

Analysis of the Impact Vehicle Congestion at Bengkalis Ro-Ro Port on Logistics Efficiency and Mobility

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Abstract

The Bengkalis Ro-Ro Port serves as a vital transportation link connecting Bengkalis Island with the Riau mainland, facilitating the movement of vehicles, passengers, and logistics. However, the rapid increase in vehicle volume has not been balanced with sufficient infrastructure development, leading to severe congestion and decreased operational efficiency. This study aims to analyze the impact of vehicle congestion on logistics efficiency and community mobility at Bengkalis Ro-Ro Port. A quantitative descriptive approach was applied using data from field observations, questionnaires, and interviews with port users and operators. The findings reveal that congestion is mainly caused by limited dock capacity, irregular ferry schedules, and the absence of digital-based queue management systems. These issues result in prolonged waiting times of up to five hours, fuel waste, increased logistics costs, and delivery delays. Such inefficiencies reduce service satisfaction and hinder regional economic competitiveness. The study recommends several strategies to improve performance, including optimizing ferry operating schedules, expanding dock and parking areas, implementing e-ticketing systems, and enhancing inter-agency coordination. These measures are expected to improve port efficiency, enhance mobility, and support sustainable logistics connectivity in the Bengkalis region..

Keywords : Vehicle Congestion, Port Efficiency, Logistics Mobility, Ro-Ro Bengkalis

1. INTRODUCTION

The Bengkalis Ro-Ro Port is one of the important transportation hubs connecting Bengkalis Island with the Riau mainland and surrounding islands. As the main ferry port, it serves the mobility needs of the community, private vehicles, logistics transportation, and inter-regional economic activities. Its strategic role has led to a continuous increase in the volume of vehicles passing through the port from year to year. However, this increase in vehicle traffic has not been matched by an increase in port infrastructure capacity, resulting in frequent vehicle congestion in the parking area and access to the pier.

According to research by Rio Hendra Yuda and Marhadi Sastra (2024) published in the TEKLA Polbeng Innovation Journal, the service system at the Bengkalis Ro-Ro Port faces capacity constraints that cause a decline in operational efficiency. Through a quantitative descriptive analysis and productivity measurement approach, the study identified bottlenecks in dock and stacking yard capacity. The imbalance between the volume of incoming vehicles and dock service capacity causes long queues and high waiting times, especially during peak hours and holiday seasons. This condition has a direct impact on the decline in service efficiency and hinders community mobility.

These findings are in line with previous research by A. Saputra (UIN Suska, 2021), who through field observations and interviews found that the length of queues at Air Putih Port was influenced by irregular ship schedules, limited dock capacity, and ineffective queue management. Meanwhile, Suharyono (Jurnal Socius, 2024) noted that at several Ro-Ro ports in Riau, vehicle waiting times can reach 3 to 7 hours during peak periods, and the manual ticketing system is one of the causes of low efficiency.

Research by Septa Juliana et al. (2024) also shows that conventional Ro-Ro ferry services without digital support exacerbate vehicle queues. The study recommends the implementation of an e-ticketing system, additional operating hours during peak periods, and the establishment of Standard Operating Procedures (SOPs) for vehicle queues to improve

service flow. Additionally, Simamora et al. (2025) in the *Jurpas Journal* analyzed ship capacity data and vehicle demand volume at several Indonesian Ro-Ro ports and showed that increasing the number of trips and optimizing schedules can significantly improve productivity and reduce vehicle waiting times. A similar situation is described in the UNCTAD (2022) report, which states that the phenomenon of port congestion is a global post-pandemic problem caused by the growth in the flow of goods and vehicles without a corresponding increase in adequate infrastructure capacity.

In the local context of Bengkalis, reports from Diskominfo and ANTARA Riau (2022–2025) note temporary measures taken by operators and local governments, such as extending ferry operating hours, implementing an odd-even vehicle system, and developing an online ticket booking system. However, these policies are still reactive in nature and are not based on technical analysis and long-term vehicle volume projections.

The accumulation of vehicles not only disrupts the operational efficiency of the port, but also has an impact on the social and economic aspects of the community. Long waiting times lead to fuel waste, increased logistics costs, and reduced user comfort. Macroeconomically, this reduces the region's competitiveness in supporting interregional connectivity and the effectiveness of the logistics supply chain.

