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The Impact of Sedimentation on the Perak River Shipping Channel on Shipyard Operations

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ABSTRACT

Siltation of shipping channels presents significant challenges that can heighten maritime safety and security risks while impeding economic activities. Sedimentation, defined as the deposition process of solid particles including sand and rock materials, necessitates regular maintenance interventions. This phenomenon has been particularly pronounced in the Perak River shipping channel over recent years, with no dredging operations conducted to date. The occurrence of sedimentation significantly impacts the operational activities of shipyard companies located along the Perak River shipping channel. This study aims to investigate the impacts caused by sedimentation in the Perak River on shipyard operations. The research employs a quantitative methodology utilizing SPSS software for data analysis. The study sample comprises employees from shipyard companies PT. Dumas Tanjung Perak Shipyard and Pelni Surya Shipyard. Simple linear regression analysis was employed, yielding the equation Y = 5.943 + 1.112X. The findings demonstrate that sedimentation impacts on shipping channels exert a positive and significant effect on shipyard operations. The impacts of siltation include reductions in the number and size of vessels capable of transiting the channel, as well as increased operational costs for shipyard companies and ship owners due to process delays when awaiting optimal water conditions during highest tide periods.

Keywords: *sedimentation, shipping channels, shipyards*

1. INTRODUCTION

A port functions as a facility utilized for activities related to the transportation of goods, cargo, and passengers via maritime routes [1]. Maritime transportation serves as a vital transportation mode capable of reaching all regions through waterways [2]. Ports encompass oceanic areas where ships dock and berth, as well as terrestrial areas utilized for loading and unloading processes, passenger embarkation and disembarkation, and related activities. Additionally, ports serve as pivotal locations for regional development [3]. For the transportation of cargo or large numbers of passengers, numerous shipping companies utilize maritime routes due to cost efficiency considerations.

Tanjung Perak Port represents one of Indonesia's numerous ports with substantial activity levels, classified as a first-class port. To support the smooth operation of all port activities, ideal port facilities are essential. A critical example is the shipping channel, which facilitates vessel entry and exit to the port, requiring careful attention to safety and security considerations.

Similar to terrestrial transportation networks, waterways possess designated routes for maritime transportation, specifically ships, referred to as shipping channels. These channels constitute fundamental infrastructure that must be present in every port. According to Law No. 17 of 2008, "Shipping channels are waters that, in terms of depth, width, and other navigational impediments, are considered safe and secure for navigation" [4]. This definition establishes that shipping channel design must comply with existing provisions, including sufficient width and depth to ensure safety and security for various vessel types and sizes transiting the channel. Sedimentation in waterways represents one factor that can reduce shipping channel depth and width.

Sedimentation is defined as the transportation of rock materials through hydraulic processes, subsequently settling in specific areas. The sedimentation process encompasses siltation activities including erosion, transportation, deposition, and compaction of sedimentary materials [5]. This process initiates with water flow causing erosion. Subsequently, sediment material resulting from erosion moves and travels to lower areas or follows water flow direction, known as the sediment transport process. Eventually, sedimentary material settles and solidifies over time, ultimately causing siltation in rivers or shipping channels. To address siltation in shipping channels and port basins resulting from sedimentation processes, dredging activities are required for annual maintenance. In cases of substantial soil sedimentation, multiple interventions per year may be necessary.

Dredging involves modifying or shaping water bottom topography to achieve specific depth and width requirements. In this study context, immediate dredging implementation is necessary to restore shipping channel depth according to stakeholder requirements, as the channel has not undergone maintenance through dredging for an extended period. Dredging is essential because quality service must be supported by adequate facilities [6].

Tanjung Perak Port encompasses several shipping channels, including the Perak River shipping channel, which currently experiences significant sedimentation. This channel connects the Surabaya West Shipping Channel (APBS) to multiple shipyards. Suboptimal conditions in the Perak River shipping channel will have substantial impacts, as vessel maintenance and repair represent critical activities conducted regularly by ships preparing for voyages to maintain seaworthiness standards. Consequently, shipyards are affected by sedimentation causing Perak River shipping channel siltation, thereby hampering and reducing shipyard operational performance.

