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The influence of professional pilots, pilotages services, and shipping safety on the smooth flow of ship traffic

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Abstract: This research aims to determine the role of ship pilotage in the mandatory pilotage waters, especially in the main port of Indonesia. This study seeks to assess the effect of professional pilots, pilotage services, and shipping safety on the smooth flow of ship traffic at the main port of Indonesia, managed by the largest port operator, Pelabuhan Indonesia. The research method used is Descriptive Quantitative. The data utilized in this study are primary data, obtained from a questionnaire with a Likert scale measurement ranging from 1 to 5 (strongly disagree to strongly agree), which was completed by employees at PT Pelabuhan Indonesia and stakeholders in the port. The sample consisted of 80 employees out of a population of 200. The analysis tool used in this research is Smart PLS 4.1.0.0. The data obtained are then analyzed using quantitative descriptive analysis techniques based on the primary data collected. The data will be presented in numerical form, which will then be interpreted. 1) Professional pilots have a significant effect on the smoothness of ship traffic; 2) Pilotage services have a significant effect on the smoothness of ship traffic; and 3) Shipping safety has a significant effect on the smoothness of ship traffic. Conclusion: The results of this study indicate that pilot professionalism, pilotage services, and shipping safety significantly impact the smooth flow of ship traffic in the port. These findings are important to consider in future efforts to improve and develop navigation systems and shipping management. In this study, the resulting state of the art shows that although professional pilots, pilotage services, and shipping safety are important elements in the shipping industry, their influence on the smooth flow of vessel traffic is not as strong as expected. This research provides valuable new insights for academics and practitioners in the maritime field, especially in the context of policy and the development of a more effective shipping system. Additionally, this study identifies areas that require more attention in efforts to improve the smooth flow of vessel traffic, which can form the basis for further research in the future.

Keywords: *Smooth vessel traffic, Professional pilots, Pilotage service, Shipping safety.*

1. Introduction

Indonesia is an archipelago, and has one of the largest number of islands in the world, reaching 17,001 islands. In addition to being the country with the largest number of islands, Indonesia is also one of the countries with the largest economy based on the value of Gross Domestic Product (GDP) [1]. Therefore, to support the country's economic activities, facilities such as traffic or transportation routes, infrastructure and modes of transportation are needed to support this [2].

One mode of transportation that supports this is ship transportation. This transportation has advantages over other modes of transportation, namely large carrying capacity, flexibility for various types of cargo and access that can be passed by this mode of transportation to various regions [3].

However, with its existence considered crucial, sea transportation often experiences obstacles. The constraints that are often faced are the limitations of the port, so that there are often bottlenecks in

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water traffic to wait between other ships loading and unloading[4].

Table 1.
Time Required for Vessels in Port for Loading and Unloading.

Location	Average Queue Time (seconds)
Unloading Process	
Container Crane	95,55
Tractor Trailer 1	96,25
Gantry Crane 1	61,05
Gantry Crane 2	65,71
Tractor Trailer 2	53,56
Weight Bridge	24,20
Total Time	396,02
Loading Process	
Container Crane	16,32
Tractor Trailer 1	57,67
Gantry Crane 1	63,22
Gantry Crane 2	64,54
Tractor Trailer 2	95,85
Weight Bridge	87,44
Total Time	385,04

Based on table 1 above, it is known that it takes time for each ship to do loading and unloading, which is 396.02 seconds + 385.04 seconds = 781.06 seconds or 13.01 minutes. This applies to ships with *dry container* loads, it is different when ships load industrial and passenger needs. For example barges, mining material transport ships, ferries and so on.

