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A Comparative Study of Ship Acquisition Projects Through New Shipbuilding, Second-Hand, and Charter Schemes: A Case Study of PT ZZZ

Iko Septiyahardi*, Silvianita
Institut Teknologi Sepuluh Nopember, Indonesia
Email: 6032241039@student.its.ac.id*, silvianita@its.ac.id

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Abstract

Metallurgical coal (met coal), particularly coking coal, is an essential raw material in steel production. Indonesia, as one of the leading coking coal producers in Southeast Asia, plays a strategic role in supporting the global steel supply chain. Most Indonesian coal exports are transported using tug and barge vessels from rivers to offshore transshipment areas before being transferred to larger vessels for export. This operational pattern presents significant challenges for shipping companies, as river conditions in Indonesia are constrained by depth, cargo capacity, and vessel characteristics. These limitations can affect operational efficiency and financial performance in the shipping sector. This study aims to analyze the investment feasibility of vessel procurement for metallurgical coal transportation at PT ZZZ by comparing three alternative schemes: new shipbuilding, second-hand purchase, and chartering. The analysis employs a quantitative approach using the Discounted Cash Flow (DCF) method, applying Net Present Value (NPV), Internal Rate of Return (IRR), and Profitability Index (PI) as evaluation indicators, based on vessel capital expenditure (CAPEX) and operational expenditure (OPEX) data. New shipbuilding is best for long-term (highest NPV, 70% margin, low risk). Second-hand suits rapid expansion (fastest payback, 32% IRR, moderate risk). Charter needs no CAPEX but has lowest margin (30%) and highest risk, for short-term only. Conclusion: new shipbuilding is optimal for PT ZZZ. The results of this study are expected to serve as a basis for shipping companies in making effective investment decisions that align with operational conditions and enhance financial efficiency.

INTRODUCTION

Metallurgical coal (met coal) is an essential component in the steelmaking process. […] Similarly, Indonesia's demand is projected to increase by 8 Mt, while Japan, Korea, and the European Union are expected to experience a combined decline of 10 Mt (International Energy Agency, 2024). Met coal demand projections are essentially based on steel production estimates from organizations such as the World Steel Association, combined with GDP growth and industrial activity, taking into account rising scrap utilization rates. Until the 2027 period, the adoption of hydrogen and various innovative processes to produce steel without using coke is expected to remain limited. In 2024 there is an estimated decrease in met coal consumption by 1.9%, bringing the total to 1,076 Mt. Although China is the main driver of the increase in 2023, the country is now expected to be the main factor in the decline in 2024 due to weakening industrial activity. Although India and Indonesia are projected to increase coal consumption, the increase is not enough to offset the decline from China. Indonesia is increasing coking coal consumption to supply new export-oriented coke ovens. The situation in Russia remains uncertain due to the ongoing war in Ukraine. In the next three years, there is not expected to

be a significant change in met coal consumption, which is mainly determined by steel demand in line with the economic outlook. Therefore, it is projected that overall met coal consumption will decline by 47 Mt, to 1,019 Mt by 2027 by the end of the three-year period, with India and Indonesia as the only major contributors to growth. India's 13 Mt increase in consumption is expected to be offset by a 63 Mt decline in China in the next three years. Similarly, Indonesia's demand is projected to increase by 8 Mt, while Japan, Korea, and the European Union are expected to experience a combined decline of 10 Mt (Erdiwansyah et al., 2021; Fragkos et al., 2021).

Metallurgical coal, especially coking coal, is an important raw material in the steel industry. Indonesia as one of the coking coal producers in the Southeast Asian region has a strategic role in supporting the global supply chain (Rahman & Raphael, 2025; Wu et al., 2017). However, in recent years national production has been relatively stagnant. The latest data shows that Indonesia's coking coal production in 2023 reached around 50 million tons, increasing slightly to 51 million tons in 2024, and is projected to remain at the same figure in 2025 (Halimatussadiah et al., 2024; Plakitkina, 2024; Rajamony et al., 2026). This stagnation reflects the limited expansion of the mine and the dynamics of the global market that have not fully recovered. On the other hand, domestic consumption is expected to increase, especially to supply the construction of new export-oriented coke ovens (Ronzon et al., 2025).

Although Indonesia is generally known as a major producer of thermal coal for power generation, its metallurgical coal reserves are relatively more limited and concentrated in the Central Kalimantan and East Kalimantan regions (Cokal Limited, 2020; Global Energy Monitor, 2023). Several major companies have developed metallurgical coal projects in Indonesia, including PT Bumi Barito Mineral (Cokal Ltd.) in Murung Raya, PT Maruwai Coal (Adaro Energy, ex-BHP Billiton) through the IndoMet project, as well as contributions from Bayan Resources and Kideco Jaya Agung in East Kalimantan. Although production is still relatively small compared to thermal coal, the potential for the development of Indonesia's coking coal is considered significant due to the increasing domestic demand from the downstream industry (Adaro Energy, 2021; Town Resources, 2021; Kideco Jaya Agung, 2020).

