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Operational Management of Ro-Ro Ferry Services to Improve Crossing Service Efficiency on the Bengkalis–Sungai Pakning Route

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Abstract. Roll-on/Roll-off (Ro-Ro) ferry transportation plays an important role in supporting community mobility and logistics distribution in the coastal areas of Bengkalis Regency. One of the main issues on the Bengkalis–Sei. Paking route is the suboptimal efficiency of the ship's berthing time, which affects vehicle queues, departure delays, and reduces the quality of the ferry service. This study aims to analyze the efficiency of the Ro-Ro ship turnaround time on the Bengkalis–Sei. Paking route and identify the factors affecting delays in the loading and unloading process of vehicles. This research method uses a descriptive quantitative approach thru field observations, measurement of ship operational times, and statistical analysis of arrival times, unloading times, loading times, and ship departure times. The research shows that the average berthing time of the ships ranges from 38 to 52 minutes, exceeding the regional ferry port operational standard set between 30 to 45 minutes. The main factors causing inefficiency include disorganized vehicle queues, limited dock capacity, weather conditions, and suboptimal port operational coordination. Analysis shows that the implementation of a digital queue system, vehicle pattern management, and optimization of loading and unloading procedures can reduce berthing time by 15–20%. This research is expected to serve as a basis for recommendations to improve the efficiency of ferry transportation services in Bengkalis Regency.

Keywords: Management, Ro-Ro Ship, Berthing Time, Operational Efficiency, Ferry Terminal

1. Introduction

Maritime transport plays a strategic role in supporting the connectivity of the archipelagic regions in Indonesia. As the largest archipelagic country in the world, Indonesia heavily relies on the maritime transport system to support community mobility, logistics distribution, and interregional economic growth. One of the maritime transportation modes widely used in the archipelagic region is the Roll-on/Roll-off (Ro-Ro) ship, which is designed to transport vehicles and passengers directly thru a ramp door system, allowing for faster and more efficient loading and unloading processes compared to conventional ships [1]. Ro-Ro ships play an important role in facilitating inter-island transportation in Indonesia. With its ability to transport vehicles and passengers directly, this ship enables easier and more efficient mobility for the community and distribution of goods. Thus, Ro-Ro ships have become one of the effective maritime transportation solutions in supporting economic growth and inter-regional connectivity in Indonesia, which consists of thousands of islands.

Bengkalis Regency is one of the island regions in Riau Province that has quite high ferry transportation activity. The Bengkalis–Sungai Paking ferry route has become a strategic corridor connecting Bengkalis Island with the Sumatra mainland. This route serves as the main pathway for community mobility, goods distribution, logistics vehicles, and supports the daily economic and social activities of the community. The high level of transportation activity on that route has led to an increasing demand for fast, safe, and efficient ferry services. According to the [2], the operational efficiency of ports and ferries is an important factor in supporting the smooth functioning of the logistics and maritime transportation system. One of the main indicators of port operational efficiency is the berthing time, which is the duration a ship remains at the dock from the berthing process until the ship leaves the port. The shorter the berthing time, the higher the operational productivity of the port and the better the level of ferry transportation service [3].

However, in the operation of Ro-Ro ships on the Bengkalis–Sei. Paking route, several obstacles are still found that cause the berthing time of the ships to be longer. The condition of vehicle queues during peak hours often causes delays in the embarkation and debarkation processes. In addition, the limited capacity of the port parking area, weather conditions, tidal fluctuations, and operational coordination between port staff and ship operators

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also affect the efficiency of the ferry service. [3, 4] research states that delays in the loading and unloading process of vehicles on Ro-Ro ships can increase the ship's operational costs and reduce the quality of ferry services. In addition, research explains that low operational efficiency in ferry transportation can lead to increased vehicle waiting times, long queues at the port, and decreased satisfaction among maritime transport users.

