J E M T
Journal of Earth and Marine Technology
homepage URL: ejurnal.itats.ac.id/jemt

Analysis of The Use of Onshore Power Supply Facilities at Port of Berlian

Jaka Septian Kustanto*[1], Natriya Faisal Rachman[1], Henna Nurdiansari[1], Akhmad Kasan Gupron[1]
[1] Politeknik Pelayaran Surabaya
*e-mail: jaka.septian@poltekpel-sby.ac.id

Article info
Received:
August 13, 2024
Revised:
Sept 02, 2024
Accepted:
Sept 27, 2024
Published:
Sept, 30 2024

Keywords:
Ships, OPS, Port of Berlian, Assessment.

Abstract
Ships contribute to CO_2 gas emissions. The government's effort to reduce these emissions is by having Onshore Power Supply (OPS) facilities. OPS is a technology that allows ships at anchor to turn off their engines and connect to the local electricity network for electricity supply. Port of Berlian currently has 8 OPS spot managed by PT. Lamong Energi Indonesia. The use of OPS still needs to be examined using valid methods. In this research, researchers use the assessment methodology that has been used at the port of Lisbon regarding this onshore electricity facility type of port where the ship is docked (mooring vessel). In this methodology, the assessment process carried out includes data gathering and data processing processes. Apart from this process, it is necessary to review the character of the port or terminal that we will examine ships that most often use land-based electricity facilities are ships with a size of 1000-2999 GT. The use of land electricity facilities provides cost efficiency of > 78%. This land electricity facility is used by General Cargo and Container type ships. These results indicate that the use of land electricity facilities is still inefficient (< 2.7%) and there is a need for further review of the implementation of existing policies.

1. Introduction

In the maritime world, ships in particular have a big impact in contributing to CO_2 gas emissions.[3] To solve this problem, the EU Commission and IMO (International Maritime Organization) have introduced several policies to constrain the shipping industry's emissions for health and environmental issues.[2,4,8] Green ports have been implemented in many countries to reduce these emissions.[5] One of the mitigation measures is the implementation of land electricity facilities. Onshore electricity facilities have a direct impact, especially when ships dock at port [10].

The Directorate General of Sea Transportation (DJPL) has issued Circular No. SE-DJPL 22 of 2022 concerning the use of Onshore Power Supply (OPS) at ports for ships sailing in Indonesian waters. Apart from that, the effort to realize this land electricity facility also received support from the Indonesian National Shipping Owners Association (INSA).[15] This was marked by the existence of an MoU between INSA and PT Pelindo Jasa Maritim in Bali on October 18 2022.[16] Currently, the implementation of OPS is the subject of study at several ports.[6,7] One of the ports of interest to researchers is the Port of Berlian, Surabaya. This port has the highest OPS among the terminals in Surabaya.[11] Researchers also want to see how efficiently the OPS facilities are used.

2. Methodology

The research method used in this study was adopted from previous research.[1] The research scheme is depicted in **figure** 1.