The region of Central Kalimantan, which produces the largest metallurgical coal, has 80% of its area covered by dense forests, peat swamps, mangrove forests, rivers, and traditional agricultural land. The highland areas of the northeast are remote and difficult to access. The central part of the province is covered with tropical forests, which produce rattan, resin, and precious woods such as ironwood and meranti. The lowlands in the south are dominated by peat bogs that intersect with many rivers (Code, 2010). The majority of Indonesia's coal is exported by loading onto tugs and barges on rivers or coasts, then taken to the sea to be transferred to large ships before being shipped abroad. This process shows how important ships are in the global distribution chain, because without ocean liners, large commodities such as coal would not have been possible to reach international markets (Kunroo & Alam, 2021). On the other hand, the shipping industry itself is the backbone of world trade, as it transports goods across continents. Therefore, investment in ships, both coal carriers, container ships, and tankers, greatly determines the smooth flow of international trade. In other words, the pattern of transporting Indonesia's coal by barges and seagoing vessels cannot be separated from the dynamics of ship investment in the global shipping industry, because the two support each

other: coal needs ships for export, while ships need cargoes such as coal to keep shipping investment profitable (Kim & Park, 2025).

Previous research has discussed vessel investment from various aspects. Kim and Park (2025) analyzed the patterns of ship investment in four countries but did not discuss the comparison of procurement schemes at the corporate level. Stasinopoulos (2011) examined the return on investment of new versus used ships for bulk ships, but not on tugboats and barges. Nguyen et al. (2022) examined operational risks in the container sector, while Onggaria and Moeis (2024) focused on loading and unloading risks, but did not discuss the risk of non-conformity of tugboat and barge specifications with river conditions. Purnomo and Tjendrasa (2020) discussed the coal transportation strategy in Indonesia but not a comparative analysis of three simultaneous ship procurement schemes.

Based on these searches, there are several research gaps. First, there has been no research that integrates operational risk analysis with financial risk in a single comparative framework for three ship procurement schemes (Nguyen et al., 2023; Nguyen & Wang, 2018). Second, research on ship investment is still dominated by large ocean vessels, while studies on tugs and barges in limited rivers such as Kalimantan are still very rare. Third, previous research has not measured the potential for financial losses measurably from the deviation of actual operational performance (Chen et al., 2023; Jacobs et al., 2016; Kaydos, 2020).

The novelty of this study is the development of an integrated analysis model between operational and financial risks simultaneously that has not been carried out by previous research, as well as a direct comparison between three ship procurement schemes, namely new shipbuilding, second-hand, and charter in the same case study using equivalent operational and financial data. This study also measures the potential for financial losses due to operational risks based on actual data such as availability, steaming time, and fuel consumption, which is a more measurable approach compared to previous operational risk research which is still qualitative. In addition, this study fills the literature gap by taking the specific context of tugs and barges transporting coal metallurgy in the Kalimantan river that have navigation limitations, and provides recommendations for conditional schemes based on short-term and long-term investment profiles.

Based on the background described, this study focuses on several main problems, namely how to conduct a feasibility analysis for ship procurement in shipping companies, what operational and financial risks are faced in the procurement process, and which procurement scheme is the most feasible both financially and operationally with the lowest level of risk.

The purpose of this study is to conduct a feasibility analysis of ship procurement through three alternative schemes, namely new shipbuilding, second-hand vessels, and charter schemes. In addition, this research aims to identify and evaluate operational and financial risks for each procurement alternative using analytical tools such as risk matrix, Net Present Value (NPV), Internal Rate of Return (IRR), and Profitability Index (PI). Ultimately, the study seeks to determine the most feasible ship procurement alternative based on a comprehensive analysis of financial and operational risks, particularly in the case study of PT ZZZ.

This study is limited to several aspects to maintain focus and relevance. The case study is conducted in a shipping company engaged in coal transportation services, namely PT ZZZ. The type of vessel analyzed is Tug & Barge (a set) used for transporting metallurgical coal. Furthermore, the data presented in this study is anonymized by disguising the company's

identity and excluding detailed strategic information. The analysis also assumes that the exchange rates of Rupiah and US Dollar remain constant throughout the calculation process.

The expected benefits of this research are to provide valuable insights for stakeholders, particularly ship owners and shipping companies, regarding the technical, operational, and financial risks associated with ship procurement decisions. By understanding these risks, companies can make more informed and strategic decisions in selecting the most appropriate procurement scheme whether through new shipbuilding, second-hand purchase, or chartering thus supporting the sustainability and long-term performance of the company.

RESEARCH METHOD

The methodology of this research contained the research steps from beginning to end along with the methods used by the author. In this chapter, the framework (flow chart) in the work of this research will be described.

1. Data and information collection

The data collection from the company that became the case study was PT ZZZ. The data collected is in the form of:

a. Operating pattern of PT ZZZ ships loaded with metallurgical coal
b. Ship structure of PT ZZZ Metallurgical Coal Transport for the 2020 - 2025 Period
c. CAPEX & OPEX cost components of tug & barge operations for metallurgical coal cargo at PT ZZZ

2. Analysis of tug and barge fleet needs

After obtaining the data mentioned above at this stage, the needs of the tug & barge fleet will be analyzed to be known:

a. Optimal tug & barge characteristics for metallurgical coal transport with existing operational conditions
b. After determining the characteristics of the tug and barge vessels needed, then a comparison was made with existing ships that were already operating for metallurgical coal transportation at PT ZZZ.

