TEUs). Fleet capacity must be in line with trade volume; if capacity is too low, there will be a shortage of ship space, triggering a surge in freight rates, but if it is too large (oversupply), the operational efficiency of shipping companies will be disrupted due to low load factors (Nurlailawati et al., 2023).

Indicators of fleet capacity include: 1) Deadweight Tonnage (DWT) or TEUs: The maximum weight or volume that can be carried by all ships operating in the network; 2) Ship Condition and Age: Determines seaworthiness and fuel efficiency. Capacity is considered optimal if the fleet consists of ships that are still within their productive technical age. 3) Ship Speed: The average ability of ships to travel between ports, which affects the turnover of goods. 4) Fleet Type and Specifications: Diversity of vessel types (such as bulk carriers, container ships, or tankers) that must be appropriate for the characteristics of the goods being distributed (Idrus et al., 2024).

The fleet capacity variable is relevant to previous studies conducted by: (Hanum & Susanti, 2024), (Parhan et al., 2025), (Riyadi, 2025).

Previous Research

Table 1. Comparison of Research Results on the Performance of the Maritime Toll Road.

No	Author (year)	Research Results	Similarities with this article	Differences with this article
1	(Nasihah & Sudirman, 2025)	Port Infrastructure Variables Affect Sea Toll Performance at Oransbari Port in Papua	Similarities with this study include the independent variable of Port Infrastructure and the dependent variable of Sea Toll Performance	The difference with this study lies in the research object, namely the Port of Oransbari in Papua
2	(Susanto et al., 2021)	Logistics Connectivity and Logistics Distribution System variables affect Sea Toll Performance	Similarities with this study are the independent variable of Logistics Connectivity and the dependent variable of Sea Toll Performance.	The difference with this study is in the independent variable of Logistics Distribution System.
3	(Sulistiana, 2023)	The variables of Operational Performance and Fleet Capacity affect Sea Toll Performance in Eastern Indonesia	Similarities with this study include the independent variable Fleet Capacity and the dependent variable Sea Toll Performance	The difference with this study is in the independent variable of Operational Performance

3. Materials and Method

This study uses a descriptive qualitative approach with a literature review method to examine the determinants of Sea Toll performance in Indonesia. This approach was chosen because the study aims to synthesize, compare, and interpret empirical findings from various relevant previous studies, particularly those related to port infrastructure, logistics connectivity, and fleet capacity as determinants of Sea Toll performance. Through this approach, the study is expected to provide a comprehensive understanding of the relationship patterns between variables and their implications for improving the performance of the national maritime logistics system (Susanto et al., 2024).

The research data was sourced from secondary data obtained through scientific publications in the form of national and international journal articles, government agency reports, and policy documents relevant to the Sea Toll program in Indonesia. The literature sources were obtained from several reputable scientific databases, including Scopus, Web of Science, ScienceDirect, Emerald Insight, Taylor & Francis, and Google Scholar as supporting

sources. The use of these various databases aims to ensure the completeness and breadth of the references analyzed (Zulfikar et al., 2024).

The selected literature was analyzed using comparative analysis and thematic synthesis. In the initial stage, each article was classified based on the focus of the variables, research methods, and main findings. Next, a comparison between studies was conducted to identify patterns of similarity, differences, and causal relationships between port infrastructure, logistics connectivity, fleet capacity, and Sea Toll performance. The results of the analysis were then synthesized to build an integrated conceptual understanding of the determinants of Sea Toll performance in Indonesia (Usman et al., 2022).

The validity of the research is maintained through the use of credible and reputable literature sources, as well as by triangulating findings from various previous studies. In addition, the analysis is carried out consistently with the theoretical framework of operational management and maritime logistics to ensure that the interpretation of the results remains objective and academically based (Puspita et al., 2022).

4. Results and Discussion

Based on the problem formulation, literature review, and relevant previous studies above, the results and discussion of this study are as follows:

The Influence of Port Infrastructure on the Performance of Sea Tolls in Indonesia

Based on a review of the literature and several relevant previous studies, it can be concluded that port infrastructure affects the performance of sea tolls in Indonesia.