On the Bengkalis–Sei. Paking route, there are four Ro-Ro ships operating with the support of two docks at each port. The presence of these two docks is expected to increase service capacity and reduce queues of ships and vehicles. However, in its operational practice, delays in ship berthing times are still found, especially during peak hours and adverse weather conditions. Therefore, an analysis of the efficiency of Ro-Ro ship berthing times is needed to determine the operational performance level of the Bengkalis–Sei. Paking crossing and to establish strategies for optimizing port services.

The performance of vessel berthing operations at ferry terminals is inextricably linked to operational efficiency in Ro-Ro ferry service. Berthing time is one of the main operating indicators in ferry transportation systems since it shows how well loading, unloading, maneuvering, and dock service operations are carried out. Reduced berthing times are a sign of better ferry service productivity, increased vessel rotation, and smoother operational flow. Operational delays at ferry ports have a substantial impact on passenger mobility, logistics distribution, and overall maritime transport performance, according to [4]. This study focuses on berthing time because it is the most measurable and operationally significant parameter on the Bengkalis–Sungai Pakning crossing route, even though operational efficiency may also be represented by other indicators like vessel utilization, passenger waiting time, and turnaround productivity. Vehicle loading and unloading operations, vehicle queue density, and dock maneuvering circumstances all have a significant impact on the route's operational characteristics. As a result, berthing time analysis is thought to be suitable for assessing the ferry service system's operational effectiveness in this study.

Effective vessel berthing procedures at ferry terminals are intimately linked to operational efficiency in Ro-Ro ferry service. Because berthing time directly affects loading, unloading, maneuvering, and dock service performance, it is commonly acknowledged as one of the key operational indicators in ferry transportation systems. Smoother ferry operations, quicker vessel rotation, and increased service productivity are all indicated by shorter berthing times. When assessing ferry service performance, additional operational metrics including turnaround productivity, vessel utilization, and passenger waiting times are crucial. But as berthing time is thought to be the most important operational factor on the Bengkalis–Sei. Pakning ferry route, our study concentrates on it in particular. Berthing time is the most pertinent indicator for assessing operational efficiency in this study since vehicle loading and unloading activities, vehicle congestion, and berth operational circumstances all have a significant impact on the operational features of this route.

2. Methodology

This research was conducted on the Roll-on/Roll-off (Ro-Ro) ferry crossing route between Bengkalis and Sungai Pakning, located in Bengkalis Regency, Riau Province, Indonesia. The study focused on operational activities at the Ro-Ro ferry terminals, including vehicle loading and unloading processes, ship maneuvering, and vessel berthing time at the dock. The Bengkalis–Sungai Pakning route is one of the main transportation corridors connecting Bengkalis Island with the mainland of Sumatra and plays an important role in supporting passenger mobility and logistics distribution. This study employed a descriptive quantitative approach combined with field operational observations to evaluate the efficiency of Ro-Ro ferry services on the Bengkalis–Sungai Pakning route. The quantitative analysis focused on measuring operational parameters including vehicle unloading time, loading time, maneuvering/waiting time, total berthing time, and operational efficiency percentages.

Figure 1. Loading and unloading activities of Roro ships at Sungai Selari Port, Bengkalis

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This study employed a quantitative descriptive method with a field study approach to analyze the operational efficiency of Ro-Ro ferries based on observed operational data. According to [5] quantitative descriptive research aims to systematically describe phenomena using numerical data analyzed through statistical methods. The research object consisted of four Ro-Ro ferries operating on the Bengkalis–Sungai Pakning crossing route, where two vessels operated from Bengkalis Port and two vessels operated from Sungai Pakning Port. In addition, the study also covered operational activities at the two active berths available at each port.