c. CAPEX and OPEX analysis of tug & barge vessels

At this stage, a thorough calculation will be made for the capital expense (CAPEX) and operational expense (OPEX) to operate tug & barge vessels. The total value of CAPEX and OPEX will be used as the basis for calculating ship revenue for financial risk analysis through Net Present Value (NPV), Internal Rate of Return (IRR) and Profitable Index (PI).

d. Risk analysis of tug and barge procurement

At this stage, both operational and financial risk analysis will be carried out. First, an analysis of operational risks that have an impact on finances will be carried out, then a financial risk analysis will be carried out.

d. Operational risk analysis

In the operational risk analysis, a sequence of operational risks of tug and barge vessels will be carried out. continued to create a risk matrix for each procurement scheme, namely new shipbuilding, used (second hand) and charter ship.

e. Financial Risk Analysis

Financial risk analysis will be carried out on the procurement scheme, namely new shipbuilding, used (second hand) and charter ships through the calculation of NPV, IRR and PI as described above.

e. Conclusions and suggestions

After conducting an operational and financial analysis of each ship procurement scenario, the most feasible conclusion was drawn in terms of ship procurement in the company that became the case study, namely PT ZZZ. Suggestions and recommendations can be used for shipping companies, especially those engaged in tug & barge types in making decisions on ship procurement in the future.

The research begins by identifying issues that are worthy of being used as a topic, especially about project investment in the shipping sector. After getting a big picture of the problem that will be used as the topic of research, then formulate what problems will be specifically answered in the research. The next step is to look for literature studies as a reference on investment, ship operations, tug & barge, financial risks, operational risks and investment trends in Indonesia. After that, the author collected data from PT ZZZ in the form of operational patterns, operational performance of ships, existing ship arrangement and CAPEX & OPEX costs of existing ships. After that, the author analyzes the most suitable ship needs for the company in terms of the characteristics and performance of existing ships that are in accordance with the company's operational pattern. After that, the author calculates CAPEX & OPEX of ship operations for new shipbuilding, second-hand and charter ship schemes as the basis for calculating the financial risk of the three ship procurement schemes. Furthermore, analyze the operational risks of the three schemes. After obtaining financial and operational risks, the final stage will determine which of the three schemes is the most feasible from a financial and operational point of view, which will be the choice of the ship procurement scheme in the company.

RESULTS AND DISCUSSION

Operational risks of tug and barge procurement

Operational risk is the potential uncertainty of the ship during operation that can disrupt the company's revenue. Shipping companies such as PT ZZZ that are the place of the research have a very small risk of losing market share because PT ZZZ is a subsidiary of a company that owns the mine so PT ZZZ does not need to look for cargo but cargo that is already available to be transported. Therefore, this discussion will focus on technical conditions and for the procurement of tugs and barges for coal cargo.

1. Operational risk identification

Identification of operational risks is carried out to find out the source of the risk and the consequences of these risks. The following is the sequence of operational risks in the procurement of ships, both New Shipbuilding (new ships, Secondhand (used ships) and Charter (charter ships):

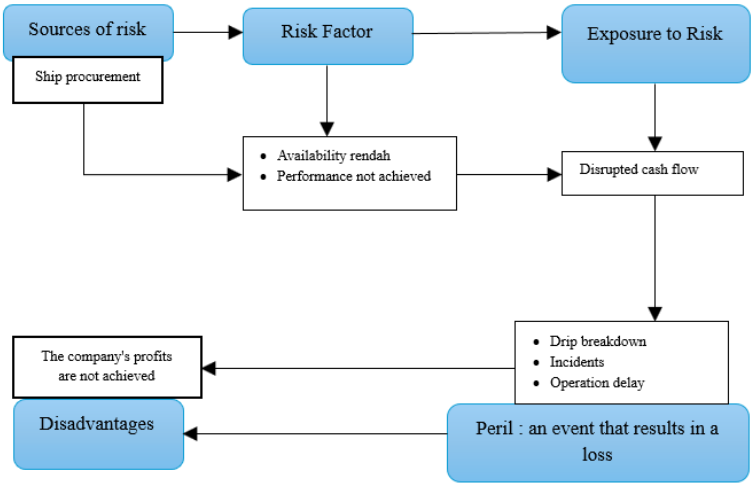

Figure 1. Sequence of operational risks for ship procurement

Source: Results processed by researchers (personal documents), 2025, based on the identification of the operational process chain of ship procurement at PT ZZZ

Based on the flowchart above, operational risks can be identified by looking at the relationship between risk factors and risk exposure to the company. From this analysis, several main risks were obtained, namely low ship availability and poor operating performance. For operating performance, it is divided into several parts, namely steaming time, fuel consumption and payload performance.

The following is a list of risks that can cause company losses and are sourced from ship procurement:

Table 1. Tug & Barge operational risk list

Category	Code	Risks	Impact	Causes
Technical	R1	Low Availability	Operational downtime	Breakdown
Performance	R2	High Steaming time	Schedule interrupted	Ship performance is not optimal
	R3	High Fuel consumption	High operational costs	Miss match Tug & Barge
	R4	Load is not optimal	Revenue decline	Load planning is not optimal

Source: PT ZZZ primary data processed by researchers, 2025

After knowing the operational risks, the next step is to analyze and assess the operational risk variables. The analysis was carried out using a risk matrix, which is the result of multiplication between like hood/frequency and consequence/severity/severity of risk. In this study, sample data from PT ZZZ was used where the average value of the population was taken from both new shipbuilding, secondhand and charter ships.