To achieve and improve the performance of sea tolls in Indonesia, management or relevant stakeholders can implement or pay attention to port infrastructure, which includes: 1) Depth of port channels and basins: Stakeholders must carry out periodic dredging (*maintenance dredging*) to ensure that large ships can enter. This creates economies of scale, where the cost of transport per unit of goods becomes cheaper because the ships that enter are no longer limited to small ships; 2) Length and capacity of docks: Management must adjust the length of the docks to the current trends in sea toll ship sizes. Adequate docks prevent queues of ships outside the port (*waiting time*); 3) Availability of loading and unloading equipment: Stakeholders need to switch from conventional methods to mechanization or automation. The provision of reliable equipment such as land *cranes* or *reach stackers* is crucial; 4) Storage yard area: Port management must provide a sufficiently large area with a neat management system. This serves to prevent *bottlenecks* when goods flow in and out of the port.

If management or relevant stakeholders can implement these four port infrastructure measures, it will have an impact on the performance of sea tolls in Indonesia, including: 1) Price disparities: With efficient infrastructure, port *handling* costs and ship rental costs per container will decrease significantly. This reduction in logistics costs, if properly monitored by the Food Task Force and local governments, will directly impact the reduction of staple food prices at the end consumer level in 3TP areas; 2) Timeliness: Reliable infrastructure (especially loading and unloading equipment and docks) minimizes the risk of delays. Ships can depart and arrive according to the predetermined schedule. Schedule certainty is very important for traders to plan their stock without fear of running out of supply; 3) Loading factor: If the port is convenient and efficient for loading, return cargo will increase, resulting in a more balanced ship load factor; 4) Availability of goods: With fast loading and unloading processes and certainty of berthing, the supply of goods to distributor warehouses in remote areas becomes more stable and continuous. This prevents goods shortages, which often trigger local inflation.

The results of this study are in line with previous studies conducted by (Nasihah & Sudirman, 2025), which state that there is an influence between port infrastructure and sea toll performance in Indonesia.

The Effect of Logistics Connectivity on Sea Toll Performance in Indonesia

Based on a review of the literature and several relevant previous studies, it can be concluded that logistics connectivity has an effect on sea toll performance in Indonesia.

To achieve and improve the performance of sea tolls in Indonesia, management or relevant stakeholders can implement or pay attention to logistics connectivity, which includes: 1) Frequency of ship visits: Sea Toll Management, together with the Ministry of Transportation and shipping operators, needs to adjust schedules and increase ship visit frequency on strategic routes, especially in 3T (underdeveloped, frontier, and outermost) areas; 2) Hinterland accessibility: Stakeholders need to improve port connectivity with hinterland areas through the construction and improvement of road and bridge infrastructure, as well as integration with logistics centers and industrial areas; 3) Transit time: Management needs to reduce logistics transit time through optimization of shipping routes, reduction of ship waiting time at ports, and implementation of an integrated digital system for real-time planning and monitoring of goods movement; 4) Multimodal integration index: Stakeholders need to develop multimodal integration (sea-land-air) through the provision of modal transfer facilities, harmonization of regulations, and development of an integrated logistics information system.

If management or relevant stakeholders can implement these four aspects of logistics connectivity, it will have an impact on the performance of sea tolls in Indonesia, including: 1) Price disparities: When the distribution flow from ports to inland markets becomes smooth, the cost savings will be reflected in lower selling prices for goods in the community; 2) Timeliness: With fixed frequencies and synchronized multimodal integration, estimates of when goods will reach consumers become highly accurate. This timeliness eliminates stock uncertainty, which speculators often use to raise prices in remote areas; 3) Load factor: The easier the access to ports, the greater the interest in filling ships with return cargo, thereby increasing the efficiency of ship subsidies as ships do not return empty; 4) Availability of goods: The community no longer needs to worry about shortages of basic goods during bad weather or technical problems, as the connectivity system has created a resilient supply chain with regular logistics reserves.

The results of this study are in line with previous studies conducted by (Susanto et al., 2021), which state that there is an influence between logistics connectivity and sea toll performance in Indonesia.

The Effect of Fleet Capacity on Sea Toll Performance in Indonesia

Based on a review of the literature and several relevant previous studies, it can be concluded that fleet capacity affects sea toll performance in Indonesia.