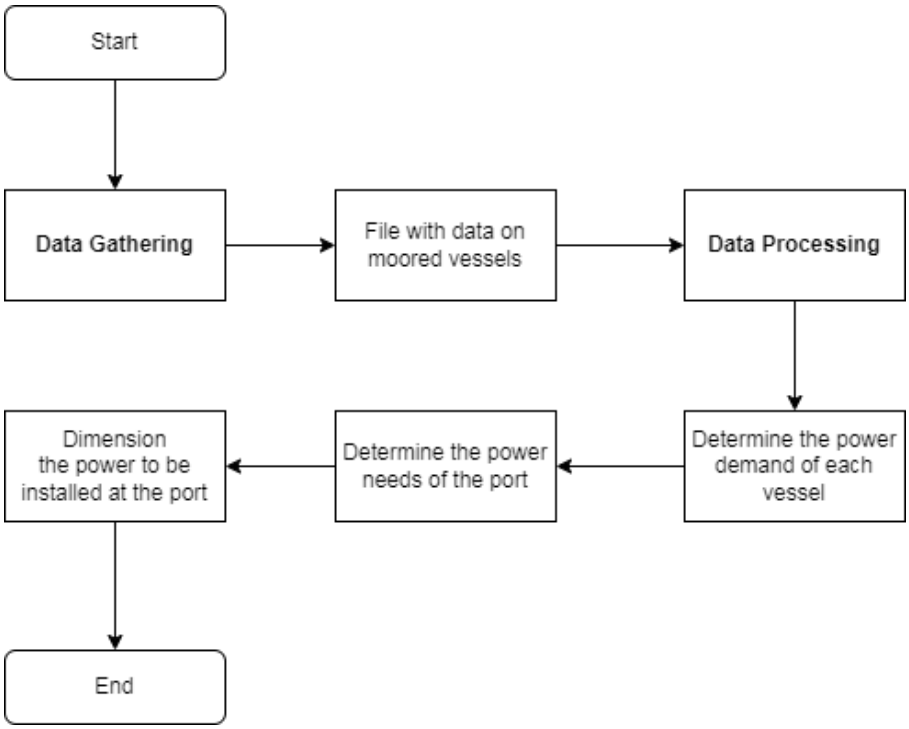

Figure 1. Methodology for Assessing OPS Facility

2.1. Data Gathering

In conducting this research, careful consideration must be given to the input data related to ships docked at the Port of Berlian. The analysis is based on historical data from 2021, which provides valuable insights into the utilization of Onshore Power Supply (OPS) facilities at the port.[9] This dataset serves as a foundation for understanding patterns and identifying areas for improvement in OPS adoption.

The characteristics examined from the data include several key attributes: the name of each ship, its type (e.g., cargo ship, tanker, or passenger vessel), gross tonnage (a measure of the ship's size and carrying capacity), the amount of electricity consumed, and the duration of OPS usage. By analyzing these parameters, researchers can uncover trends and correlations, such as whether larger ships or specific types of vessels are more likely to use OPS, and determine the average energy consumption and operational duration. These insights are crucial for designing targeted strategies to improve OPS utilization, enhance port sustainability, and promote environmentally friendly practices in the maritime sector.

2.2. Data Processing

In this research, the OriginLab software application was employed as a key tool to process and analyze the input data collected from ships docked at the Port of Berlian. This application provided researchers with a robust platform to visualize data, identify trends, and conduct detailed analyses of OPS usage patterns. Additionally, the study incorporated an evaluation of the benefits of using alternative energy sources, such as fuel efficiency improvements, when ships rely on their auxiliary propulsion engines instead of OPS. This comparison offered valuable insights into the operational and environmental trade-offs of both energy options.

The research methodology was systematically structured to ensure comprehensive and reliable results. It began with the design of the study, outlining objectives and hypotheses to guide the investigation. Data collection techniques included the acquisition of historical records related to OPS usage and ship operational characteristics. Instrument development involved creating tools and parameters to measure variables such as electricity consumption, ship type, and duration of OPS use. Finally, data analysis techniques were applied, utilizing statistical and graphical tools within OriginLab to interpret the

findings, draw conclusions, and propose recommendations for enhancing OPS adoption at the Port of Berlian.

3. Results and discussions

The results and discussion in this research include: port characteristics, OPS usage statistics, energy usage costs.

3.1. Port Characterization

The Port of Berlian, located in Surabaya, Indonesia, serves as a vital hub for multipurpose terminal operations in the region. Established under the Decree of the Minister of Transportation No. KP.410 of 2010, the port is managed by PT BJTI, a terminal operator with Port Business Entity (BUP) status. This designation allows the Port of Berlian to facilitate diverse logistics and maritime activities crucial for trade and commerce in Surabaya and beyond.[17]

PT BJTI offers a range of essential services at the Port of Berlian, including loading and unloading operations, stacking warehouse management, and refrigeration support through Cooling Container Plug and Shore Connection services. Collaborating with PT Lamong Energi Indonesia, the port ensures efficient energy distribution for shore connections. It features eight dedicated spots with a combined power capacity of 3 MVA, further enhancing its capability to support modern shipping needs and ensuring a seamless flow of goods through the facility.

3.2. OPS Usage Statistic

From research data, researchers then mapped the data for assessment purposes in this research. **Figure** 2 shows that the use of OPS has so far been used by container and general cargo ships.