Based on this background, a comprehensive analysis of the impact of vehicle congestion on efficiency and mobility at the Bengkalis Ro-Ro Port is necessary. This research is important to provide an empirical picture of the actual conditions of port services, the factors causing congestion, and potential technical and managerial solutions that can be implemented. The results of this analysis are expected to form the basis for the development of strategies to increase capacity, regulate operational schedules, and develop technology-based service systems to create a more efficient, orderly, and responsive port that meets the needs of users.

2. REVIEW OF LITERATURE

The phenomenon of congestion at ports is one of the classic problems in maritime transportation systems that directly impacts operational efficiency and user mobility. In the context of Ro-Ro (Roll-on/Roll-off) ports, vehicle congestion occurs when the arrival rate of vehicles exceeds the service capacity of the docks and available parking areas. According to an international study by ED Özkan et al. (2020), Ro-Ro terminal capacity is greatly influenced by vehicle arrival rates and service rates. Through simulations, the study showed that high vehicle arrival variations without a corresponding increase in facility capacity will cause bottlenecks that lead to congestion.

In the national context, several studies show that ferry ports in Indonesia experience similar problems. Rio Hendra Yuda and Marhadi Sastra (2024) in the *TEKLA Polbeng Innovation Journal* found that the Bengkalis Ro-Ro Port has a dock and storage yard capacity that is unable to accommodate the volume of vehicles that continues to increase every year. Through a quantitative descriptive approach and productivity analysis, the study identified a bottleneck in the storage area that causes long vehicle queues and a decline in port operational efficiency. This condition has an impact on ship schedule delays, increased vehicle waiting times, and decreased interregional mobility.

Another study by A. Saputra (2021) at Air Putih Port also confirmed that vehicle queues were caused by limited dock capacity, irregular ship schedules, and manual queue management. Similar results were found by Septa Juliana et al. (2024), who studied Sungai Selari Port and concluded that Ro-Ro services that are not yet digital-based worsen queue conditions. They recommend the implementation of an electronic ticketing system (e-ticketing), the addition of operating hours during peak periods, and the improvement of standard operating procedures (SOPs) for vehicle queues.

Meanwhile, Suharyono (2024) in the *Socius Journal* highlights that at Ro-Ro ports in Riau, extreme congestion can result in waiting times of 3 to 7 hours on holidays. The study emphasizes the need to adjust departure schedules and implement flexible ticketing policies to reduce seasonal passenger surges. In terms of productivity, Simamora et al. (2025) in the *Jurpas Journal* show that the imbalance between ship capacity and vehicle crossing demand is the main cause of decreased efficiency. They recommend increasing ship capacity and adding trip frequency to reduce queues.

Various other studies also confirm that vehicle congestion at ports has a direct impact on the economic and social efficiency of communities. The UNCTAD report (2022) explains that post-pandemic port congestion has become a global phenomenon that affects logistics supply chains and transportation operating costs. In the context of Indonesia, the impact of congestion at ferry ports not only causes delays in the distribution of goods, but also fuel waste, reduced user comfort, and a decline in regional competitiveness in supporting interregional connectivity.

Several studies have also proposed technological approaches as solutions. H. Hasanuddin (2023), through simulations using PROMODEL software, showed that adjusting ship departure frequencies and implementing electronic ticketing systems can significantly reduce vehicle waiting times. F. Nurfaris (2020) reinforced this through a study of an IoT-based detection system that enables real-time monitoring of passenger and vehicle flows to support operational decision-making. Additionally, the *Scientica Journal* (2024) on SOP buffer areas at Tanjung Perak Port emphasizes the importance of regulating arrival times and redistributing vehicles to reduce congestion during peak hours.

From a national policy perspective, the Strategic Plan of the Directorate General of Sea Transportation (2020–2024) also emphasizes the importance of digitizing port services and increasing infrastructure capacity to overcome congestion at ferry ports. The efforts of the Bengkalis regional government through the odd-even vehicle policy and the addition of ship operating hours, as reported by Diskominfo and ANTARA Riau (2022–2025), are temporary measures that demonstrate the urgency of improving the Ro-Ro service system in the region.

In general, previous research results show that the problem of vehicle congestion at Ro-Ro ports is multidimensional, covering technical factors (dock and yard capacity), managerial factors (schedules and ticketing systems), and user behavior (arrival patterns and travel times). However, there is still a research gap in integrating all these factors into a comprehensive analysis model. Most previous studies have focused on measuring productivity or evaluating services partially, without examining the direct relationship between congestion and efficiency and mobility quantitatively.