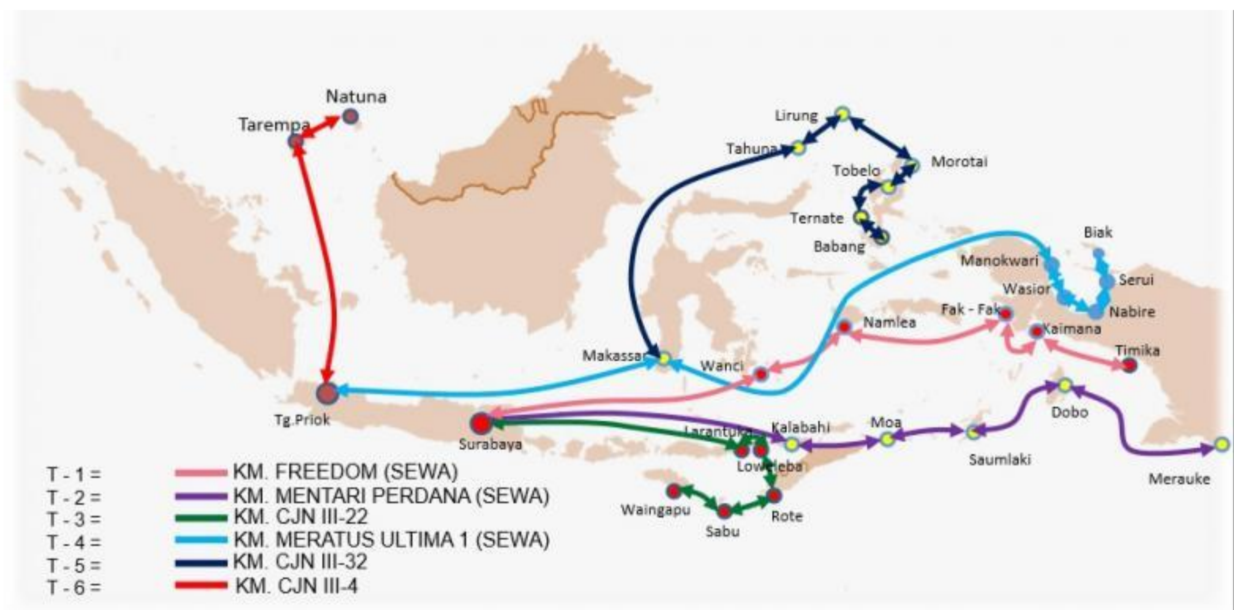

Figure 1.
Sea Toll.
Source: Indonesia [5].

Based on Figure 1 above, it is known that the ports in Indonesia are partly cantered on Java Island and Eastern Indonesia. In addition, sea traffic through which ships pass is mostly cantered in eastern Indonesia, this often causes smooth traffic, because it is only cantered in a few ports.

Based on the background of the problem, the following problem formulations related to the smoothness of ship traffic were determined: 1) Does Professional Pilots affect the Smoothness of Ship Traffic; 2) Does Pilotage Service affect the Smoothness of Ship Traffic; and 3) Does Shipping Safety affect the Smoothness of Ship Traffic.

Based on the background of the problem, the following problem formulations related to the smoothness of ship traffic were determined: 1) Does Professional Pilots affect the Smoothness of Ship Traffic; 2) Does Pilots Service affect the Smoothness of Ship Traffic; and 3) Does Shipping Safety affect the Smoothness of Ship Traffic in main port of Indonesia.

2. Material and Method

This study used a descriptive quantitative approach. This strategy was chosen because it allows researchers to explore and understand phenomena related to smooth vessel traffic. Descriptive quantitative data collection and analysis allows researchers to tailor their methodology to the requirements of the study and the characteristics of the people under study. Where the sample in this research study involved 80 respondents from 200 Populations [6].

The primary data used in this study came from questionnaires filled out by employees of port companies at the Port of PT Pelabuhan Indonesia and Stake holder. Primary data from the questionnaire was collected through Google forms, which allowed the creation of research data tables. To support the research on smooth ship traffic, the researcher collected previous research data from leading academic journal articles, including Thomson Reuters Journal, Springer, Taylor & Francis, Scopus, Emerald, Sage, Web of Science, Sinta Journal, DOAJ, and EBSCO, as well as platforms such as Publish or Perish and Google Scholar, books, and other relevant documents, to gain insight into smooth traffic [7].

The analytical tool used in this research is Smart PLS version 4.1.0.0. This research uses Validity, Reliability, Inner Model, Outer Model, and Hypothesis tests.

3. Data Analysis

3.1. Data Analysis

3.1.1. Smooth Ship Traffic

Smooth shipping is a condition in which the movement of ships in a given port or waterway is efficient, safe and free of obstacles. It includes the planning of ship arrivals and departures, optimal dock utility and minimal disruptions such as long queues or accidents. Factors influencing this include good traffic management, coordination between port operators and maritime authorities, and the availability of supporting infrastructure such as clear and unobstructed shipping lanes. The main objective of smooth vessel traffic is to reduce vessel waiting times (turnaround times) and increase port performs. With smooth traffic, goods can be delivered on time, which has a positive impact on logistics efficiency and the economy [8].

Indicators or dimensions contained in Smooth Traffic include: 1) Vessel waiting time: The time a vessel takes from arrival to departure. The shorter the waiting time, the smoother the vessel traffic; 2) Shipping Line Density: The degree of congestion of a lane, measured by the number of vessels passing through a particular lane in a given period of time; 3) Berth Occupancy Efficiency: The level of dock optimisation to allow ships to load and unload without hindrance; 4) Stakeholder coordination: The ability of port authorities, ship operators and related parties to manage schedules and vessel traffic flows; 5) Presence of Operational Barriers: The absence of obstacles such as illegally parked vessels, faulty equipment or adverse weather conditions affecting traffic; 6) Speed of administrative processes: Smooth administrative processes, such as document clearance, that expedite vessel operations; and 7) Availability of Alternative Lines: The existence of alternative shipping lanes to relieve congested main lanes [9].