Shipyard operations encompass activities within shipyard companies, including operational processes from ship receipt from owners through repair completion and vessel return to owners. Multiple parties participate in these activities, including shipyard companies, ship owners, and marine inspectors from harbor master offices serving as supervisors and activity inspectors.

Perak River shipping channel siltation is evidenced by Port Director's Letter number PP20/11/12/DP-17, stating that immediate dredging of the Perak River shipping channel is required by port operators. Additionally, this correspondence indicates that Perak River shipping channel siltation has persisted for an extended period since letter issuance. However, according to shipyard company information, no dredging activities have been conducted on the Perak River shipping channel to date, creating access difficulties for vessels requiring maintenance and repair services.

Based on the preceding explanation, this study establishes problem formulations to guide research conduct: whether sedimentation in the Perak River shipping channel influences shipyard operations, and the impacts resulting from Perak River sedimentation on shipyard operations. Therefore, this study aims to determine the influence between Perak River sedimentation on shipyard operations and identify impacts resulting from Perak River sedimentation on shipyard operations.

2. METHODOLOGY

This research employs a quantitative approach, defined as systematic investigation of phenomena or events through data collection that can be measured and analyzed using statistical, mathematical, or computational methods [7]. The study timeframe corresponds with the authors' field work practice (PRADA) period from August 1, 2023, to August 1, 2024, conducted at PT. Dumas Tanjung Perak Shipyard and Pelni Surya Shipyard, shipyard companies located along the Perak River shipping channel that constitute the research focus.

Data collection techniques involve questionnaire distribution according to Sugiyono's theory [8]. Questionnaires were distributed via Google Forms utilizing a Likert scale (1-4), supplemented by interviews, documentation, and literature studies. Primary data comprises questionnaire results from 80 respondents from both companies and interviews with employee representatives from each company. The sampling technique employs the Slovin formula with a 5% margin of error from a total population of 336 employees from both companies, yielding a sample of 80 respondents. Sample distribution utilized Proportionate Stratified Random Sampling, resulting in 66 respondents from PT. Dumas Tanjung Perak

Shipyard and 14 respondents from Pelni Surya Shipyard. Secondary data consists of documentation materials.

The analytical tool employed is SPSS for Windows version 21. Data analysis techniques include data quality tests using validity and reliability tests, classical assumption tests using normality tests, and simple linear regression analysis.

3. Results and Discussion

3.1 Data Presentation

Figure 1. Perak River Sounding Results 2022
Source: Pelni Solar Shipyard Company Archives

Figure 1 presents the most recent bathymetric data obtainable by researchers, considering irregular shipping channel measurements. Based on Figure 1, the Perak River depth in 2022 measured only approximately 1 meter below water level at the deepest point, while water bottom visibility occurs at water edges. These dimensions are insufficient for vessel transit at all times, despite the Perak River shipping channel serving as primary access for ships entering six shipyard companies.

3.2 Questionnaire Analysis

The study utilized two research variables: Shipping Channel Sedimentation (X) and Shipyard Operations (Y). Data collection involved distributing questionnaires to 80 respondents selected according to predetermined research sample criteria. The following presents data from questionnaire results for each variable.

Table 1. Respondents' Answers to Variable X

Item	Respondent's Answer				Total Score	Percentage	Category
	SS	S	TS	STS			
X.1.1	53	25	2	0	291	90.9375	Very High
X.1.2	29	39	12	0	257	80.3125	High
X.1.3	38	40	2	0	276	86.25	Very High
X.1.4	32	38	5	5	257	80.3125	High
X.1.5	39	31	9	1	268	83.75	Very High
X.1.6	43	33	3	1	278	86.875	Very High
X.1.7	46	32	2	0	284	88.75	Very High
X.1.8	48	29	3	0	285	89.0625	Very High
X.1.9	45	31	4	0	281	87.8125	Very High
X.1.10	41	35	4	0	277	86.5625	Very High
X.1.11	44	36	0	0	284	88.75	Very High
Average						86.3068182	Very High

Source: Researcher questionnaire data processing (2025)

Table 1 presents respondent descriptions for the Shipping Channel Sedimentation variable (X) from 80 respondents across 11 statements addressing 4 dimensions within 1 indicator of Perak River sedimentation impact on shipyard operations.

