The Impact of Fluctuations in Fuel Prices and the Rupiah Exchange Rate on the Operational Management Efficiency of Shipping Companies

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Abstract
Fuel oil (BBM) prices and the rupiah exchange rate are two external economic variables that significantly influence the cost structure of shipping companies, particularly in an archipelagic country such as Indonesia. This study aimed to examine the effects of fuel price fluctuations and rupiah exchange rate movements on the efficiency of shipping operational management. The study employed a quantitative descriptive-verification approach using secondary time-series data, including high-speed diesel (HSD) and marine fuel oil (MFO) prices, the rupiah exchange rate against the US dollar, ship fuel consumption, and operational costs per voyage. The data were analyzed using multiple linear regression and could be extended to panel data regression for cross-fleet observations. The results indicated that increases in fuel prices raised ship operational costs and potentially reduced maritime transportation volume, while rupiah depreciation increased the costs of fuel procurement, spare parts, and vessel maintenance due to dependence on imported components. Operational efficiency could be improved through information technology-based fuel consumption monitoring, optimization of vessel economic speed (slow steaming), and budget planning that accounted for exchange rate fluctuations and energy cost sensitivity. This study contributed an operational efficiency strategy framework for shipping companies that is adaptive to energy price pressures and exchange rate volatility.

INTRODUCTION

Fuel oil (BBM) prices and the rupiah exchange rate are two external economic variables that significantly influence the cost structure of shipping companies, particularly in an archipelagic country such as Indonesia (Devy et al. 2025; Fathoni et al. 2025; Palupi et al. 2024; Soekirman et al. 2026). This study aimed to examine the effects of fuel price fluctuations and rupiah exchange rate movements on shipping operational management efficiency. The study employed a quantitative descriptive-verification approach using secondary time-series data, including high-speed diesel (HSD) and marine fuel oil (MFO) prices, the rupiah exchange rate against the US dollar, vessel fuel consumption, and operational costs per voyage (Sudjaka 2018; Yıldız 2025). The data were analyzed using multiple linear regression and could be extended to panel data regression for cross-fleet observations (Bimpikis et al. 2023; Grubic 2018; Lv et al. 2026; Özcan 2025; Zhang et al. 2025). The results indicated that increases in fuel prices raised vessel operational costs and potentially reduced maritime transportation volume, while rupiah depreciation

increased the costs of fuel procurement, spare parts, and vessel maintenance due to dependence on imported components (Candra 2025; Priyanto 2017; Septriani n.d.). Operational efficiency could be improved through information technology-based fuel consumption monitoring, optimization of vessel economic speed (slow steaming), and budget planning that accounted for exchange rate fluctuations and energy cost sensitivity (Elkafas 2025; Giusti 2022; Moreira 2018; Notteboom et al. 2017; Pradana 2024). This study contributed an operational efficiency strategy framework for shipping companies that is adaptive to energy price pressures and exchange rate volatility.

METHOD

This study employed a quantitative descriptive-verification approach. The descriptive approach was used to examine trends in fuel prices, the rupiah exchange rate, vessel fuel consumption, and shipping operational costs over time, while the verification approach was applied to test the effects of fuel price and exchange rate variables on operational efficiency (Siliwangi University, 2025; Indonesian University of Education, 2023).

The study used secondary time-series data, including HSD/MFO fuel prices, the rupiah exchange rate against the US dollar, vessel fuel consumption, operational costs per voyage, and efficiency indicators such as fuel cost per nautical mile or Energy Efficiency Operational Indicator (EEOI) (Siliwangi University, 2025; ITS Repository, 2023). When observations involved multiple vessels or shipping companies across several periods, the analysis was extended using panel data regression (Indonesian University of Education, 2023).

The research population consisted of shipping companies or fleets with complete operational records during the observation period. The sample was selected using purposive sampling, focusing on fleets or companies with consistent data availability on fuel prices, exchange rates, and operational costs throughout the study period (Indonesian University of Education, 2023).