The smoothness of ship traffic is relevant to the research conducted by: Putri, et al. [10];

Sumiyatiningsih and Indriawan [11]; Fatah, et al. [12] and Pattipawaej, et al. [13].

3.1.2. Professional Pilots

Professional pilots are individuals who have the expertise and official certification to provide ship pilotage services to a high professional standard. The pilots responsible for ensuring that ships can move safely and efficiently in narrow, high-risk or busy shipping lanes. Professional pilot familiar with the characteristics of local waters, including currents, depths, weather conditions and port layouts. They also have effective communication skills to coordinate with ship captains and port authorities. The role of pilots is crucial in preventing marine casualties, protecting the marine environment and ensuring the safety of shipping. The quality of the pilotage service depends largely on the competence, experience and responsibility of a professional pilot [14].

Indicators or dimensions contained in Professional Pilots include: 1) Qualifications and Certifications: Possession of professional certifications to international standards (IMO) that demonstrate pilots competence; 2) Knowledge of local waters: In-depth understanding of local conditions such as currents, depths and navigational hazards in the duty area; 3) Communication skills: The pilots ability to communicate with shipmasters, crew and port authorities to ensure smooth operations; 4) Work experience: Length of service and track record in handling different types of vessels without incident; 5) Adherence to SOPs: Performing duties in accordance with Standard Operating Procedures to ensure safety and efficiency; 6) Use of Navigation Technology: Mastery of the use of navigational aids such as radar, GPS or AIS to assist in vessel management; and 7) Safety Track Record: The success rate of the pilots in preventing incidents or accidents while pilotage [15].

Professional Pilots is relevant to the research conducted by:Ibrahim, et al. [16]; Speich, et al. [17]; Zaccone and Martelli [18] and Sun, et al. [19].

3.1.3. Pilotages Service

Pilotage is an activity of pilots performed to assist the master of ship in navigating in difficult or high-risk waters, such as entering or leaving a port, passing through a canal or an area of heavy traffic. The service aims to improve safety, time efficiency and protection of the marine environment. Pilot services involve the use of modern navigational equipment such as radar and GPS, as well as in-depth local knowledge. The service is also used to comply with international and local maritime regulations that require the presence of stewards in certain areas. With a pilotage service in place, the risk of collision, grounding or other and no incidents , resulting in smooth and safe shipping operations [20].

Indicators or dimensions contained in the Pilotage Service include: 1) Availability of pilots: The number of pilots available to meet the needs of vessels, particularly during peak periods; 2) Speed of Response: The time it takes for the Pilots to arrive at the vessel after a request for pilotage has been made; 3) Navigational Accuracy: The degree of accuracy in providing navigational instructions to vessels so that they can operate safely and efficiently; 4) Quality of Pilotage Aids: Availability and maintenance of equipment such as pilot boats, radars and electronic charts; 5) Safety level of operations: The frequency of incidents or accidents during pilotage, which reflects the quality of the service; 6) Compliance: Compliance of the pilotage service with local and international regulations; and 7) Service User Satisfaction: The level of satisfaction of masters and ship operators with the quality and efficiency of the pilotage service [21].

Pilotage Services are relevant to the research conducted by:Yolandita [22]; Amir, et al. [23]; Dedi and Meizi [24] and Oktafiansyah [25].

3.1.4. Shipping Safety

Maritime safety is a state in which all activities related to ships and their operations are carried out by no risks to crew, passengers, cargo and the marine environment. This covers a wide range of aspects, from standard ship maintenance and compliance with international maritime regulations (such as SOLAS) to the effective implementation of emergency procedures. Maritime safety also includes crew training, the use of modern navigation technology and coordination with port authorities and stewards. The aim is to prevent incidents such as collisions, fires or marine pollution. Good maritime safety practices ensure the smooth running of shipping operations, protect lives and assets, and support the sustainability of marine ecosystems [26].

Indicators or dimensions contained in Shipping Safety include: 1) Vessel Condition: The serviceability of the vessel based on regular inspections of its structure, machinery and safety equipment; 2) Compliance with Maritime Regulations: The degree of compliance of shipping operations with international regulations such as SOLAS and the ISM Code; 3) Use of navigation technology: Use of modern equipment such as ECDIS (Electronic Chart Display and Information System) and AIS (Automatic Identification System); 4) Crew training: Frequency and quality of crew training in dealing with emergency situations; 5) Risk management procedures: The existence of a system to identify, analyse and reduce the risk of accidents or incidents; 6) Coordination with port authorities: The level of coordination between the ship and the port authority to ensure safe operations; and 7) Incident track record: The frequency of maritime incidents such as collisions, groundings or pollution in a given area [27].

Shipping Safety is relevant to the research conducted by: Syibli and Nuryaman [28]; Mursidi, et al. [29]; Santosa and Sinaga [30]; Suganjar, et al. [31] and Mudiyanto, et al. [32].