To achieve and improve the performance of sea tolls in Indonesia, management or relevant stakeholders can implement or pay attention to fleet capacity, which includes: 1) Deadweight tonnage or TEUs: Stakeholders must ensure that the size of the ships deployed is in line with market demand on the route. The use of ships with larger capacities (e.g., an increase from 100 TEUs to 300 TEUs) will create *economies of scale*; 2) Condition and age of ships: Management must periodically rejuvenate the fleet. Younger ships have higher engine reliability and lower maintenance costs; 3) Ship speed: Stakeholders need to set minimum speed standards for Sea Toll ships so that *voyage time* between ports remains competitive; 4) Fleet type and specifications: Management must match the type of ship to the characteristics of the commodities and facilities at the destination port. For example, providing ships with their own *cranes* (*self-discharging*) for ports that do not yet have complete infrastructure.

If management or relevant stakeholders can implement these four aspects of fleet capacity, it will have an impact on the performance of sea tolls in Indonesia, including: 1) Price disparities: By achieving *economies of scale* through the use of ships with the right capacity and efficient engines, *freight* costs per unit will decrease. This reduction in transportation costs is a key variable in lowering the selling price of basic commodities in the 3TP region, thereby narrowing the price gap with Java; 2) Timeliness: Vessels in prime condition and with stable speeds will ensure on-time performance. This reduces uncertainty in the supply chain and ensures that goods arrive at their destination port on schedule; 3) Load factor: Adjusting fleet specifications (such as ships capable of transporting specific local commodities) will encourage local entrepreneurs to use ship space; 4) Availability of goods: Ships with adequate

DWT/TEU capacity ensure that all demand for basic goods in a region can be transported in one voyage. This prevents *backlogs* or accumulation of goods at the port of origin, so that stocks of goods in remote markets are maintained throughout the year.

The results of this study are in line with previous studies conducted by (Sulistiana, 2023), which state that there is an influence between fleet capacity and sea toll performance in Indonesia.

Conceptual Framework

Based on the problem formulation, relevant previous studies, results, and discussion of the above research, the following conceptual framework was determined:

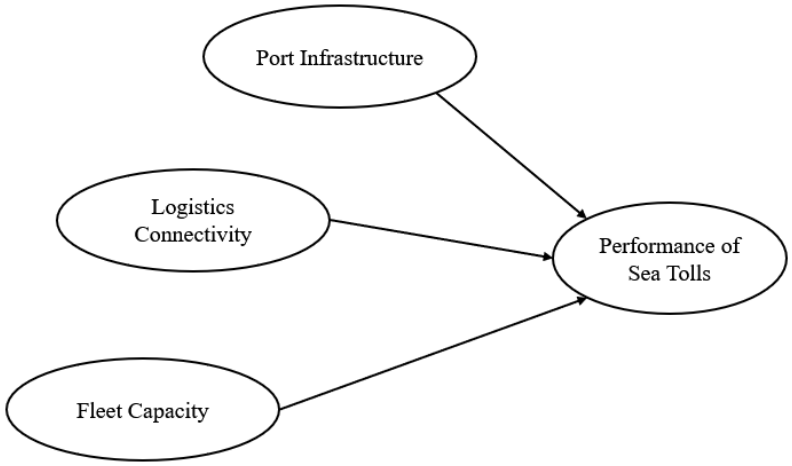

Figure 2. Conceptual Framework.

Based on Figure 2 above, port infrastructure, logistics connectivity, and fleet capacity influence the performance of sea tolls in Indonesia. In addition to the independent variables above that influence the dependent variable (Sea Toll Performance), there are other variables that influence Sea Toll Performance, including:

a) Government Policy: (Rakhmawati et al., 2023), (Effendi et al., 2022), (Kurniawan, 2023).
b) Logistics Information System: (Simpony et al., 2022), (Putri et al., 2023), (Sahara & Romadona, 2024).
c) Human Resource Quality: (Murgani & Hasibuan, 2022), (Magga, 2023), (Harma & Amir, 2025).

5. Conclusion

Based on the research question, results, and discussion above, the conclusion of this study on sea toll roads in Indonesia is:

1) Port infrastructure affects the performance of toll roads in Indonesia. Where limitations in channel depth, dock capacity, loading and unloading facilities, and storage areas remain major obstacles to improving the operational efficiency and utilization of Sea Toll ships, so good training infrastructure is needed to support the performance of sea tolls.
2) Logistics connectivity affects toll road performance in Indonesia. Low ship visit frequency, limited hinterland accessibility, long transit times, and weak intermodal integration have resulted in suboptimal goods distribution and stagnant cargo volumes.
3) Fleet capacity affects toll road performance in Indonesia. Where the mismatch between ship carrying capacity and potential cargo demand, as well as low backhaul, results in relatively low ship load factors.

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