Data collection was carried out using observation, documentation, interviews, and literature review techniques. Direct field observations were conducted to obtain operational data such as vehicle unloading time, loading time, ship maneuvering time, and total berthing time [6,7]. Documentation activities included recording the number of vehicles, vehicle types, ferry departure schedules, and operational conditions at the ports. Interviews were conducted with ferry operators, port officers, and vehicle traffic controllers to identify factors affecting berthing efficiency. Furthermore, literature studies were conducted using books, scientific journals, regulations, and maritime transportation references related to Ro-Ro ferry operations and port efficiency. In general, Ro-Ro ships operating on the Bengkalis–Sei. Pakning route have the following characteristics:

Table 1. Characteristics of Operational Parameters for the Bengkalis-Sungai Pakning Route

Parameter	Description
Vessel Type	Roll-on/Roll-off (Ro-Ro)
Main Function	Passenger and vehicle transportation
Loading and Unloading System	Ramp door
Cargo	Motorcycles, passenger cars, trucks, and passengers
Operational Route	Bengkalis–Sei. Pakning
Number of Berths	2 berths at each port
Number of Operating Vessels	4 ferries

The variables analyzed in this study included vehicle unloading time (Tb), vehicle loading time (Tm), maneuvering or waiting time (Tt), total berthing time (Ts), and operational efficiency (E). The total berthing time of the ferry was calculated using the following equation [8]:

$$T_s = T_b + T_m + T_t \quad (1)$$

where:
Ts = Total berthing time of the vessel
Tb = Vehicle unloading time
Tm = Vehicle loading time
Tt = Maneuvering/waiting time

The average berthing time was calculated using the following equation [9]:

$$\bar{T_s} = \frac{\sum T_s}{n} \quad (2)$$

where:

$\bar{Ts}$ = Average berthing time
$\sum Ts$ = Total berthing time of all observed vessels
n = Number of observed vessels

Operational efficiency was analyzed by comparing the standard berthing time with the actual berthing time using the following equation:

$$E = \frac{T_{standar}}{T_{actual}} \times 100\% \quad (3)$$

where:
E = Operational efficiency (%)
Tstandard = Standard berthing time
Tactual = Actual berthing time

The research stages began with problem identification related to Ro-Ro ferry operational efficiency, followed by literature review, field data collection, operational data processing, berthing time efficiency analysis, identification of factors causing delays, and formulation of operational improvement recommendations [11], [12].

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The collected data were analyzed descriptively to evaluate the operational performance of Ro-Ro ferries and identify strategies for improving crossing service efficiency on the Bengkalis–Sungai Pakning route.

According to International Maritime Organization, efficient port and ferry operations are essential for improving maritime logistics systems and reducing operational delays in ferry transportation services. Therefore, this study is expected to contribute to improving operational management and service quality in Indonesian ferry transportation systems.

3. Result and Discusion

3.1 Operational Conditions of the Bengkalis–Sungai Paking Port and Ro-Ro Ship

The Bengkalis–Sungai Paking ferry route is operated using four Ro-Ro ships with the support of two main docks at each port. This operational system aims to expedite the loading and unloading process of vehicles and reduce vehicle queues during peak hours. At Bengkalis Port, there are two active berths that are used alternately for incoming and outgoing ship services. Similarly, at Paking Port, there are two operational berths that support the smooth flow of vehicle and passenger transportation [13]. The Ro-Ro ferry route Bengkalis–Pakning has a sailing distance of about 3–5 nautical miles or ±5–9 km, connecting Bengkalis Island with the Pakning area on the Sumatra mainland. With a relatively short sailing distance, the operation of Ro-Ro ships on this route is greatly influenced by the efficiency of docking time and the loading and unloading process of vehicles at the port. The high frequency of ship departures makes the Bengkalis–Pakning route one of the important ferry transportation routes in Bengkalis Regency.