4. Results and Discussion

In this study, the research results include testing the outer model and inner model:

4.1. Outer Model Validity Test

4.1.1. Convergent Validity

If the correlation coefficient> 1 or = 1, then the validity measure is considered high. In table 1, below are the results of the outer model *convergent validity* test

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Table 2.
Convergent Validity Analysis.

	Professional Pilot (X1)	Pilotage Service (X2)	Shipping Safety (X3)	Traffic Smoothness (Y1)
X1.1	0.860			
X1.2	0.821			
X1.3	0.582			
X1.4	0.736			
X1.5	0.339			
X1.6	0.320			
X1.7	0.118			
X1.8	-0.021			
X1.9	-0.001			
X2.1		-0.344		
X2.2		-0.817		
X2.3		-0.386		
X2.4		-0.571		
X2.5		0.501		
X2.6		0.396		
X2.7		0.157		
X3.1			0.620	
X3.2			0.517	
X3.3			0.530	
X3.4			-0.121	
X3.5			-0.712	
X3.6			-0.575	
X3.7			0.217	
X3.8			0.383	
X3.9			-0.269	
Y1.1				-0.460
Y1.2				-0.303
Y1.3				0.262
Y1.4				0.870
Y1.5				0.283
Y1.6				-0.293

Based on the output in table 2 above, that all variables used in this study are declared invalid, because each indicator in each variable gets a *loading factor* value < 0.60, it can be stated that the indicators of each variable are not eligible for research.

4.1.2. AVE (Average Variance Extracted)

Latent variables can explain on average more than half of the variance of their indicators.

Table 3.
AVE Analysis.

Variable	Average Variance Extracted (AVE)
X1	0.281
X2	0.242
X3	0.228
Y1	0.216

Based on Table 3 above, the AVE value of the Professional Pilots as variable is 0.281, Pilots services 0.242, Shipping Safety is 0.228 and Smooth Ship Traffic is 0.216. This shows that all variables in this study obtained a value of less than (<) 0.5, meaning that each variable has poor discriminant validity.

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4.1.3. Outer Model Reliability Test

4.1.3.1. Composite Reliability

This reliability test is intended to measure how relevant and consistent a respondent is in answering or filling out a questionnaire, related to the questionnaire provided.

Table 4.
Composite Reliability Analysis.

Variable	Composite Reliability
X1	0.647
X2	0.365
X3	0.602
Y1	0.342

Based on the test results in table 4 above, the *composite reliability* value of the Professional Pilots as variable is 0.647, the *composite reliability* value of the Pilots Service is 0.365, the *composite reliability* value of Shipping Safety is 0.602 and the *composite reliability* value of Smooth Ship Traffic is 0.342. Which shows that the value of all these variables is smaller (<) than 0.7, meaning that all variables are declared unreliable.

4.1.4. Cronbach's Alpha

Reliability test with *composite reliability* can be strengthened with *Cronbach's alpha.* The criteria for evaluating variables if the *Cronbach's alpha* value for each variable is> 0.7, then it can be declared reliable, Santosa [33].

Table 5.
Cronbach's Alpha Analysis.

Variable	Cronbach's Alpha
X1	0.563
X2	0.117
X3	0.130
Y1	0.177

Based on the test results in table 5 above, the *Cronbach's alpha* value of the Professional Pilots as variable is 0.563, the *Cronbach's alpha* value of the Pilots Services is 0.117, the *Cronbach* 's alpha value of Shipping Safety is 0.130 and the *Cronbach's alpha* value of Smooth Ship Traffic is 0.177. This shows that all variables are smaller (<) than 0.7, so all variables are declared unreliable.

4.1.5. Structural Model Analysis (Inner Model)

This structural model test aims to see the relationship or influence between constructs, significant values and R Square.

