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Optimization of Operational Management System on Ships for Cost and Time Efficiency

Septria Sadewi[1*], Muljanto Siladjaja[2]
[1]Universitas Dirgantara Marsekal Suryadarma, Jakarta, Indonesia, 241175007@students.unsurya.ac.id
[2]Universitas Dirgantara Marsekal Suryadarma, Jakarta, Indonesia, muljanto@unsurya.ac.id

[*]Corresponding Author: 241175007@students.unsurya.ac.id[1]

Abstract: The shipping industry plays a critical role in global trade, with over 80% of international trade being transported by sea. However, rising operational costs and inefficiencies in shipping operations, such as fuel consumption, route management, and port turnaround times, pose significant challenges. This study aims to explore optimization strategies for ship operational management to enhance cost efficiency and reduce travel time. Using a qualitative approach, data was collected from academic journals, books, and online sources, focusing on best practices and technological innovations in the maritime sector. The findings highlight the importance of data-driven management systems, such as navigation algorithms and Internet of Things (IoT) technologies, in reducing fuel consumption and improving route optimization. Furthermore, improving port infrastructure and managing waiting times at ports are identified as key factors in enhancing overall operational efficiency. This research provides recommendations for implementing an integrated operational management system that combines technology, data utilization, and effective time management. The results suggest that optimizing ship management systems can significantly reduce operational costs and improve competitiveness in the global shipping market, contributing to the development of maritime policies and strategies for enhancing logistics efficiency.

Keyword: Ship Operational Management, Efficiency Optimization, Maritime Technology

INTRODUCTION

The shipping industry has become the backbone of global trade, making a significant contribution to the world's economic growth. According to the United Nations Conference on Trade and Development (UNCTAD, 2023) report, more than 80% of global trade is transported via sea routes, making this sector a crucial element in the international supply chain. However, despite this growth, operational efficiency remains a major challenge. High operational costs, inefficient travel times, and regulatory environmental pressures are pressing issues that need to be addressed. In this regard, shipping companies must be able to adapt to various changes and optimize their operational systems to remain competitive in the global market.

Efficiency in ship operations, which includes route management, fuel utilization, and time management, is the key to a shipping company's success. (Fitria, Wahyudi, and Utomo, 2022) emphasize that inefficient operations can directly impact a company's profitability, reduce competitiveness, and lead to resource wastage. One of the main factors affecting efficiency is fuel usage management, which is one of the largest components of ship operational costs. Optimal fuel management not only reduces expenses but also contributes to lower carbon emissions, which is increasingly becoming a global environmental policy concern. This issue has been exacerbated by the IMO 2020 policy, which limits the sulfur content in ship fuel, increasing operational costs and forcing companies to seek innovative strategies in fleet management (IMO, 2020).

In addition to global challenges, the shipping industry in Indonesia faces unique problems. As an archipelagic country, Indonesia has complex shipping routes, uneven port infrastructure, and high domestic logistics costs, which reach 23.5% of the national Gross Domestic Product (GDP) (Sari, Mulyatno, & Rindo, 2024). With vast geography and diverse inter-island conditions, cost and time efficiency are top priorities for improving the competitiveness of Indonesia’s shipping industry in the global market. The suboptimal state of ports and limited inter-port connectivity further exacerbate operational efficiency problems. Therefore, the Indonesian shipping sector must innovate to overcome these challenges in order to compete with the international shipping industry.

Modern technology presents a potential solution to these challenges. (Pratistha et al., 2024) indicate that the application of data-driven technology, such as algorithm-based navigation systems and the Internet of Things (IoT), can significantly reduce ship waiting times at ports and improve shipping route efficiency. This technology enables ships to operate more efficiently in terms of fuel consumption and travel time by obtaining real-time data. Additionally, the implementation of data-based management systems provides a clearer picture of a ship’s operational conditions, which in turn allows for more precise decision-making and responsive adjustments to changing field conditions.

This study focuses on exploring and implementing optimization strategies for ship operational management systems, using data-driven approaches and technological innovations to achieve better cost and time efficiency. The findings of this study are expected to provide practical contributions to shipping companies, whether in improving operational efficiency, reducing costs, or supporting the development of policies that enhance the competitiveness of the national shipping industry. By optimizing operational management, it is hoped that logistics efficiency can be significantly improved, supporting national economic growth and addressing the challenges of global competition.

METHOD

This study employs a qualitative approach aimed at gaining a deeper understanding of ship operational management systems in enhancing cost and time efficiency. Data is collected through a literature review involving scientific journals, books, and relevant sources available on the internet. These sources provide insights into theories and best practices in ship operational management, cost efficiency, and innovations in the shipping sector. The scope of this study includes various case studies and previous research related to ship operations and the implementation of effective management systems.

The data collection method involves accessing scientific journals, relevant textbooks, and research reports available on online platforms and academic databases. Additionally, sources obtained from shipping industry websites and annual reports of shipping companies are also used as references to understand the challenges and solutions in ship operations. This data collection aims to obtain comprehensive information related to ship management practices that can be optimized for cost and time efficiency.