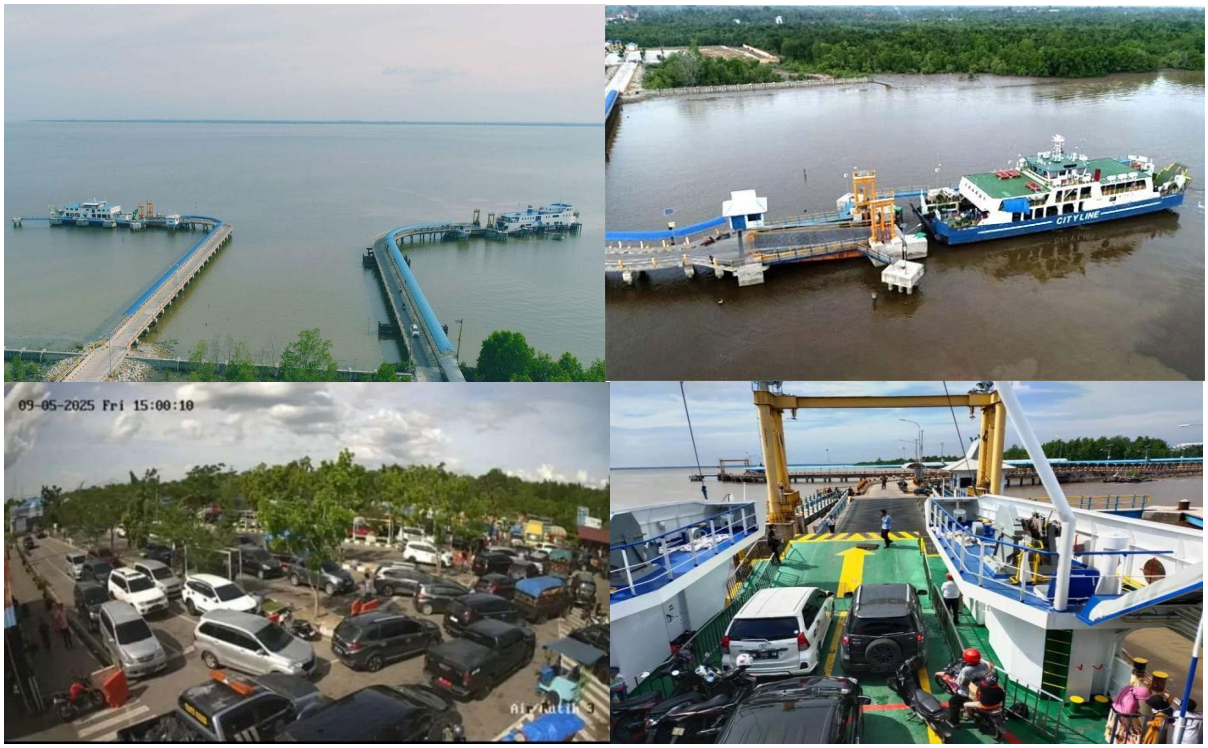

Figure 2. Operational Conditions of the Bengkalis–Sungai Pakning Ro-Ro Port and Ship Bengkalis Sungai Pakning ferry terminal
Source: Department of Transportation, Bengkalis Regency Bengkalis

The presence of two port at each port provides operational advantages such as: 1. Reducing the waiting time for ships to port 2. Accelerating ship rotation 3. Reducing vehicle queues at the port 4. Increasing the capacity of ferry services . The high volume of vehicles, weather, and coordination of loading and unloading activities all affect operational efficiency in certain situations [18]. Therefore, to maintain operational smoothness, sea vessels must adhere to the rules and regulations in effect at the port. Thus, the crossings can operate more efficiently and reduce the likelihood of congestion. With greater awareness and cooperation from all parties, the port is expected to operate more efficiently and provide the best service for all maritime transport users.

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3.2 Operational Data of Four Ro-Ro Ships

The research was conducted on four Roll-on/Roll-off (Ro-Ro) ships operating on the Bengkalis–Pakning route. The ship operations consist of two ships departing from Bengkalis Port and two other ships from Pakning Port. Each port has two active berths used to support the smooth unloading and loading process of vehicles and to expedite the ship service rotation. Observations were made on several operational parameters of the ships , including vehicle unloading time, vehicle loading time, ship maneuver/waiting time, and total berthing time at the dock. According to the International Maritime Organization, the operational analysis of ferry vessels is very important to determine the level of port service efficiency and maritime transport productivity.