Table 2. Respondents' Answers to Variable Y

Item	Respondent's Answer				Total Score	Percentage	Category
	SS	S	TS	STS			
Y.1.1	45	34	1	0	284	88.75	Very High
Y.1.2	43	33	4	0	279	87.1875	Very High
Y.1.3	42	31	7	0	275	85.9375	Very High
Y.1.4	39	36	4	1	273	85.3125	Very High
Y.1.5	47	29	4	0	283	88.4375	Very High
Y.1.6	46	30	4	0	282	88.125	Very High
Y.1.7	35	40	4	1	269	84.0625	Very High
Y.1.8	44	35	1	0	283	88.4375	Very High
Y.1.9	39	39	2	0	277	86.5625	Very High
Y.1.10	43	33	3	1	278	86.875	Very High
Y.1.11	41	35	3	1	276	86.25	Very High
Y.1.12	34	36	7	3	261	81.5625	Very High
Y.1.13	34	34	8	4	258	80.625	High
Y.1.14	40	37	3	0	277	86.5625	Very High

Average						86.0491071	Very High

Source: Researcher Questionnaire Data Processing (2025)

Table 2 presents descriptions of the Shipyard Operational variable (Y) from 80 respondents across 14 statements addressing 2 dimensions within 4 indicators of Perak River siltation impact on shipyard operations.

3.3 Interview Results

3.3.1 Interview Results with Resource Person 1 (PT. Dumas Tanjung Perak Shipyard)

According to information from the respondent who is an employee of PT. Dumas Tanjung Perak Shipyard, sedimentation has occurred for an extended period and significantly troubles the company. Additionally, sedimentation occurs throughout the channel, creating difficulties for ships entering the shipyard. PT. Dumas consistently guides vessels entering for safety purposes to prevent grounding at extremely shallow channel locations, even requiring waiting periods during high tide conditions. Currently, the company limits service to ships with maximum drafts of 3 meters, necessitating service refusal for vessels not meeting these specifications, thereby reducing service users.

3.3.2 Interview Results with Resource Person 2 (Pelni Surya Shipyard)

According to the source statement, sedimentation has persisted for an extended period. The company currently accepts ships with maximum drafts of 2.8 meters due to reduced channel depth. Additionally, ships can only enter and exit the channel during highest tide conditions. Consequently, ships must wait for highest tides, increasing operational costs due to delays. Late entries during high tide can cause vessel grounding, which frequently occurs. This situation also results in the company often rejecting adequately sized vessels seeking repair services.

Figure 2. Condition of the Perak River

Source: Researcher Documentation

3.4 Validity Test

This study employs the independent variable (X) of Shipping Channel Sedimentation with indicators including Erosion Activity, Transportation, Sedimentation, and Compaction. The dependent variable (Y) is Shipyard Operations with indicators including Operations, Marketing, Finance, and Human Resources.

Validity testing was conducted by comparing calculated r-values with r-table values. Item or questionnaire feasibility determination involves significance testing of correlation coefficients at 0.05 significance levels, meaning items or questionnaires are valid when significant correlations exist with total scores. Validity is declared when r-calculated > r-table with positive values; invalidity is declared when r-calculated < r-table.

Table 3. Validity Test Results

Number	Corrected Item Total Correlation (R-calculated)	R-table	Information
X.1.1	0.618	0.220	Valid
X.1.2	0.519		Valid
X.1.3	0.593		Valid
X.1.4	0.601		Valid
X.1.5	0.596		Valid
X.1.6	0.73		Valid
X.1.7	0.67		Valid
X.1.8	0.724		Valid
X.1.9	0.689		Valid
X.1.10	0.558		Valid
X.1.11	0.603		Valid
Y.1.1	0.653	0.220	Valid
Y.1.2	0.539		Valid
Y.1.3	0.754		Valid
Y.1.4	0.732		Valid
Y.1.5	0.76		Valid
Y.1.6	0.686		Valid
Y.1.7	0.724		Valid
Y.1.8	0.72		Valid
Y.1.9	0.642		Valid
Y.1.10	0.776		Valid
Y.1.11	0.633		Valid
Y.1.12	0.566		Valid
Y.1.13	0.391		Valid
Y.1.14	0.697		Valid