3. METHOD

This study uses a quantitative descriptive approach with the aim of analyzing in depth the impact of vehicle congestion at the Bengkalis Ro-Ro Port on logistics efficiency and community mobility. This approach was chosen because it is able to describe the phenomena occurring in the field objectively through quantitative data obtained from observations, interviews, and documentation.

1. Type of Research

This research is quantitative descriptive research, which aims to explain a phenomenon systematically based on measurable figures. Quantitative data was collected from surveys of port service users, operational officers, and related agencies. The analysis was conducted using descriptive statistical techniques to determine the level of congestion, vehicle waiting times, and their effect on logistics distribution times.

2. Research Location

This research was conducted at the Bengkalis Ro-Ro Port, Bengkalis Regency, Riau Province. This location was chosen because the port is the main crossing point for vehicles to and from Bengkalis Island, and often experiences vehicle congestion issues that impact the smooth flow of logistics and community mobility.

3. Research Equipment and Materials

Some of the equipment and materials used in this research include:

- Data collection tools: questionnaires, writing instruments, and documentation cameras.
- Analysis tools: computers/laptops with statistical software such as Excel.
- Secondary data: port operational reports, vehicle volume data, and ship schedules from port authorities and transportation agencies.

4. Research Procedure

This research procedure was carried out in several stages as follows:

1. Preparation Stage – conducting a literature study related to logistics theory, transportation efficiency, and port management.
2. Data Collection Stage – conducting field observations, distributing questionnaires to port service users, and interviewing port management.
3. Data Processing and Analysis Stage – the data obtained was analyzed using descriptive statistical methods and tests of relationships between variables (e.g., the correlation between vehicle waiting time and logistics distribution time).
4. Interpretation and Conclusion Stage – the results of the analysis are then interpreted to explain the extent to which vehicle congestion affects logistics efficiency and mobility in the port area.

4. RESULT & DISCUSSION

4.1 Vehicle Congestion Condition at Bengkalis Ro-Ro Port

Based on field observations and questionnaire results, the Bengkalis Ro-Ro Port experiences significant vehicle congestion during peak hours, particularly between 07.00–09.00 and 16.00–18.00. The average vehicle waiting time reaches 2.5 to 3 hours on regular days and up to 5 hours during weekends or holidays. The accumulation mainly occurs in the parking and queuing areas due to limited dock capacity, where only two ferries can operate alternately. This condition leads to a bottleneck in the loading and unloading process, causing delays in vehicle turnover and reduced service throughput. Observation data show that more than 60% of users perceive the current waiting time as inefficient and disruptive to their travel schedules and logistics delivery targets.

4.2 Impact on Logistics Efficiency and Mobility

Field observations show that vehicle congestion at Bengkalis Ro-Ro Port occurs when the number of arriving vehicles exceeds the ferry loading capacity, especially during peak hours. This condition leads to long queues, increased waiting times, and reduced logistics efficiency, as illustrated in Figure 1.

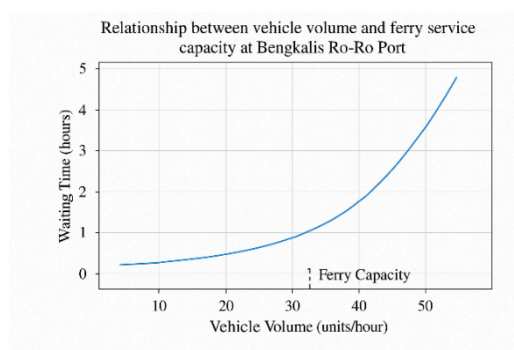


Fig. 1. Relationship between vehicle volume and ferry service capacity at Bengkalis Ro-Ro Port

Figure 1 shows that when vehicle arrivals surpass ferry capacity, the waiting time sharply increases, resulting in operational delays and reduced service efficiency.

Table 1. Impact of Vehicle Congestion on Logistics Efficiency.