Table 2. Operation of Roro Ships at Air Putih Port (Bengkalis) - Selari Port (Sei. Pakning)

Vessel	Operational Port	Unloading Time (minutes)	Loading Time (minutes)	Maneuver/Waiting Time (minutes)	Total Berthing Time (minutes)
KMP Swarna Putri (A)	Port 1 Bengkalis	14	18	6	38
KMP Lestari 2 (B)	Port 2 Bengkalis	17	21	8	44
KMP Bahari (C)	Port 1 Sei. Pakning	19	24	9	49
KMP Domar (D)	Port 2 Sei. Pakning	15	20	7	50

Based on the operational data, it is evident that the ships operating from Bengkalis have lower docking times compared to the ships operating from Pakning. Ship A has the lowest total docking time of 38 minutes, while Ship D has the highest docking time of 50 minutes. Therefore, the total docking time of the operating ro-ro ships can be calculated as follows.

$$\bar{T_s} = \frac{38 + 44 + 49 + 50}{4} = 45.25 \text{ minute}$$

The operational analysis indicates that the average berthing time of Ro-Ro ferries on the Bengkalis–Sungai Pakning route reached 45.25 minutes, exceeding the regional ferry operational standard of 35–40 minutes. Ferries operating from Bengkalis demonstrated shorter berthing times compared to ferries operating from Sungai Pakning due to more organized vehicle queues and lower dominance of logistics vehicles. According to [19] oceanographic factors such as currents, tides, and waves have an impact on the berthing process of ships at the ferry terminal.

The operational inefficiency was mainly influenced by vehicle congestion, high volumes of logistics trucks, limited parking areas, and manual queue management systems. In addition, environmental factors such as weather conditions and tidal fluctuations also contributed to operational delays, particularly during vessel maneuvering and docking processes. However, in this study, environmental variables were analyzed descriptively through field observations and interviews rather than through quantitative environmental modeling. Therefore, optimizing vehicle management, digitizing the queue system, and improving port operational management are essential to enhance the efficiency of ferry transportation services. Therefore, optimizing vehicle arrangements, digitizing queue systems, and improving port operational management are essential to enhance the efficiency of ferry transportation services.

3.3 Management of Berthing Time Efficiency

The operational efficiency of the ship is calculated using the comparison between the standard berthing time and the actual berthing time of the ship. Assuming a standard berthing time of 35 minutes, the efficiency of each ship is obtained as follows:

KMP Swarna Putri (A) $= E_A = \frac{35}{38} \times 100\% = 92.1\%$

KMP Lestari 2 (B) $= E_B = \frac{35}{44} \times 100\% = 79.5\%$

KMP Bahari (C) $= E_C = \frac{35}{49} \times 100\% = 71.4\%$

KMP Domar (D) $= E_D = \frac{35}{50} \times 100\% = 70.0\%$

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Table 3. Operational Efficiency of Ro-Ro Ferries on the Bengkalis–Sungai Pakning

Vessel	Operational Origin	Total Berthing Time	Efficiency (%)
KMP Swarna Putri (A)	Bengkalis	38 minutes	92.1
KMP Lestari 2 (B)	Bengkalis	44 minutes	79.5
KMP Bahari (C)	Sei. Pakning	49 minutes	71.4
KMP Domar (D)	Sei. Pakning	50 minutes	70