The following is the operational data of each ship with a procurement scheme operating at PT ZZZ:

Table 2. Data availability (new shipbuilding)

Month	Availability	Remarks
Month -1	97.742%	1 Vessel docking 14 days
Month -2	100.000%	
Month -3	99.774%	Breakdown 33.6 hours

Month	Availability	Remarks
Month -4	99.618%	Breakdown 46.6 hours
Month -5	96.188%	1 Vessel docking 22 days
Month -6	96.314%	1 Vessel docking 27 days
Month -7	100.00%	
Month -8	100.000%	
Month -9	99.961%	Breakdown 5.75 hours
Month -10	100.00%	
Month -11	100.00%	
Month -12	100.00%	
Average	99.133%	

Source: PT ZZZ operational data for a 12-month period, processed by researchers, 2025

Based on the table, 2 new ships (New shipbuilding) have an average availability in a year, which is 99,133%. What makes availability less is due to breakdown and carrying out docking repair because it has entered its due date.

Table 3. Data availability (secondhand)

Month	Availability	Remarks
Month -1	99.993%	Breakdown 1.15 hours
Month -2	96.293%	1 Vessel docking 23 days
Month -3	95.439%	1 Vessel docking 31 days
Month -4	96.590%	1 Vessel docking 22 days
Month -5	95.455%	1 Vessel docking 29 days
Month -6	95.455%	1 Vessel docking 35 days
Month -7	93.40%	2 Vessel docking 46 days
Month -8	98.729%	1 Vessel docking 9 days
Month -9	99.923%	Breakdown 12.6 hours
Month -10	100.00%	
Month -11	100.00%	
Month -12	100.00%	
Average	97.606%	

Source: PT ZZZ operational data for a 12-month period, processed by researchers, 2025

Based on the table 3 used ships (secondhand) have an average availability in a year, which is 97,606%. What makes availability less is due to breakdown and carrying out docking repair because it has entered its due date.

Table 4. Data availability (charter)

Month	Availability	Remarks
Month -1	98.564%	Breakdown 148 hours
Month -2	99.486%	Breakdown 79.5 hours
Month -3	95.390%	1 Vessel docking 31 days
Month -4	91.515%	3 Vessel docking 61 days
Month -5	95.424%	1 Vessel docking 28 days

Month	Availability	Remarks
Month -6	97.459%	2 Vessel docking 20 days
Month -7	93.884%	3 Vessel docking 46 days
Month -8	91.870%	3 Vessel docking 62 days
Month -9	97.393%	1 Vessel docking 15 days
Month -10	99.735%	Breakdown 40 hours
Month -11	99.744%	Breakdown 40 hours
Month -12	99.78%	Breakdown 34 hours
Average	96.687%	

Source: PT ZZZ operational data for a 12-month period, processed by researchers, 2025

Based on the table 4 used ships (secondhand) have an average availability in a year, which is 96,687%. What makes availability less is due to breakdown and carrying out docking repair because it has entered its due date.

Table 5. PT ZZZ ship incident data

Month	New shipbuilding	Secondhand	Charter
	Incident	Incident	Incident
Month -1			9
Month -2			1
Month -3		2	3
Month -4			
Month -5	2		4
Month -6			
Month -7			2
Month -8			3
Month -9			3
Month -10			8
Month -11	2	2	2
Month -12			6
Total	4	4	41

Source: PT ZZZ incident log for a 12-month period, processed by the researcher, 2025.

Based on the table 5 charter ships have the highest total incidents and operational downtime, which is 41 incidents. Meanwhile, new ships (new shipbuilding) and used ships (secondhand) have the same number of incidents, namely 4 incidents.

Based on the provisions, the minimum availability limit is more than 90% if the income is 100% charter rate every month. If the ship's availability is below 90%, the ship's revenue, namely availability, is multiplied by the charter rate. Furthermore, five criteria for the level of occurrence frequency/likelihood related to availability are determined as follows:

1) Criterion 1 if the likelihood is almost non-existent (rare), i.e. the ship's availability is less than 100% less than equal to 1 time
2) Criterion 2 if the likelihood is rare (unlikely), namely the ship's availability is less than 90% between 2 – 5 times

3) Criterion 3 if the likelihood is possible is that the ship's availability is less than 90% between 6 – 9 times
4) Criterion 4 if the likelihood is often (likely) is that the ship's availability is less than 90% between 10 – 12 times
5) Criterion 5 if the likelihood is almost certain is that the ship's availability is less than 90% more than 12 times

Here's a summary of the table:

Table 6. Criteria for occurrence frequency/likelihood risk availability

RISK	CRITERIA	LIKELIHOOD
Almost doesn't happen (rare)	1	x≤1 Event
Rare (unlikely)	2	2- 5 events
Possible	3	6 - 9 incidents
Often (likely)	4	10-12 incidents
Almost certain	5	> 12 incidents

Source: The results of the researcher's study based on the ISO 31000:2009 standard [14] and the operational conditions of PT ZZZ

Operational risks related to availability have an impact on the company's revenue (financial impact). The calculation of losses resulting from this availability is based on the result of multiplying the percentage of availability and ship charter rates that have been discussed in the previous subsection. The following are the impact/consequence criteria:

Table 7. Criteria consequence risk availability

RISKS	CRITERIA	CONSEQUENCE
Insignificant (TS)	1	Loss < 10 million
Small (K)	2	Loss 10 - 50 million
Intermediate (M)	3	Loss of 50 - 100 million
Large (B)	4	Loss 100 - 1 m
Very large (SB)	5	Loss > 1 M

Source: The results of the researcher's study based on the financial risk profile of PT ZZZ

After knowing the likelihood and consequence criteria based on tables 4.26 and 4.27, the next step is to create a risk matrix for each ship procurement scheme, namely new shipbuilding, secondhand and charter ship. The risk matrix is the result of multiplication of likelihood and consequence which will result in the risk status summarized in the following table:

Table 8. Risk analysis matrix

Likelihood (P)	Consequence(I)				
	Insignificant (TS) (1) Unsignificant	Small (K) (2) Minor	Medium (M) (3) Moderate	Large (B) (4) Significant	Very large (SB) (5) Catastrophic
Almost certain (5)	5	10	15	20	25
Likely (4)	4	8	12	16	20

Likelihood (P)	Consequence(I)				
	Insignificant (TS) (1) Unsignificant	Small (K) (2) Minor	Medium (M) (3) Moderate	Large (B) (4) Significant	Very large (SB) (5) Catastrophic
Possible (3)	3	6	9	12	15
Unlikely : (2)	2	4	6	8	10
Almost non-occurrence (rare) (1)	1	2	3	4	5

Source: Adapted from ISO 31000:2009 [14] and Hanafi (2014) [15], adapted to research needs

LEVEL RISK	AMOUNT RISK	COLOR
Very high	12 <x<25	
Height	10<x<12	
Medium	5<x<9	
Low	3<x<4	
Very low	1<x<2	

From the ship procurement scheme, namely new shipbuilding, secondhand and charter ships. The following are the results of the risk assessment:

Table 9. Ship availability risk level (R1)

Availability	Likelihood (P)	Consequence (I)	Risk (R)	Level
New shipbuilding (new ship)	1	1	1	Very low
Secondhand (Used Ship)	1	1	1	Very low
Charter (charter)	1	1	1	Very low

Source: Results of the researcher's analysis

After determining the risk level of the availability category (R1), the next step is to create a risk matrix for each ship procurement scheme, namely new shipbuilding, secondhand and charter ship from the performance category, namely steaming time (R2), fuel consumption (R2) and cargo efficiency (R4). The following is data for steaming time, fuel consumption and cargo efficiency in one year:

Table 10. Average performance of steaming time (R2), fuel consumption (R3) and cargo (R4)

Status	Cargo Efficiency (CE)			Steaming Time Efficiency (TE)			Fuel Consumption Efficiency (FE)		
	Achieve	Target	Dev	Achieve	Target	Dev	Achieve	Target	Dev
New Shipbuilding	103.97%	100.00%	3.97%	99.38%	100.00%	-0.62%	108.12%	100.00%	8.12%
Secondhand	102.29%	100.00%	2.29%	94.71%	100.00%	-5.29%	92.88%	100.00%	-7.12%
Charter	103.51%	100.00%	3.51%	79.46%	100.00%	-20.54%	80.83%	100.00%	-19.17%

Source: PT ZZZ operational performance data for a period of 12 months, processed by researchers, 2025

Based on the provisions, the performance targets of steaming time efficiency, fuel consumption and cargo efficiency are 100%. Furthermore, five criteria for the level of occurrence frequency/likelihood related to the 3 items above are determined as follows:

Table 11. Criteria for occurrence frequency/likelihood of risk of steaming time (R2), fuel consumption (R3) and cargo (R4)

RISK	CRITERIA	LIKELIHOOD
Almost doesn't happen (rare)	1	≤1 incident
Rare (unlikely)	2	2- 5 events
Possible	3	6 - 9 incidents
Often (likely)	4	10-12 incidents
Almost certain	5	> 12 incidents

Source: The results of the researcher's study based on PT ZZZ's operational standards.

Table 12. Criteria for the impact/consequence of the risk of steaming time (R2), fuel consumption (R3) and cargo (R4)

RISKS	CRITERIA	CONSEQUENCE
Insignificant (TS)	1	Deviation of -5% from target
Small (K)	2	Deviation -6 to -10% from target
Intermediate (M)	3	Deviation -21s.d -30% from target
Large (B)	4	Deviation -30 to -40% from target
Very large (SB)	5	> deviation - 40% of the target

Source: The results of the researcher's study are based on PT ZZZ's operational targets.

The following are the results of the risk assessment:

Table 13. Ship steaming time risk level (R2)

Steaming time	Likelihood (P)	Consequence(I)	Risk	Level
New shipbuilding (new ship)	5	1	5	Medium
Secondhand (Used Ship)	5	2	10	Height
Charter (charter)	5	4	20	Very High

Source: Results of the researcher's analysis

Table 14. Ship's fuel consumption risk level (R3)

Fuel consumption	Likelihood (P)	Consequence(I)	Risk	Level
New shipbuilding (new ship)	5	1	5	Medium
Secondhand (Used Ship)	4	2	8	Medium
Charter (charter)	5	3	15	Very High

Source: Results of the researcher's analysis

Table 15. Ship efficiency cargo risk level (R4)