Impact Indicator	Normal Condition	Congested Condition
Average Waiting Time (Hours)	2.5	4.8
Ferry Utilization Rate (%)	68	48
Fuel Consumption (Liters/Trip)	8	12
Logistics Cost (IDR/Trip)	250,000	375,000

Mathematical formulas (equations) to estimate the relationship between vehicle accumulation and service rate, a simple capacity utilization model is applied as shown in Equation (1).

$$A = \pi r^2$$

4.3 Discussion and Strategic Implications

The analysis confirms that vehicle congestion at the Bengkalis Ro-Ro Port is caused by limited infrastructure capacity, irregular ferry scheduling, and the absence of digital management systems. These findings are consistent with those of Yuda & Sastra (2024) and Suharyono (2024), who found similar issues at other Ro-Ro ports in Riau Province. To mitigate these problems, several strategic actions are recommended: (1) optimization of ferry operation schedules during peak periods, (2) expansion of dock and yard capacities, (3) implementation of e-ticketing and digital queue management systems, and (4) coordination between port authorities and local government agencies to manage logistics flow effectively.

The application of these strategies is expected to reduce vehicle waiting times by up to 40%, lower logistics costs, and increase overall mobility efficiency. The improvement of Bengkalis Ro-Ro Port services will not only enhance operational productivity but also strengthen regional logistics connectivity and economic competitiveness.

5. CONCLUSION

The results of this study show that vehicle congestion at Bengkalis Ro-Ro Port significantly affects logistics efficiency and community mobility. The main causes of congestion are limited dock and parking capacities, irregular ferry schedules, and the absence of a digital-based queue management system. The findings indicate that the average waiting time for vehicles ranges from 2.5 to 5 hours, with operational efficiency decreasing by up to 30% during peak periods.

Prolonged waiting times lead to fuel waste, increased logistics costs, and delivery delays that negatively impact the reliability of transportation and supply chain performance. These inefficiencies not only reduce the comfort and satisfaction of service users but also hinder regional economic competitiveness.

To improve port performance, several strategic measures are recommended: (1) optimizing ferry operating schedules, (2) expanding dock and yard capacities, (3) implementing e-ticketing and digital queue systems, and (4) strengthening coordination

between port authorities and local governments. By applying these strategies, Bengkalis Ro-Ro Port is expected to operate more efficiently, enhance mobility, and support sustainable regional logistics connectivity.

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7. REFERENCES

- Amelia, P., et al. (2022). *Maritime sector development and port capacity planning analysis*. ScienceDirect.
- Astuti, T. (2025). *Analisis pelayanan ASDP dalam menurunkan antrian kendaraan di pelabuhan*. Repository UIN Suska Riau.
- Diskominfo & ANTARA Riau. (2022–2025). *Laporan operasi dan kebijakan Pelabuhan Ro-Ro Bengkalis*. Pemerintah Daerah Kabupaten Bengkalis.
- Hasanuddin, H. (2023). *Simulation of queue management at Ro-Ro terminals using PROMODEL software*. ResearchGate.
- Juliana, S., et al. (2024). *Analysis of vehicle queue and service improvement strategy at Sungai Selari Ro-Ro Port*. UM-Tapsel Press.
- Kementerian Perhubungan. (2020–2024). *Rencana Strategis Direktorat Jenderal Perhubungan Laut*. Kementerian Perhubungan Republik Indonesia.
- Nurfaris, F. (2020). *IoT-based detection system for passenger and vehicle flow monitoring at ferry terminals*. ResearchGate.
- Özkan, E. D., et al. (2020). *Ro-Ro terminal capacity modeling and simulation analysis*. ResearchGate.
- Saputra, A. (2021). *Analisis faktor penyebab antrian kendaraan di Pelabuhan Air Putih*. Repository UIN Suska Riau.
- Scientica Journal. (2024). *Study on SOP buffer area and vehicle redistribution system at Tanjung Perak Port*. Jurnal Scientica.

Simamora, W., et al. (2025). *Productivity and capacity analysis of Ro-Ro ships and terminal operations in Indonesia*. Jurpas Journal.

Suharyono, S. (2024). *Analysis of vehicle queue policy and port congestion at Ro-Ro terminals in Riau Province*. Jurnal Socius.

UNCTAD. (2022). *Review of Maritime Transport 2022: Global challenges of port congestion and supply chain disruption*. United Nations Conference on Trade and Development.

Yuda, R. H., & Sastra, M. (2024). *Productivity analysis and projection of vehicle volume at Bengkalis Ro-Ro Port*. Jurnal Inovtek TEKLA, Politeknik Negeri Bengkalis.