The Table 3. shows that KMP Swarna Putri (A) had the highest operational efficiency with a berthing time of 38 minutes and an efficiency value of 92.1%. Meanwhile, KMP Domar (D) recorded the longest berthing time of 50 minutes with the lowest efficiency value of 70.0%. Overall, ferries operating from Bengkalis showed better operational performance than ferries from Sungai Pakning due to faster loading and unloading processes and lower vehicle congestion at the port area. The research results show that ships operating from Bengkalis have a higher efficiency level compared to ships from Pakning. This is influenced by the more orderly vehicle queue conditions and the dominance of light vehicles at the Bengkalis port. Conversely, ships from Pakning have a longer berthing time due to the dominance of logistics vehicles and heavy vehicles that require more loading time. Additionally, the vehicle congestion in the Pakning port area also causes delays in the vehicle embarkation process.

The presence of two docks at each port significantly influences the smooth operation of Ro-Ro ships. The dual-dock system allows ships to berth in parallel, thereby reducing the queue of ships waiting to port. Operationally, port 1 at both ports is more frequently used for light vehicles and passenger vehicles, while port 2 tends to serve logistics vehicles and heavy vehicles. The difference in vehicle characteristics affects the loading and unloading duration of each ship.

Ship A, which operates at Pier 1 Bengkalis and Pier 1 Paking, has the shortest docking time of 38 minutes. This indicates that the traffic flow of vehicles at both piers is relatively smoother and more efficient. Conversely, Ship C, which uses a combination of Pier 1 Bengkalis and Pier 2 Sei. Paking, has the longest docking time of 50 minutes. This condition is influenced by the high volume of cargo vehicles and logistics trucks at Pier 2 Paking, causing the vehicle loading process to take longer. In addition, although there are two docks available, several operational challenges are still encountered, such as: a. Vehicle congestion in the queue lanes b. Limited vehicle parking area c. Irregularity of vehicles entering the ramp door d. Delays due to weather and tides e. Suboptimal operational coordination.

3.4 Comparison Analysis of Bengkalis and Sei. Pakning Ships

Bengkalis Port and Sei differed significantly, according to the comparative operational analysis. Sei. Pakning Port in terms of logistics density, operational management, vehicle composition, and terminal layout. Passenger cars and motorbikes, which often require shorter loading and unloading times, are the main modes of transportation used at Bengkalis Port. On the other hand, big vehicles and logistics trucks predominate at Sei. Pakning Port, necessitating lengthier loading and maneuvering periods and longer berthing times.

Operational efficiency is also impacted by variations in terminal layout conditions. Smoother boarding operations are made possible by Bengkalis Port's comparatively well managed vehicle circulation and queue arrangements. Due to a lack of parking spaces and waiting rooms, Sei. Pakning Port is increasingly congested, especially during periods of high logistics activity.

From the standpoint of operational management, Bengkalis Port's vehicle queue control and boarding coordination are comparatively better organized than Sei's operational activities. Longer wait times and erratic vehicle circulation patterns result from Pakning's continued reliance on human queue methods. Additionally, because logistics vehicles need more operational space and take longer to load than typical passenger vehicles, Sei. Pakning Port's increased logistics density greatly adds to operational delays.