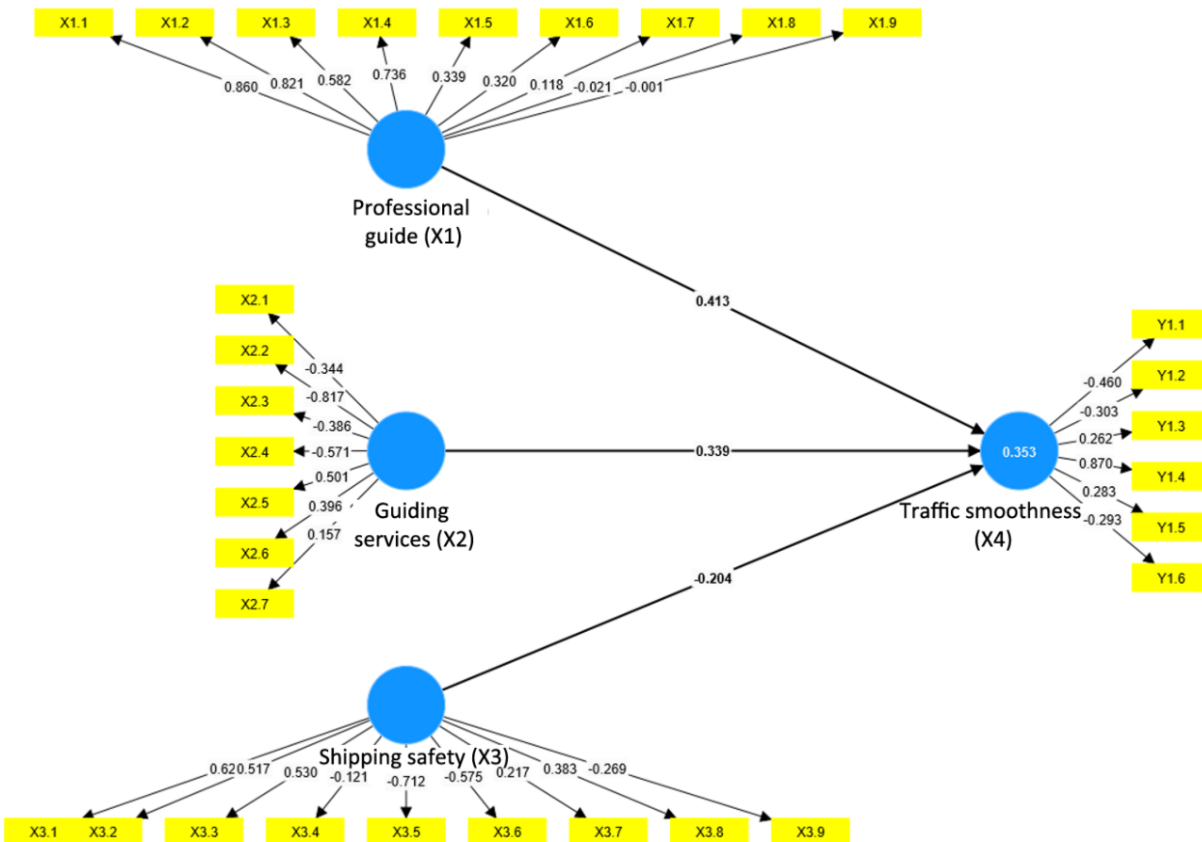

Figure 2.
Output Inner Model.

4.1.6. Hypothesis Testing Results (Significance Test)

Hypothesis testing uses the output of *path coefficients* and indirect effects:

Table 6.
Hypothesis Test Results.

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Professional Pilots (X1) -> Traffic Smoothness (Y1)	0.413	0.040	0.397	1.040	0.298
Pilotage Service (X2) -> Traffic Smoothness (Y1)	0.339	0.214	0.259	1.307	0.191
Shipping Safety (X3) -> Traffic Smoothness (Y1)	-0.204	-0.211	0.244	0.837	0.403

The purpose of this bootstrapping test is to minimize abnormalities in the research data. The following are the results of the bootstrapping test:

4.1.7. The Effect of Professional Pilots on the Smoothness of Ship Traffic

The results of testing the first hypothesis show the effect of professional pilots on the smoothness of ship traffic, as seen in table 6. The results of the hypothesis test analysis obtained a value (O) in which the path coefficient is 0.413 with a statistical T value of 1.040 and a P value of 0.298. This value is smaller (<) than the t table value (1.990) and the P Values value is greater (>) 0.05, meaning that it has no positive and insignificant effect.

So professional pilots have no positive and insignificant effect on the smooth flow of ship traffic (H1 Rejected).

4.1.8. The Effect of Pilots Service on the Smoothness of Ship Traffic

The results of testing the second hypothesis show the effect of pilotage services on the smooth running of ship traffic, as seen in table 6. The results of the hypothesis test analysis obtained a value (O) in which the path coefficient is 0.339 with a statistical T value of 1.307 and a P value of 0.191. This value is smaller (<) than the t table value (1.990) and the P Values value is greater (>) 0.05, meaning that it has no positive and insignificant effect.

The guide service has no positive and insignificant effect on the smooth flow of ship traffic (H2 Rejected).

4.1.9. The Effect of Shipping Safety on the Smoothness of Ship Traffic

The results of testing the third hypothesis show the effect of shipping safety on the smooth running of ship traffic, as seen in table 6. The results of the hypothesis test analysis obtained a value (O) in which the path coefficient is -0.204 with a statistical T value of 0.837 and a P value of 0.403. This value is smaller (<) than the t table value (1.990) and the P Values value is greater (>) 0.05, meaning that it has no positive and insignificant effect.

Shipping safety has no positive and insignificant effect on the smooth flow of ship traffic (H3 Rejected).