Cargo efficiency	Likelihood (P)	Consequence(I)	Risk	Level
New shipbuilding (new ship)	1	1	1	Very low
Secondhand (Used Ship)	2	1	2	Very low
Charter (charter)	2	1	2	Very low

Source: Results of the researcher's analysis

Based on the operational risk assessment consisting of availability (R1), steaming time (R2), fuel consumption (R3) and cargo efficiency (R4), here is a summary:

Table 16. Summary of ship operational risk assessment at PT ZZZ

Likelihood (P)	Consequence(I)				
	Tidak signifikan (TS) (1) *Unsignificant*	Kecil (K) (2) *Minor*	Menengah (M) (3) *Moderate*	Besar (B) (4) *Significant*	Sangat besar (SB) (5) *Catasthropic*
Hampir pasti terjadi *(almost certain)* (5)	R2 New ShipBuilding R3 New ShipBuilding 5	R2 Secondhand 10	R3 Charter 15	R2 Charter 20	25
Sering terjadi *(likely)* (4)	4	R3 Secondhand 8	12	16	20
Mungkin terjadi *(possible)* (3)	3	6	9	12	15
Jarang terjadi *(unlikely)* (2)	2	4	6	8	10
Hampir tidak terjadi *(rare)* (1)	R1 New Shipbuilding Secondhand Charter 1 R4 New Shipbuilding	R4 Secondhand Charter 2	3	4	5

Source: Results of the researcher's analysis

After the risk level assessment is carried out, then an evaluation of the risk appetite is carried out to determine whether the identified risk is still within acceptable tolerance limits. Risk appetite in this study is determined based on the range of the impact of the company's financial losses as a representation of the company's ability to bear the financial impact due to operational risks. From the analysis in the previous subsection. The part of operational risk that has medium to high risk to finance is steaming time (R2) and fuel consumption (R3). Therefore, in this section, these two variables will be analyzed related to risk appetite. Here are the criteria:

Table 17. Criteria for risk appetite

Level risk	Financial exposure	Appetite
Low	≤ 100 million	Accept
Medium	100 million - 1 M	Monitor
High	≥ 1 M	Mitigate

Source: The results of the researcher's study based on PT ZZZ's financial ability

Furthermore, the potential revenue loss from the total loss time and fuel loss due to the non-achievement of steaming time and fuel consumption will be calculated.

Loss revenue = Loss steaming time + loss fuel consumption

= (Loss time x revenue per day) + (loss fuel x fuel price per day)

For revenue per day based on the calculation in the previous subdivision is IDR 1,003,061.01 for owned vessels and IDR 501,530.50 for charter vessels. Meanwhile, the price of fuel per liter is IDR 24,000 based on the previous subsidy.

The following are the results of calculating revenue loss caused by steaming time and fuel consumption

Table 18. Revenue loss due to steaming time

Vessel	Los Time (hour/year)	Loss Revenue Potential	Level
New Shipbuilding	-0.675476191	-Rp1,414,004.51	Low
Secondhand	-11.18526537	-IDR 23,414,616.09	Low
Charter	-209.6678386	-Rp219,453,530.40	Medium

Source: Results of the researcher's calculations

Table 19. Revenue loss due to fuel consumption

Vessel	Los Fuel (L/year)	Loss Revenue Potential	Level
New Shipbuilding	1044.67381	IDR25,072,171.43	Low
Secondhand	-1379.553147	-Rp33,109,275.53	Low
Charter	-16472.57978	-Rp395,341,914.80	Medium

Source: Results of the researcher's calculations

Table 20. Total loss revenue

Vessel	Loss Revenue Potential	Level
New Shipbuilding	IDR23,658,166.92	Low
Secondhand	-Rp56,523,891.62	Low
Charter	-Rp614,795,445.20	Medium

Source: Results of the researcher's calculations

Based on the results of operational risk analysis on four main parameters, namely ship availability (R1), steaming time (R2), fuel consumption (R3), and cargo performance (R4), as well as the evaluation of risk appetite, several key findings were obtained that showed differences in risk levels in each ship procurement scheme. From the aspect of availability, all procurement schemes show a very low level of risk, so that the availability factor of the ship is not a significant differentiator in determining the optimal alternative. Significant differences are seen in the aspects of steaming time and fuel consumption, where both parameters are the main source of risk in tug & barge configuration operations. The results of the analysis show that charter ships have the highest level of risk, with a very high category, which is caused by a considerable deviation in performance from operational targets. This condition indicates a discrepancy between the technical specifications and the actual performance of the vessel, which has a direct impact on the efficiency of sailing time and fuel consumption.

Meanwhile, secondhand vessels show medium to high levels of risk, which are mainly influenced by factors of technical condition and the age of the vessel. New shipbuilding has the lowest level of risk, with performance that is closest to operational targets.

In terms of cargo performance, all schemes show a very low level of risk, so it is not a critical factor in differentiating the level of operational risk.

Furthermore, when the results of risk analysis are associated with risk appetite, the result is obtained that the charter scheme (used ship) produces potential losses in the medium category that must be monitored to improve its performance so as to reduce the risk appetite value. Meanwhile, new shipbuilding and secondhand ships produce potential losses in the low category so they are acceptable.