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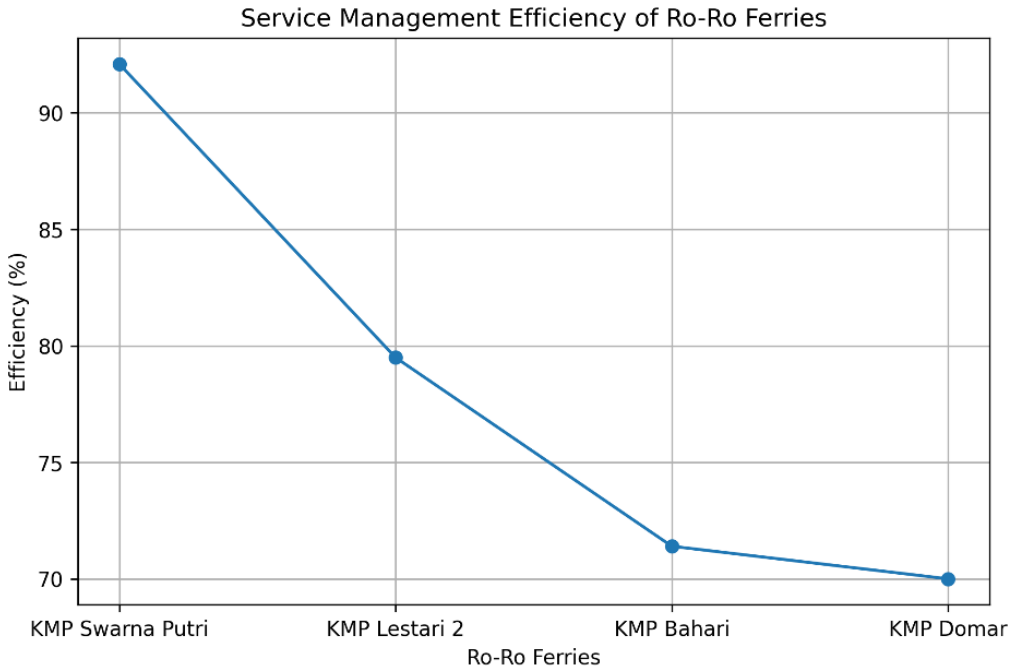

Figure 3. Service Management Efficiency Graph

The graph of service management efficiency The operational efficiency level of each Ro-Ro ferry on the Bengkalis–Sungai Pakning route is shown in **Figure 3.** With an operational efficiency of 92.1%, KMP Swarna Putri outperformed KMP Lestari 2 with 79.5%. KMP Bahari and KMP Domar, on the other hand, reported lower efficiency levels of 71.4% and 70.0%, respectively. According to the findings, ferries with quicker berthing times typically provide better service. The large number of logistical vehicles, traffic jams, and lengthy loading procedures were the primary causes of the reduced efficiency of ferries operating out of Sungai Pakning. Therefore, to increase the operational efficiency of Ro-Ro ferry services on the Bengkalis–Sungai Pakning route, port service management system optimization—such as digital vehicle queue systems, improved ferry scheduling, and maximum usage of the two available berths—is required. Additionally, streamlining the loading and unloading procedures could assist cut down on vehicle wait times by enhancing communication between the port authorities and boat operators. Putting in place real-time ferry tracking systems may also yield useful information for schedule optimization and increased productivity. The Ro-Ro ferry services on the Bengkalis–Sungai Pakning route have the potential to greatly improve their operational performance and customer satisfaction levels by addressing these important areas of concern.

Table 4. Factors Affecting Berthing Time of Ro-Ro Ferries on the Bengkalis–Sungai Pakning Route

Factor	Level of Influence	Score
Vehicle congestion	Very High	5
Logistics vehicles	High	4
Limited parking area	High	4
Weather and tidal conditions	Moderate	3
Manual operational system	High	4
Vessel maneuvering	Moderate	3

Table 4. shows the main factors affecting the berthing time of Ro-Ro ferries operating on the Bengkalis–Sungai Pakning route. Vehicle congestion was identified as the most dominant factor with the highest influence score of 5, categorized as “Very High.” This indicates that long vehicle queues at the port significantly increase loading and unloading time, ultimately affecting ferry operational efficiency. Logistics vehicles and the manual operational system were categorized as having a “High” influence with scores of 4. The dominance of heavy and logistics vehicles requires longer maneuvering and loading processes compared to regular passenger vehicles, while manual operational management reduces the effectiveness of vehicle flow and scheduling. In addition, limited parking areas also received a high influence score of 4 because insufficient parking and queue capacity often lead to congestion around the port area. Meanwhile, weather and tidal conditions, as well as vessel

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maneuvering, were categorized as having a “Moderate” influence with scores of 3. Although these factors do not occur continuously, they still affect berthing operations under certain environmental and navigational conditions. Overall, the table indicates that operational and traffic management factors are the primary causes of high berthing time on the Bengkalis–Sungai Pakning Ro-Ro crossing route.