5. Discussion

5.1. The Effect of Professional Pilots on the Smoothness of Ship Traffic

The results of the study showing that Professional Pilots have a significant impact on the smoothness of vessel traffic may be an interesting finding that requires further analysis. In theory, professional pilots with qualifications and certificates are considered to be capable of providing accurate and safe guidance to vessels during the navigation process. However, in practice, pilotage qualifications alone to be sufficient to directly influence the smooth flow of vessel traffic. This may be due to more dominant external factors such as port infrastructure, traffic management policy or operational conditions in the port. If the infrastructure is inadequate or the vessel traffic management system is inefficient, the performance of even highly qualified pilots may have a significant impact.

In addition, knowledge of local waters is also considered an important indicator in supporting pilotages. This knowledge includes an understanding of currents, depths and potential navigational hazards in a particular area. However, if the local water conditions are already well regulated by modern technology such as radar or Automatic Identification System (AIS), the contribution of pilots' local knowledge to smooth traffic is limited. This suggests that technological factors and integrated navigation systems have a greater influence than the skills of individual pilot.

Communication skills, which include the pilot ability to coordinate with the skipper and port authorities, should also support smooth vessel operations. However, if the port's communication system is not operating optimally, for example due to technical malfunctions or delays in information transmission, the individual communication skills of the pilots will not be sufficient to overcome major problems. In other words, the smooth flow of ship traffic depends more on the effectiveness of the overall communication system than on the skills of individual pilot.

In addition, pilots professional experience is often seen as an advantage in dealing with complex vessel traffic management situations. However, if the vessel traffic management process is not supported by clear procedures, or if there is a lack of coordination between the parties involved, the professional experience of the pilots will be able to significantly reduce operational bottlenecks. For example, even if

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experienced pilots are able to handle large vessels well, the long queues of vessels due to dock restrictions will remain a major problem hindering the smooth flow of traffic.

Adherence to SOPs is another indicator that is expected to improve pilotage efficiency. However, if the SOPs implemented are relevant to the operational conditions of the port, the impact on the smooth flow of vessel traffic will be minimal. For example, SOPs that are too rigid or inflexible to changing situations can slow down the vessel handling process, especially in emergency situations or when there is a surge in vessel traffic.

In addition, the use of navigation technology such as radar, GPS and electronic charts is an important aspect of supporting pilotage. However, if the port infrastructure is not equipped with supporting technology such as the Vessel Traffic System (VTS), or if the technology is not operated properly, the impact of the pilot's use of technology is limited. In this case, the smooth flow of vessel traffic depends more on the reliability of the integrated technology system at the port level.

The safety track record of pilot, which indicates their ability to prevent incidents, is also not always directly correlated with the smooth flow of vessel traffic. While a good safety track record reflects the professionalism of the pilots, other factors such as quay capacity, availability of alternative channels and vessel dwell time in port may have a greater influence. For example, if the number of vessels waiting to berth far exceeds the port's capacity, then even if the pilots have a good track record, the smooth flow of vessel traffic will still be compromised.

On the other hand, the smooth flow of vessel traffic is heavily influenced by factors such as vessel waiting time, which indicates how quickly vessels can load and unload and depart. This waiting time is influenced not only by the quality of pilotage, but also by the efficiency of port management. If the port does not have enough berth capacity or the administrative process is slow, the smooth flow of shipping will be disrupted even if the pilots are professional.

The density of shipping lanes also plays an important role. If the main shipping lanes are already overcrowded, the smooth flow of traffic will be disrupted, regardless of the quality of the pilotage service. In this case, solutions such as opening alternative lanes or increasing port capacity may be more effective than relying on the skills of pilots.

Indicators such as the efficiency of Berth utilisation and the speed of administrative processes are also often key determinants of smooth vessel traffic. If quays are not optimally utilised or administrative processes take a long time, vessel traffic will be hampered. This suggests that improvements at the level of port management may have a greater impact than improvements in the quality of pilotage.

Finally, coordination between stakeholders and the presence of operational obstacles such as weather disturbances or equipment breakdowns are often more dominant in affecting the smooth flow of vessel traffic. If coordination between the parties involved, such as port authorities, ship operators and pilotage operators, is not good, professional pilotage services will still be able to overcome the existing problems.

Overall, the results show that while professional pilotage plays an important role, the smooth flow of vessel traffic is determined more by systemic factors such as infrastructure, technology and port management. This points to the need for a holistic approach to improving the smooth flow of vessel traffic, rather than focusing on individual aspects such as the quality of pilots.

5.2. The Effect of Pilotage Services on the Smoothness of Ship Traffic

The results of the study, which show that pilot services have a significant impact on the smoothness of vessel traffic, indicate that other factors are more dominant in determining the efficiency of vessel traffic. In theory, pilotage services, which include the availability of skippers, aim to ensure that vessels receive adequate guidance when entering a port. In practice, however, skipper availability alone may not be sufficient if other processes, such as coordination between operators or availability of port facilities, are not working properly. For example, if berths are full or there are other operational bottlenecks, the presence of a professional skipper will not be able to speed up the overall vessel traffic.