From this operational risk analysis, it can be concluded that:

1. The main operational risks in tug-barge operations come from the aspects of steaming time and fuel consumption.
2. The risk of steaming time and fuel consumption of new ships (new shipbuilding) is in the medium category while used ships (secondhand) are in the high category for steaming time and medium for fuel consumption. As for charter ships, both steaming time and fuel consumption have a very high-risk value
3. Charter ship schemes have a moderate risk appetite while new and used (secondhand) ships have a low-risk appetite
4. For new shipbuilding operational risks, it provides a balance between efficiency, operational performance and acceptable risk levels

Financial risks of tug and barge procurement

After the operational risks are analyzed, then an analysis of financial risks is carried out in the procurement of Tug 1600 ship configurations + 5000-ton Barge new shipbuilding, secondhand and charter ships. In this analysis, several assumptions are set to make the calculation easier, namely:

1. Estimated revenue for new shipbuilding and secondhand ships is obtained entirely from the results of leasing ships to cargo owners. Meanwhile, for charter ships, the revenue is 50% of what is received from the cargo owner.
2. CAPEX is in accordance with what is summarized in subchapter 4.4, namely
   - IDR 49,000,000,002.21 for new shipbuilding
   - IDR 36,750,000,002.21 for used boats (secondhand)
3. The charter rate used is as discussed in the previous subchapter, which is IDR 1,507,208,191/month for owned vessels. Meanwhile, for charter ships, the profit-sharing scheme is 20%, which is IDR 301,441,638.21/month for service users and the remaining 80% for ship owners
4. Charter rates are assumed to increase by 10% per year
5. The increase in operating costs is assumed to experience a linear increase of 5% every year
6. Depreciation period and economic life of ship assets of 20 years for new ships (New shipbuilding) and 10 years for used ships (secondhand)
7. The lifespan of a new ship (New Shipbuilding) is 20 years and a used ship (Secondhand) is 10 years
8. Fully capital (full equity) ship procurement scheme
9. Discount factor of 10%
10. USD exchange rate of IDR 16,000

After determining the above assumptions, then conduct a financial risk analysis with outputs in the form of financial feasibility criteria as follows:

1. Net present value greater than zero (NPV > 0)
2. Internal rate of return greater than 10% (IRR > 9%)
3. Profitability index greater than 1 (PI > 1)
4. Profit margin

a) Financial Risk Analysis of New Shipbuilding Scheme

The following is a summary:

Table 21. Results of the calculation of the financial model of New Shipbuilding

Item	Units	Amount
CAPEX	1 set	-Rp49,000,000,002
OPEX (Cash out)	per year	-IDR 7,392,585,308
Revenue (Cash in)	per year	IDR18,086,498,292.53
Net cash flow	per year	IDR10,693,912,984.51
NPV	20 years	IDR124,589,172,632.53
IRR	20 years	31%
Profitability index (PI)	20 years	3.542636176
Payback period (PP)	years	4.582045887
Profit margin	%	70%

Source: The results of the researcher's DCF analysis using CAPEX/OPEX PT ZZZ data

For the new ship scheme (New Shipbuilding), the NPV value is positive, which is IDR 124,589,172,632.53 and the IRR is 31% above the criterion, which is > 10%. While the profitability index is more than 1, which is 3.54. This indicates that the investment in this scheme is feasible to run. Besides that, the payback period of this scheme is 4.58 years, meaning that in the 5th year this scheme has broken even. This scheme also generates a profit margin of 70%. Of all aspects the financial assessment of this scheme is worth running.

b) Financial Risk Analysis of Secondhand Shipping Schemes

The following is a summary:

Table 22. Results of the calculation of the financial model of a used ship (Secondhand)

Item	Unit	Amount
CAPEX	1 set	-Rp36,750,000,002
OPEX (Cash out)	average per year	-Rp8,973,233,717
Revenue (Cash in)	average per year	IDR18,086,498,292.53
Net cash flow	per year	IDR 9,113,264,575.08
NPV	Rp	IDR52,216,519,996.56
IRR	%	32%
Profitability index (PI)		2.420857687
Payback period (PP)	years	4.032583461
Profit margin	%	59%

Source: The results of the researcher's DCF analysis using CAPEX/OPEX PT ZZZ data

For the secondhand ship scheme, the NPV value is positive, which is IDR 52,216,519,996.56 and the IRR is 32% above the criterion, which is > 10%. While the profitability index is more than 1, which is 2.42. This indicates that the investment in this scheme is feasible to run. In addition, the payback period of this scheme is 4.03 years, meaning that in the 5th year this scheme has broken even. This scheme also generates a profit margin of 59%. Of all aspects the financial assessment of this scheme is worth running.

c) Financial risk analysis of charter ship schemes

The following is a summary:

Table 23. Calculation results of the charter ship financial model (Charter)

Item	Unit	Amount
CAPEX	1 set	IDR0
OPEX (Cash out)	per year	-IDR 2,441,973,692
Revenue (Cash in)	average per year	IDR7,053,734,334.09
Net cash flow	average per year	IDR 4,611,760,641.78
NPV	Rp	IDR14,409,794,541.76
IRR	%	None
Profitability index (PI)		None
Payback period (PP)	years	None
Profit margin	%	30%

Source: The results of the researcher's DCF analysis use OPEX data and PT ZZZ's profit sharing scheme

For the charter ship scheme, the NPV value is positive, which is IDR 14,409,794,541.76. In this scheme, the financial aspects, namely IRR, profitability index and payback period, cannot produce value because in this scheme there is no initial capital (CAPEX) because the ship is chartered and directly operated. Service users only provide fuel. In this scheme, in addition to the NPV value, there is a profit margin value that can be assessed as a financial aspect whose value is 30%. From the aspect of financial assessment that has been carried out, this scheme is feasible to run.