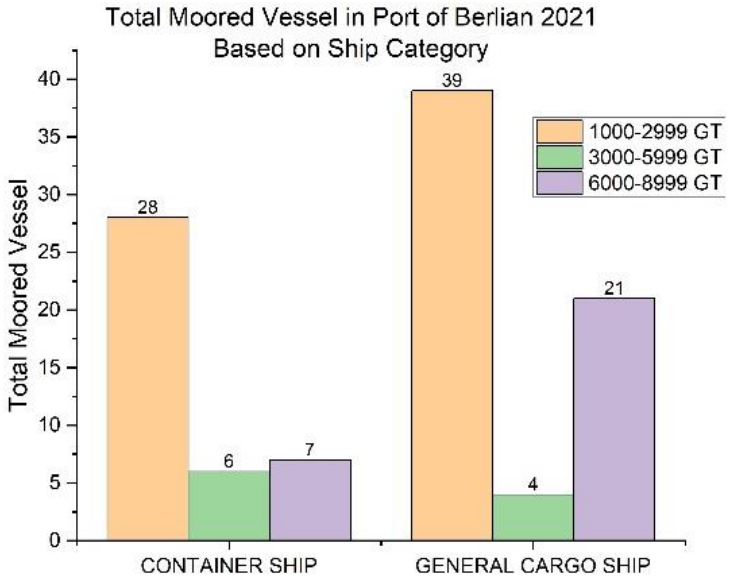

Figure 2. Total Moored vessel in Port of Berlian 2021 Based on Ship Category

The use of OPS is still dominated by ships with GT between 1000-2999 GT, followed by GT above 6000 GT. The Data also give us information that the minimum usage of 35 minutes by MV. Akashia ship in August and the longest usage by MV. Pulau Nunukan ship in December with a usage of 46 hours 59 minutes. Apart from that, the researchers also displayed a graph of electricity use using OPS that occurred during the period January to December 2021. This Graph show us information that the OPS usage is still beyond expected. The Port could use more power to use in ships where they berthing at Port of Berlian. , which is shown in **Figure** 3.

This graph shows the total power usage per vessel at Terminal Berlian in Surabaya, Indonesia, for the year 2021. Here's an explanation of the key aspects:

1. **X-Axis (Time)**:
   - The horizontal axis represents the months from January (Jan) to December (Des) in 2021, providing a time frame for the recorded power usage.
2. **Y-Axis (Power Used per Vessel)**:
   - The vertical axis represents the amount of power used per vessel in kilowatt-hours (kWh). The scale ranges from 0 to 2,500 kWh.
3. **Data Representation**:
   - Each blue dot or square on the graph represents the total power consumed by a single vessel during its stay at the terminal.
   - The spread of the points suggests variability in power consumption among vessels, with some using as little as a few hundred kWh while others exceed 2,000 kWh.
4. **Trends and Observations**:
   - There is significant fluctuation in power consumption throughout the year, likely reflecting differences in the operational needs of vessels (e.g., refrigeration, shore power usage).
   - Peaks in power usage are seen sporadically, indicating some vessels required unusually high power compared to the average.

This graph highlights the diverse energy demands of vessels at Terminal Berlian and may help in optimizing power management strategies at the terminal.

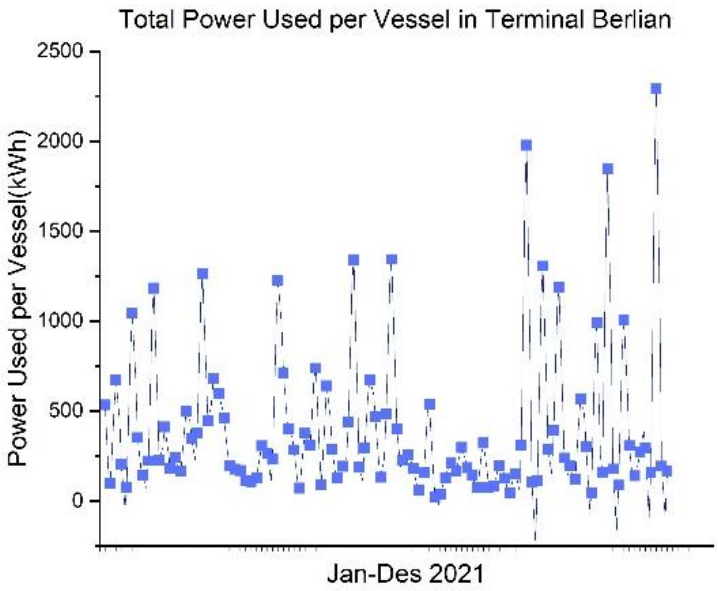

Figure 3. Total Power Used per Vessel in Port of Berlian

3.3. Energy Usage Costs

Calculation of energy requirements when docking is an important factor in using OPS. Researchers then calculated the costs required when using OPS and not using OPS.