Another indicator, speed of response, is also considered an important element in pilotage services. A quick response by the pilot in providing guidance or dealing with emergency situations can help to reduce the risk of accidents. However, if the supporting systems in the port, such as vessel traffic management or the efficiency of administrative processes, are inadequate, the speed of the pilot response will not have a significant impact on the smooth flow of vessel traffic. This shows that the speed of individual services needs to be supported by a good management system to achieve optimal results.

In addition, the navigational accuracy provided by stewards aims to ensure that vessels can navigate safely and efficiently in port waters. While navigational accuracy is important to prevent incidents, its impact on the smooth flow of vessel traffic may be limited if the main shipping lanes are congested. Under these conditions, the navigational accuracy of the pilot may only serve to minimise the risk of accidents, but may not be sufficient to speed up the overall vessel traffic.

The quality of pilotage aid, such as radar and other navigation technologies, is also an important part of the pilotage service. However, if the port infrastructure is not supportive or if these aids are not used optimally, their effect on the smooth flow of vessel traffic will be negligible. For example, sophisticated navigational aids are of no use if coordination between the parties involved in vessel traffic management is ineffective.

Another indicator often considered important in pilotage is the level of operational safety. Operational safety aims to ensure that the pilotage process is carried out without incident or accident. However, if operational obstacles such as bad weather or damage to port infrastructure occur frequently, operational safety will not be sufficient to improve the smooth flow of vessel traffic. In this case, a focus on infrastructure improvement and mitigation of operational obstacles may be more relevant.

In addition, compliance with procedures or regulations is an important element of pilotage services. This compliance includes meeting the operational standards set by the port authority. However, even if the level of compliance is high, smooth vessel traffic will not be achieved if the port administration process is slow or the berthing capacity is insufficient. This suggests that compliance with procedures alone is not sufficient without efforts to improve the overall efficiency of port management.

Service user satisfaction is also often used as an indicator of the quality of pilotage services. A high level of user satisfaction usually indicates that the service meets expectations. However, in the context of smooth vessel traffic, service user satisfaction to be relevant if key issues such as congestion in the shipping lane or restrictions on alternative lanes have not been addressed. In other words, user satisfaction with the pilotage service reflects the quality of the individual experience rather than its impact on the overall efficiency of vessel traffic.

Meanwhile, indicators of smooth vessel traffic, such as vessel waiting time, are often more influenced by systemic factors. For example, long waiting times are usually caused by poorly managed vessel queues or limited berthing capacity. Under these conditions, high quality pilotage services will be able to reduce waiting times significantly.

The density of shipping lanes is also an important factor in the smooth flow of vessel traffic. If the main shipping lanes are already congested, no matter how good the pilotage services are, ships will still have difficulties in navigating smoothly. In this case, solutions such as opening alternative lanes or better traffic management may be more effective.

The efficiency of quay utilise and the speed of administrative procedures are also often major bottlenecks in the smooth flow of shipping. If the quay is not optimally utilised or the administrative process takes a long time, vessel traffic will remain disrupted despite high quality pilotage services. It is therefore more important to focus on improving the overall port system in order to improve the smooth flow of vessel traffic.

Finally, the existence of operational bottlenecks, such as equipment breakdowns or weather disturbances, are often the main obstacles to smooth vessel traffic. If these obstacles cannot be overcome, even good pilotage services will have a significant impact. In this context, improving risk mitigation capabilities at port level is more important than simply improving the quality of pilotage services.

Overall, the findings suggest that while pilotage services play an important role, the smooth flow of vessel traffic depends more on systemic factors such as the efficiency of port management, coordination between stakeholders and adequate infrastructure. This underlines the need for a holistic approach to improve the smooth flow of vessel traffic, where pilotage services are one component of a larger system.

5.3. The Effect of Shipping Safety on the Smoothness of Ship Traffic

The results of the study, which show that vessel safety has effect and is significant on the smoothness of vessel traffic, illustrate that there are other factors that are more dominant in influencing the smoothness of operations in certain ports or waters. Although vessel safety, including indicators such as the condition of the vessel, is a crucial element in ensuring that vessels can operate without technical constraints, this result shows that the smoothness of vessel traffic is more determined by the efficiency of the port system and traffic management. Ships in good condition will still face long waiting times if the docks are full or the queuing system is not operating effectively.

In addition, maritime regulatory compliance as an element of maritime safety is usually aimed at ensuring that ships operate in accordance with established safety standards. However, in the context of smooth traffic, this compliance may have a significant impact if other aspects, such as congested shipping lanes or slow administrative procedures, are the main obstacles. This shows that compliance with maritime regulations is more important for preventing accidents than for improving the efficiency of vessel traffic.