After knowing the financial analysis of the three schemes above, here is a summary:

Table 24. Comparison of financial risks 3 schemes

Item	Unit	New shipbuilding	second-hand	Charter
CAPEX	1 set	-Rp49,000,000,002	-Rp36,750,000,002	IDR0
OPEX (Cash out)	per year	-IDR 7,392,585,308	-Rp8,973,233,717	-IDR 2,441,973,692
Revenue (Cash in)	per year	IDR18,086,498,292.53	IDR18,086,498,292.53	IDR7,053,734,334.09
Net cash flow	per year	IDR10,693,912,984.51	IDR 9,113,264,575.08	IDR 4,611,760,641.78
NPV	Rp	IDR124,589,172,632.53	IDR52,216,519,996.56	IDR14,409,794,541.76
IRR	%	31%	32%	None
Profitability index (PI)		3.542636176	2.420857687	None
Payback period (PP)	years	4.582045887	4.032583461	None
Profit margin	%	70%	59%	30%

Source: Results of the researcher's analysis

Based on table 24, it can be seen that the new shipbuilding scheme has the highest NPV, profitability index and profit margin while the used ship scheme (Secondhand) has the highest IRR and the fastest payback period. As for charter ships, although they have a positive NPV value and profit margin, the value is the lowest, besides that this scheme is not relevant for the

calculation of IRR, profitability index and payback period because it does not require initial capital (CAPEX)

Comparison of operational and financial risks of new shipbuilding, secondhand and charter

The following is a summary of the operational and financial risks of the 3 ship procurement schemes:

Table 25. Comparison of operational and financial risk analysis of Tug & Barge procurement scheme

No	Item	Unit	Risk Type	New shipbuilding	second-hand	Charter
1	Availability	Level	Operational	Very low	Very low	Very low
2	Steaming time	Level		Medium	High	Very high
3	Fuel consumption	Level		Medium	Medium	Very high
4	Risk appetite	Level		Low	Low	Medium
5	CAPEX	1 set	Financial	-Rp49,000,000,002	-Rp36,750,000,002	IDR0
6	OPEX (Cash out)	per year		-IDR 7,392,585,308	-Rp8,973,233,717	-IDR 2,441,973,692
7	Revenue (Cash in)	per year		IDR18,086,498,292.53	IDR18,086,498,292.53	IDR7,053,734,334.09
8	Net cash flow	per year		IDR10,693,912,984.51	IDR 9,113,264,575.08	IDR 4,611,760,641.78
9	NPV	Rp		IDR124,589,172,632.53	IDR52,216,519,996.56	IDR14,409,794,541.76
10	IRR	%		31%	32%	None
11	Profitability index (PI)			3.542636176	2.420857687	None
12	Payback period (PP)	years		4.582045887	4.032583461	None
13	Profit margin	%		70%	59%	30%

Source: Results of the researcher's analysis

From table 25, it can be seen that new shipbuilding and secondhand ships have the most acceptable operational risks, while charter ships are acceptable but must be monitored to maintain their performance. Meanwhile, in terms of financial risk, all three are financially feasible. The explanation for each scheme is as follows:

1. New shipbuilding has low operational risks. Meanwhile, from the financial side, the NPV value is the largest, which is IDR 124,589,172,632.53 and the highest profit margin, which is 70%. This scheme is suitable for long-term investment as it generates the highest economic value throughout the life of the project
2. Secondhand vessels have low operational risks. Meanwhile, in terms of finance, the IRR value is the largest, which is 32% and the fastest payback period. This scheme is suitable for short-term investments with limited capital but wants rapid expansion
3. Charter ships have the highest operational risk of the 3 schemes. Meanwhile, from the financial side, the profit margin is the smallest, but cash flow is still positive. This scheme is suitable for short-term investments and first-time investments because it does not require initial capital (CAPEX).

CONCLUSION

Based on the analysis and discussion, it can be concluded that ship procurement feasibility in shipping companies can be evaluated through operational and financial risk analysis across new shipbuilding, secondhand, and charter schemes, each showing different characteristics and levels of feasibility. The new shipbuilding scheme is the most feasible, with the highest economic indicators (NPV of 124.5 billion, IRR of 31%, PI of 3.5, and a payback period of 4.5 years), the highest profit margin (70%), and the lowest operational risk, making it suitable for long-term investment. The secondhand scheme is also financially feasible (NPV of 52.2 billion, IRR of 32%, PI of 2.4, and payback period of 4 years) and is appropriate for capital efficiency, although it carries moderate operational risk due to vessel age and maintenance needs. Meanwhile, the charter scheme generates positive cash flow (4.6 billion) without requiring initial capital but has the lowest profit margin (30%) and the highest operational risk, making it more suitable for short-term or temporary needs. Overall, the integration of technical, operational, and financial analysis indicates that the new shipbuilding scheme is the most optimal choice for PT ZZZ, followed by the secondhand scheme as an alternative, while the charter scheme serves as a flexible short-term solution depending on the company's investment objectives.

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