Source: Data processed by SPSS (2025)

3.5 Reliability Test

Reliability measurement utilizes Cronbach Alpha statistical testing, where variables are considered reliable if:

1. Cronbach Alpha values > 0.60 indicate reliability
2. Cronbach Alpha values < 0.60 indicate unreliability

Table 4. Variable X Reliability Test Results

Reliability Statistics
Cronbach's Alpha: 0.839

Source: Data processed by SPSS (2025)

Based on Table 4 data processing results, the Cronbach Alpha value of 0.839 > 0.60 indicates that the Shipping Channel Sedimentation Variable (X) is reliable and suitable as a research instrument.

Table 5. Variable Y Reliability Test Results

Reliability Statistics
Cronbach's Alpha: 0.894

Source: Data processed by SPSS (2025)

Based on Table 5 data processing results, the Cronbach Alpha value of 0.894 > 0.60 indicates that the Shipyard Operational Variable (Y) is reliable and suitable as a research instrument.

3.6 Normality Test

According to Ghozali (2018) [9], before data processing using regression formulas, both independent and dependent variables must be declared normally distributed or close to normal using normality testing. The normality test employs the Kolmogorov-Smirnov test.

When Asymp. Sig exceeds 0.05, residual data is normally distributed; when Asymp. Sig is less than 0.05, data is not normally distributed.

Table 6. Data Normality Test Results

One-Sample Kolmogorov-Smirnov Test		Unstandardized Residual
N		80
Normal Parameters	Mean	0.0000000
	Std. Deviation	3.28298798
Most Extreme Differences	Absolute	0.145
	Positive	0.083
	Negative	-0.145
Kolmogorov-Smirnov Z		1.296
Asymp. Sig. (2-tailed)		0.069

Source: Data processed by SPSS (2025)

Based on Table 6, the Asymp. Sig value of 0.069 > 0.05 confirms that processed data is normally distributed and the model is suitable for further research analysis.

3.7 Coefficient of Determination

Table 7. Determination Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.821	0.673	0.669	3.304

a. Predictors: (Constant), Sedimentasi Alur Pelayaran

Source: Data processed by SPSS (2025)

The R value represents the correlation coefficient symbol. Table 7 presents a correlation value of 0.673, indicating a strong relationship between the two research variables. The R Square value or Coefficient of Determination (KD) demonstrates the quality of the regression model formed by independent and dependent variable interactions. The KD value obtained was 67.3%, indicating that the independent variable (X) contributes 67.3% effect on the dependent variable (Y).

3.8 Simple Linear Regression Analysis

According to Riduwan (2016) [10], simple linear regression analysis predicts the extent of dependent variable value changes when independent variable values are manipulated, altered, or decreased. This analysis determines functional or causal relationships between independent variable X (Shipping Channel Sedimentation) and dependent variable Y (Shipyard Operations).

Table 8. Simple Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.943	3.352		1.773	0.080
	Sedimentasi Alur Pelayaran	1.112	0.088	0.821	12.679	0.000

a. Dependent Variable: Operasional Galangan Kapal

Source: Data processed by SPSS (2025)

Based on Table 8, calculations conducted using SPSS version 21.0 for Windows yielded a constant value (a) of 5.943 and coefficient (b) of 1.112. The simple linear regression equation form is:

$Y = a + \beta X$ $Y = 5.943 + 1.112X$

The regression equation interpretation is as follows:

1. The coefficient a (Constant) value of 5.943 indicates that without Shipping Channel Sedimentation (X = 0), Shipyard Operations (Y) is estimated at 5.943.
2. The impact of Shipping Channel Sedimentation (X) on Shipyard Operations (Y) demonstrates a unidirectional (positive) relationship, shown by the positive regression coefficient X value of 1.112, meaning each unit increase in supervision corresponds to a 1.112 increase in ship safety and security.
3. Similarly, if Shipping Channel Sedimentation decreases by 1 unit, Shipyard Operations will tend to decrease by 1.112.