The collected data is then analyzed using a thematic analysis approach to identify patterns relevant to the research topic. Through this approach, the study can formulate recommendations based on findings in the literature and analyzed reports. To enhance the validity of the findings, the references used will be verified and compared with results from previous relevant studies.

RESULTS AND DISCUSSION

Results

Based on the literature analysis conducted, it was found that ship operational management systems significantly influence cost and time efficiency in shipping. Several studies discussed indicate that optimizing fuel usage and ship route planning can significantly reduce operational costs and travel time. For example, research conducted by Fitria, Wahyudi, and Utomo (2022) revealed that using a data-driven management system to monitor ship speed and fuel consumption can save up to 15% of the ship's annual operational costs. This demonstrates that effective use of technology and data analytics can maximize ship efficiency, ultimately leading to substantial reductions in operational costs.

Additionally, the use of modern technology such as algorithm-based navigation systems and the Internet of Things (IoT) has proven effective in enhancing operational efficiency. In a study by Djamaluddin (2024), the implementation of these technologies allowed shipping companies to predict ship arrival times more accurately and optimize route planning, directly reducing waiting times at ports and increasing fleet productivity. IoT technology enables real-time monitoring of ship conditions, providing valuable data for making more precise operational decisions. Research also shows that the implementation of data-driven optimization models, such as algorithms for regulating ship speed and sailing routes, can accelerate the loading and unloading process. This, in turn, contributes to cost and operational time reductions, making the shipping process more efficient.

However, in the Indonesian context, challenges related to port management and complex shipping routes remain significant. Uneven port infrastructure and limited facilities, such as loading and unloading capacity and delays in administrative processes, lead to increased ship waiting times. This directly impacts rising domestic logistics costs, adding an extra burden to shipping companies. Nevertheless, the implementation of an optimal management system can address most of these issues, especially if supported by technology that enables better coordination between ships and ports. In the long term, improving port infrastructure and developing a technology-based management system can reduce dependence on external factors that hinder operational efficiency.

Discussion

The results of this study align with previous findings highlighting the importance of efficiency in ship operations to reduce costs and time. One of the most significant aspects is fuel consumption optimization. Given that fuel constitutes the largest component of ship operational costs, reducing fuel consumption can lead to substantial savings. A study conducted by Marsudi, Maulana, and Wahyudi (2024) recommends the use of a data-driven management system that can identify fuel consumption patterns and enable more efficient route planning. By leveraging historical data on fuel consumption and weather conditions, shipping companies can regulate ship speed more consistently and select optimal routes, thereby minimizing fuel wastage. This study also shows that enhancing dynamic route planning can help ships avoid conditions that may lead to further fuel inefficiencies.

However, a major challenge that remains is the uneven port infrastructure. This leads to high waiting times at some ports, which in turn affects the ship's total travel time. With the implementation of intelligent management systems, shipping companies can minimize the

negative impact of suboptimal infrastructure. Sitorus, Sitorus, and Ricardianto (2016) suggest that more efficient port planning and the use of technology to monitor and manage waiting times in real time will help reduce ship waiting times and maximize operational hours. Implementing such technologies can accelerate the loading and unloading process while reducing idle time at inefficient ports, ultimately increasing productivity and lowering overall logistics costs.

The use of modern technology also plays a crucial role in improving operational efficiency. IoT-based systems and optimization algorithms can provide real-time data, allowing ships to adapt to existing conditions, such as adverse weather or changes in port conditions. Erwin et al. (2023) state that these technologies enable the design of more adaptive operational systems, which not only enhance fleet productivity but also reduce travel time and logistics costs. With the right technology, ships can automatically adjust routes based on the latest weather information or unexpected events, helping to avoid delays and expedite cargo deliveries. Moreover, integrating these technologies can enhance coordination between ships and port authorities, enabling more efficient communication to minimize operational obstacles.

From these findings and discussions, it can be concluded that optimizing ship operational management systems requires a holistic approach that involves technology, data utilization, and infrastructure improvements. Therefore, achieving more efficient ship operations can be realized through collaboration between shipping companies, the government, and technology, ultimately providing positive impacts for the shipping industry as a whole.

CONCLUSION

This study highlights the importance of an efficient operational management system in the shipping industry to optimize costs and travel time. The analysis results indicate that the implementation of data-driven technology, such as algorithm-based navigation systems and the Internet of Things (IoT), can help reduce fuel consumption and travel duration. Additionally, optimizing ship route management and reducing port waiting times are key factors in improving operational efficiency.

However, a major challenge faced by the shipping industry, particularly in Indonesia, is the uneven port infrastructure. Therefore, collaborative efforts between shipping companies and the government are necessary to improve port facilities and enhance the national logistics system.

Overall, this study suggests that optimizing ship operational management requires the integration of technology, data utilization, and effective time management. Implementing an optimal system can not only reduce operational costs but also enhance the competitiveness of shipping companies in the global market. This research provides a foundation for developing policies and strategies to improve efficiency in the shipping industry and serves as a reference for further studies on innovation in ship operational management.

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