The researchers' calculation of energy use adopted the method used by Danawiryya et al.[12] From the data that has been collected, there are 19 ships that have used the OPS facilities at Port of Berlian 105 times. Electricity usage with OPS alone reached 42,286.22 kWh. The BJTI company sets the OPS installation cost at IDR 400,000/ship and the electricity price at IDR 2,350/kWh. So, we can get the cost of using OPS using a formula.

$$OPS\ Cost = total\ using\ OPS * OPS\ price + ship * OPS\ Installation\ Fee$$

$$OPS\ Cost = 105 \times 2{,}350 + 19 \times 400{,}000 = 106{,}972{,}617$$

It was found that the cost of using OPS in a year reached Rp. 106,972,617. Then also calculate the use of the ship's generator. From data from PT. Pertamina in 2021, The Company sells Marine Fuel Oil (MFO) at a base price of 13,400 per liter (not including VAT, PPH and PBBKB). By using a comparison with previous research, it can be assumed that oil usage for 422286.22 kWh is 37565.74 liter. So, the cost required to drive the auxiliary engine is

$$Fuel\ Cost = fuel\ consumption * oil\ price$$

$$Fuel\ Cost = 37{,}565.74 * 13{,}400 = 503{,}380{,}916$$

From these results, we then calculate the fuel cost efficiency

$$fuel\ cost\ efficiency = (Fuel\ Cost - Shore\ Connection\ Cost)/(Fuel\ Cost)$$

$$fuel\ cost\ efficiency = (503{,}380{,}916 - 106{,}972{,}617)/503{,}380{,}916 \times 100\% = 78{,}75\%$$

The calculations reveal that utilizing the Onshore Power Supply (OPS) facility results in a remarkable cost efficiency of 78.75%. This substantial reduction in operational costs makes OPS a highly attractive option for shipping companies aiming to optimize their expenditures during docking. Such significant savings underscore the financial advantages of transitioning from traditional auxiliary propulsion engines to OPS for powering ships while at berth.

Beyond the direct financial benefits, the use of OPS also contributes significantly to environmental sustainability. By shifting to OPS, ships can substantially reduce their carbon dioxide (CO_2) emissions, which are typically generated by running diesel-powered auxiliary engines while docked. [15] This reduction not only supports global efforts to combat climate change but also aligns with environmental regulations and green port initiatives. For companies, this dual advantage—cost savings and environmental responsibility—presents a compelling case to adopt OPS facilities as a standard practice in their operations at the Port of Berlian.

The utilization of Onshore Power Supply (OPS) facilities at the Port of Berlian remains minimal. In 2021, only 105 ships out of a total of 2,918 visits utilized OPS, accounting for a mere 2.7% of total ship activity. This low adoption rate highlights a missed opportunity for reducing air pollution caused by ships running on auxiliary engines while docked, as well as for conserving energy and cutting electricity costs. OPS technology is a critical component of sustainable port operations, enabling ships to plug into the local power grid and turn off their engines, thus minimizing harmful emissions and fuel consumption.

The limited use of OPS facilities also underscores a gap between government policy and its practical implementation. Despite regulatory efforts to promote OPS adoption, the lack of enthusiasm or compliance from service users—primarily shipping companies—suggests that the policies have not been effectively enforced or incentivized. Addressing this issue requires decisive action, including stricter regulations, financial incentives, and public awareness campaigns to encourage adoption. Countries like China have successfully implemented OPS on a larger scale by mandating its use and providing subsidies, demonstrating that robust measures can significantly increase usage rates and achieve environmental benefits. [13,14]

4. Conclusion

The utilization of Onshore Power Supply (OPS) at the Port of Berlian terminal remains significantly low, with only 2.7% of ships making use of the facility. Shipping companies need to reassess their reliance on auxiliary electricity while docked and consider transitioning to OPS as a more sustainable and cost-effective alternative. By using OPS, vessels can not only reduce their operational costs associated with power generation but also significantly minimize air pollution and carbon emissions, aligning with global efforts toward greener and more sustainable port operations.