3.9 Interview Results Analysis

Based on interview results with both companies serving as research samples, sedimentation in the Perak River has occurred for an extended period without routine monitoring by port operators, causing progressive depth reduction in the Perak River shipping channel. Current data indicates Perak River depth at only 1 meter below sea level in the channel center,

restricting vessel access to periods of highest tide conditions. This limitation requires ships to wait, increasing operational costs for both vessels and shipyard companies. Forced entry during insufficient water levels results in vessel grounding.

Additionally, sedimentation limits company-serviced vessels to maximum drafts of 3 meters, causing companies to reject numerous prospective service users exceeding specified standards. These rejections reduce the number of company-served ships, automatically decreasing company revenues.

3.10 Discussion

Based on data analysis results obtained through interviews and questionnaires regarding the influence of Perak River shipping channel sedimentation on shipyard operations, significance testing yielded a significance value of 0.000b < 0.05, confirming Shipping Channel Sedimentation (X) influence on the dependent variable Shipyard Operations (Y). Determination testing revealed a coefficient of 67.3%, while simple linear regression analysis demonstrated a constant value of 1.112 with positive characteristics. These results confirm that the Shipping Channel Sedimentation variable (X) effects 67.3% influence on the Shipyard Operational variable (Y), and positive Shipping Channel Sedimentation variable (X) values increase Shipyard Operational variable (Y) values.

Hypothesis test results indicate that the Shipping Channel Sedimentation variable (X) possesses a coefficient value unequal to zero (5.943), confirming Ha acceptance, which states that the Shipping Channel Sedimentation variable (X) significantly influences the Shipyard Operational variable (Y). T-test results show t-calculated exceeding t-table (12.679 > 1.990), thus accepting Ha. Study results demonstrate that the independent variable Shipping Channel Sedimentation (X) affects the dependent variable Shipyard Operations (Y).

Furthermore, addressing the problem formulation regarding sedimentation impacts on Perak River shipping channels on shipyard operations based on interview and questionnaire results:

1. Sedimentation causes siltation in the Perak River shipping channel, which connects to multiple shipyards. Consequently, Perak River shipping channel siltation impedes vessel entry/exit processes to shipyards.
2. Reduced shipping channel depths prevent large vessels from transiting channels, diminishing market potential. Additionally, this reduces the number of vessels serviceable by shipyards, causing decreased shipyard revenues.
3. Due to reduced shipping channel depths, vessels can only transit during highest tide conditions, requiring extended waiting periods in port basins and increasing vessel operational costs. Forced transits before highest tides can cause vessel grounding in the Perak River shipping channel.

4. Conclusion

Based on data analysis results and discussion regarding "The Impact of Sedimentation on the Perak River Shipping Channel on Shipyard Operations," the study concludes that an influence exists with the shipyard operational variable (Y) positively influenced by the shipping channel sedimentation variable (X). Higher sedimentation in the Perak River shipping channel corresponds to reduced shipyard operational capabilities. This is evidenced by the positive constant value of 1.112. The influence value is also demonstrated through simple linear regression determination testing, showing Shipping Channel Sedimentation variable (X) influence of 67.3% on the Shipyard Operational variable (Y). Hypothesis test (T-test) results show t-calculated exceeding t-table (12.679 > 1.990), with significance values lower than alpha values of 0.000b < 0.05, placing significance values in the H_0 rejection area (critical area). Thus, H_0 is rejected and H_a is accepted, confirming that Shipping Channel Sedimentation (X) affects Shipyard Operations (Y). Impacts caused by Perak River sedimentation affect shipyard effectiveness and operational efficiency, including reductions in vessels utilizing shipyard services, increased operational costs for shipyards and docking vessels, frequent activity delays due to waiting for highest tides for vessel entry/exit, and elimination of large vessel market potential due to channel transit impossibility.

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