In addition, the use of navigation technology is often seen as a solution to improve maritime safety. Technologies such as radar and GPS allow ships to navigate with high precision, especially in congested waters. However, while navigation technology helps to reduce the risk of collisions, its impact on the smooth flow of shipping remains limited when the main shipping lanes are congested or there are no alternative routes. In these situations, systemic solutions such as better traffic management or the opening of new lanes become more relevant.

Crew training is another indicator of safety at sea, aimed at ensuring that crew members have sufficient competence to deal with different situations. However, even if the crew is well trained, smooth vessel traffic will be achieved if there are obstacles in the port, such as poor coordination between stakeholders or insufficient berth availability. In this case, crew training is more likely to improve individual skills than to have a direct impact on the overall smoothness of operations.

Risk management procedures are also an important element of maritime safety, aimed at identifying and mitigating potential risks during vessel operations. However, in the context of smooth operations, these risk management procedures focus on mitigating incidents rather than speeding up operational processes. Therefore, even if risk management procedures are well implemented, the smooth operation of ships can still be hampered if there are systemic obstacles, such as slow administrative procedures or inadequate port facilities.

Coordination with port authorities is another factor often considered critical to maritime security. The aim of this coordination is to ensure that ships can enter and leave the port safely. However, in the context of smooth shipping operations, this coordination may not be sufficient if port capacity is limited or there is no effective traffic management system. This suggests that smooth operations require a more holistic approach, where coordination is only one of many elements to be improved.

Another maritime safety indicator is the incident track record, which reflects how well ships and ports are able to prevent or manage incidents. While a good incident track record indicates a high level of safety, it does not always have a direct impact on the smooth flow of shipping. Ships may still face long waiting times or low berthing efficiency if other problems, such as operational bottlenecks or congestion in shipping lanes, are not addressed.

Meanwhile, indicators of smooth vessel traffic, such as vessel waiting time, are more often influenced by managerial factors than by elements of vessel safety. Long waiting times are usually caused by a lack of berth capacity, a sub-optimal queuing system or slow loading and unloading processes. Under these conditions, good ship safety will not be able to reduce waiting times without improvements in operational management.

Congestion in shipping lanes is another indicator that is more influenced by the design and organize of shipping lanes. Congested lanes require better traffic management systems, such as opening alternative lanes or using technology to monitor and manage traffic. While vessel safety is important to prevent incidents in congested lanes, its impact on smooth operations will be limited if congestion is not properly managed.

In addition, the efficiency of berth utility often depends on how well the port is able to manage vessel schedules and loading and unloading operations. If berths are not optimally utilised, the smooth flow of vessel traffic will be hampered, even if vessel safety is ensured. This confirms that port infrastructure and management factors are more important in improving traffic flow.

Stakeholder coordination is also an important element in the smooth flow of vessel traffic. Poor coordination between parties such as port authorities, ship operators and logistics companies is often a major obstacle. In this context, ship safety will not be sufficient to overcome the problems caused by lack of coordination.

Finally, operational obstacles such as bad weather, equipment breakdowns or technical failures are often the main obstacles to the smooth flow of shipping. While good ship safety can reduce the risk posed by these obstacles, their impact remains limited if they are not addressed directly. It is therefore more important to focus on reducing operational barriers to improve the smooth flow of shipping.

Overall, these findings suggest that while vessel security is important to ensure operational safety, the smooth flow of vessel traffic is more determined by systemic factors such as port efficiency, traffic management and adequate infrastructure. This underlines the need for a holistic approach to improve the smooth flow of vessel traffic, where vessel safety is one element to be considered among others.

6. Conclusions

6.1. Conclusions

Based on the results and discussion above, the conclusions of this study are:

1) Professional Pilots has effect and is significant to the Smoothness of Ship Traffic;
2) Pilotage Services have effect and significant to the Smoothness of Ship Traffic; and
3) Shipping Safety has effect and significant to the Smoothness of Ship Traffic.

Based on the conclusions that have been given, suggestions are needed to build hypotheses in further research. This research suggestion is as follows:

1) It is important to conduct a thorough evaluation of the training system for professional pilot. Better and continuous training will help improve the skills and knowledge of pilot in dealing with various situations in the field. In addition, cooperation between various stakeholders is needed to create better standards for services.
2) Secondly, the authorities are advised to conduct stricter supervision of the implementation of services. Good supervision will ensure that guiding services are implemented in accordance with the established standards and can provide maximum benefits for the smooth flow of vessel traffic.
3) Third, there needs to be a more comprehensive approach to shipping safety. This includes the improvement of shipping infrastructure, the use of modern technology in navigation, and increased awareness and training for all parties involved in the shipping industry.

The implementation of these proposals is expected to improve the smooth flow of shipping, although the results show that the factors studied do not significantly affect the safety of shipping. Further research is also needed to identify other factors that may contribute to the smooth flow of shipping, so that corrective actions can be taken appropriately and effectively.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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