Data analysis was conducted in several stages. First, descriptive statistical analysis was performed to examine fuel price trends, exchange rate movements, and changes in operational costs. Second, correlation analysis was applied to identify preliminary relationships between independent and dependent variables. Third, multiple linear regression analysis using the Ordinary Least Squares (OLS) method was employed for the time-series model (Siliwangi University, 2025). For panel data involving multiple companies or fleets across different periods, fixed-effects panel data regression was applied to obtain more robust estimates of the relationships among variables (Indonesian University of Education, 2023).

In general, the research model can be written as follows:

$$EFF_t = \beta_0 + \beta_1 BBM_t + \beta_2 EXCHANGE_t + \varepsilon_t$$

where EFF_t is an indicator of operational efficiency (fuel cost per voyage, fuel consumption per mile, or EEOI); BBM_t is the fuel price; $KURS_t$ is the rupiah exchange rate against the US dollar; β_0 is a constant; β_1 and β_2 are the regression coefficients; and

ε_t is the error term. The model explains that shipping operational efficiency is influenced by fuel prices and the rupiah exchange rate, with the choice of efficiency measures adjusted to the availability of company operational data (ITS Repository, 2023; Siliwangi University, 2025).

RESULTS AND DISCUSSION

Fuel Consumption of PT PELNI Ships

Data analysis results show a decrease in PT PELNI's fuel consumption from 118 liters per mile to 85 liters per mile after implementing information technology-based monitoring (Antara, 2020; Mimbar Maritim, 2020). This decrease of approximately 28 percent confirms that shipping operational efficiency can be significantly improved through real-time monitoring and control of fuel consumption, as presented in Figure 1.

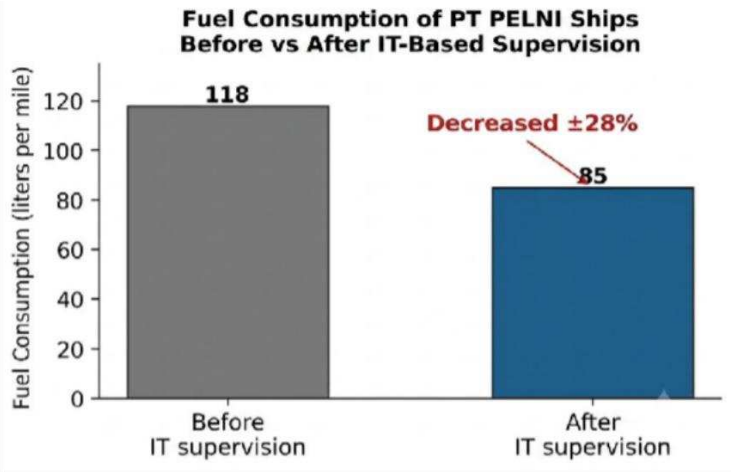

Figure 1. Fuel consumption of PT PELNI ships before and after information technology-based supervision

Source: Compiled from secondary data reported by Antara (2020) and Mimbar Maritim (2020)

Impact of Ship Operation Optimization

Figure 2 shows that optimizing general cargo vessel operations simultaneously reduces operational speed, fuel consumption, and EEOI indicators (ITS Repository, 2023). This finding strengthens the argument that slow steaming and route optimization strategies can achieve both energy and cost efficiency simultaneously, without sacrificing shipping reliability.