In general, it is observed that ships operating from Sei. Pakning have longer berthing times compared to ships from Bengkalis. The increase in berthing time from Ship A to Ship D indicates that the loading and unloading process of vehicles and ship maneuvers on the Sei. Pakning route tend to take longer. This is influenced by the high volume of logistics vehicles and heavy vehicles that dominate the operations of ships from Sei. Pakning. Logistics vehicles require more space and longer arrangement time compared to light vehicles, making the vehicle embarkation process less efficient. Additionally, the condition of vehicle queues in the port area also affects the high berthing time of the ships. Ship A has a lower berthing time because the vehicle queues are relatively more organized and dominated by light passenger vehicles. On the other hand, Ship C and Ship D experience increased berthing times due to vehicle congestion and longer vehicle loading processes.

3.5 Discussion

The research results show that the berthing time of Ro-Ro ships on the Bengkalis–Sei.Pakning route is still relatively high, averaging 45.25 minutes, exceeding the operational standard of the ferry port, which is 35–40 minutes. Ships operating from Bengkalis have a shorter berthing time compared to ships from Sei. Pakning. This is because the ships from Sei. Pakning are dominated by logistics vehicles and heavy vehicles that require longer loading and unloading times. The main factors causing the high berthing time include vehicle queues, the high volume of logistics vehicles, limited port parking areas, weather and tidal conditions, and the port's operational system, which is still done manually. In addition, the vehicle loading process is the most dominant factor affecting the operational efficiency of the ship.

The presence of two port at each port has helped increase service capacity and reduce ship queues. However, the scheduling of ships and the vehicle queuing system still need to be optimized to make the ferry service more effective. Based on the research findings, the implementation of a digital queuing system, optimization of port usage, separation of logistics vehicle lanes and light vehicles, as well as improvements in port operational management can be solutions to reduce ship docking time and enhance the efficiency of the Bengkalis–Sei. Pakning ferry transportation service.

4. Conclusion

Based on the results of the study, it can be concluded that the operational efficiency of Ro-Ro ferries on the Bengkalis–Sungai Pakning route is still not optimal. The average berthing time of the four observed ferries reached 45.25 minutes, which is higher than the standard operational berthing time for regional ferry ports, estimated at 35–40 minutes. Ferries operating from Bengkalis showed better operational efficiency compared to ferries operating from Sungai Pakning due to shorter loading and unloading processes and more organized vehicle queues.

The main factors contributing to the high berthing time were vehicle congestion, the dominance of logistics and heavy vehicles, limited parking and queue areas, weather and tidal conditions, as well as manual operational management systems. Among these factors, the vehicle loading process was identified as the most dominant contributor to increased berthing time.

The availability of two operational berths at each port has helped improve ferry service capacity and reduce vessel waiting times. However, berth utilization, ferry scheduling, and vehicle queue management still require optimization to achieve better operational performance.

Therefore, implementing digital vehicle queue systems, improving operational management, separating logistics and passenger vehicle lanes, and maximizing berth utilization are recommended to reduce ferry berthing time and improve crossing service efficiency. These improvements are expected to support smoother passenger mobility and logistics distribution while enhancing the overall quality of Ro-Ro ferry transportation services on the Bengkalis–Sungai Pakning route.

Only operational observations made on four operational Ro-Ro ferries on the Bengkalis–Sungai Pakning route throughout the research period are included in this study. As a result, long-term seasonal operational variations, such as monsoon weather and holiday traffic fluctuations, may not be fully reflected in the data, which mostly reflect daily operational conditions during the observation period. Longer observation times and more sophisticated quantitative operational analysis techniques should be used in future studies to increase the thoroughness of ferry operational efficiency assessments.

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