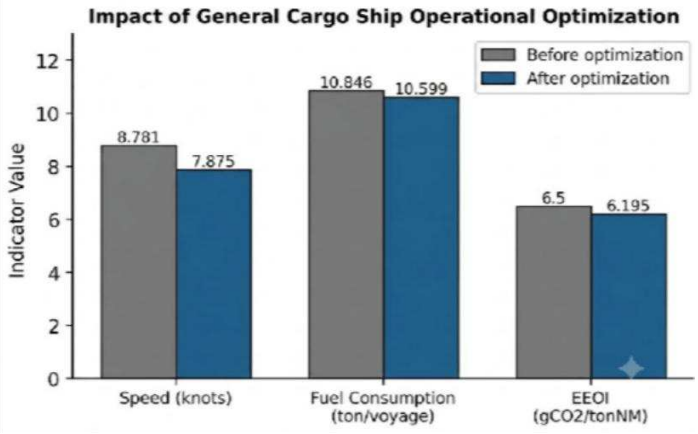

Figure 2. Impact of general cargo ship operation optimization on speed, fuel consumption, and EEOI
Source: Adapted from Repositori ITS (2023)

The Influence of Fuel on Shipping Operational Management

Fuel price increases directly increase ship operating and voyage costs. Because fuel accounts for a significant portion of the operating cost structure, changes in HSD or MFO prices can impact business margins, freight rates, shipping frequency, and various other operational decisions (Scientific Journal of Maritime and Transport Logistics, 2025; Mimbar Maritim, 2020). Therefore, controlling fuel consumption is a top priority for maintaining efficiency.

The Impact of the Rupiah Exchange Rate on Operational Efficiency

The weakening rupiah increases the costs of purchasing fuel, imported components, and ship maintenance. This situation places shipping companies under double pressure when fuel prices rise simultaneously with the rupiah depreciation (Semarang State University, 2020; Antara, 2020). In such a situation, companies need to adjust their budgets and tariff strategies to maintain cost efficiency and business continuity.

Suitability of Research Methods

A descriptive-verifiable quantitative method using time series analysis or panel data regression is most appropriate for this topic because it can measurably test the influence of two external economic variables on shipping operational indicators (Siliwangi University, 2025; Indonesian University of Education, 2023). This method is also commonly used in transportation and logistics sector research when the variables analyzed are energy prices, exchange rates, and economic performance indicators (Indonesian University of Education, 2023; Gadjah Mada University, 2017).

Managerial Implications

Based on the discussion above, several managerial implications can be formulated as operational efficiency strategies for shipping, namely:

1. Preparing an operational budget based on the sensitivity of fuel prices and the rupiah exchange rate (Siliwangi University, 2025).
2. Implementing real-time fuel consumption monitoring across the entire fleet (Mimbar

Maritim, 2020; Antara, 2020).

3. Optimizing the economic speed of ships based on routes, weather conditions, and cargo (ITS Repository, 2023).
4. Consider hedging policies or fuel purchase contracts to reduce the risk of exchange rate fluctuations.
5. Adaptively adjust transportation rates so that the pressure of rising costs does not completely burden the company (Scientific Journal of Maritime and Transport Logistics, 2025).

CONCLUSION

Fluctuations in fuel prices directly affect shipping operational efficiency by increasing vessel operating costs and potentially influencing maritime transportation volumes. Meanwhile, rupiah depreciation increases the costs of fuel procurement, spare parts, and vessel maintenance due to dependence on imported components. These two variables create mutually reinforcing cost pressures for shipping companies, requiring adaptive operational management strategies. The appropriate research approach for this topic is a quantitative descriptive-verification method using time-series data, which can be extended to panel data regression when the research involves multiple fleets or shipping companies. Through this approach, the effects of fuel prices and exchange rate movements on shipping operational efficiency can be empirically examined with greater analytical reliability.

Based on the findings, several recommendations are proposed. For shipping company management, it is recommended that companies implement real-time fuel consumption monitoring systems, develop budgets that account for price volatility, adopt slow steaming and route optimization strategies, and consider hedging mechanisms to mitigate exchange rate risks. For policymakers, recommended measures include providing fiscal incentives for energy-efficient practices, implementing fuel price stabilization policies, and strengthening domestic supply chains. Future research should expand the scope by incorporating multiple companies through panel data analysis, examining moderating variables such as technology adoption, applying qualitative approaches, and conducting longitudinal studies to provide a more comprehensive understanding of shipping operational efficiency dynamics.

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