To encourage wider adoption of OPS, further research is needed to enhance transparency and accessibility of data, particularly concerning the costs and benefits of OPS usage. Providing open data would allow stakeholders, including shipping companies and the general public, to make informed decisions and evaluate the economic and environmental impact of OPS adoption. Additionally, there is a pressing need to review and strengthen regulations mandating the use of OPS by shipping companies. Such policies should prioritize the realization of a green port initiative at the Port of Berlian, setting a benchmark for sustainable practices in Indonesia's port operations.

Acknowledgment
Thank you to Politeknik Pelayaran Surabaya for helping and supporting this research and PT BJTI for the OPS Data Gathering. This work has been funded by PPPM Politeknik Pelayaran Surabaya under the programme of Research, and Community Service Grants 2024.

References:

[1] Amaral M, Amaro N, Arsénio P. "Methodology for Assessing Power Needs for Onshore Power Supply in Maritime Ports". Sustainability, 16670, 15(24). DOI: 10.3390/su152416670 (2023)
[2] Chen, L., et al. "Provision of Emission Control Area and the impact on shipping route choice and ship emissions". Transp. Res. D Transp. Environ. 58, 280–291.(2018)
[3] Dai, L., Hu, H., & Wang, Z. "Is Shore Side Electricity greener? An environmental analysis and policy implications". Energy Policy, 111144. doi:10.1016/j.enpol.2019.111144(2019)
[4] Eide, M.S., Endresen, Ø., Skjong, R., Longva, T., Alvik, S. "Cost-effectiveness assessment of CO2 reducing measures in shipping". Marit. Policy Manag. 36 (4), 367–384.(2009)
[5] Gutierrez-Romero J, Esteve-Perez J, Zamora B. "Implementing Onshore Power Supply from renewable energy sources for requirement of ships at berth". Applied Energy, 255. DOI: 10.1016/j.apenergy.2019.113883(2019)
[6] He S, Deng R, Zhou R et al. "The Design and Simulation of Associated Protection for Low Voltage Shore-to-ship Power Supply System in Inland Port". Journal of Physics: Conference Series. DOI: 10.1088/1742-6596/2503/1/012064(2023)
[7] Li K, Du K."Research on Onshore Power Supply System in Port for Ships". IOP Conference Series: Earth and Environmental Science.DOI: 10.1088/1755-1315/558/5/052022 (2020)
[8] Lindstad, H., Eskeland, G.S., Psaraftis, H., Sandaas, I., Strømman, A.H., 2015. Maritime shipping and emissions: a three-layered, damage-based approach. Ocean Eng. 110, 94–101.(2015)
[9] Mujahid TM, Setiyoko AS, Darmajanti P. "Analisis Teknis Dan Simulasi Load Flow Penerapan Shore Connection Di Pelabuhan Terminal Berlian-Surabaya". JE-UNISLA, 7, 2(2022)
[10] Peng Y, Li X, Wang W et al. "A Method For Determining The Allocation Strategy Of On-Shore Power Supply From A Green Container Terminal Perspective". Ocean and Coastal Management, 158-175, 167.DOI: 10.1016/j.ocecoaman.2018.10.007(2019)
[11] Sasmita D, Pambudi A, Hidayat E et al." Analisis Teknis Penggunaan Shore Connection Di Pelabuhan Terminal Teluk Lamong". Electronic Control, Telecomunication, Computer Information and Power Systems, 7, 2 (2022)
[12] Silaksanti D, Tjipto Sudarmo S. Cost And Environmental Benefit In The Use Of Shore Connection In BJTI Port. GROSTLOG.(2020)
[13] Xu, L., Di, Z., Chen, J., Shi, J., & Yang, C.. "Evolutionary game analysis on behavior strategies of multiple stakeholders in maritime shore power system". Ocean & Coastal Management, 202, 105508. doi:10.1016/j.ocecoaman.2020.105508(2021)
[14] Yin, M., Wang, Y., & Zhang, Q. "Policy implementation barriers and economic analysis of shore power promotion in China". Transportation Research Part D: Transport and Environment, 87, 102506. doi:10.1016/j.trd.2020.102506. (2020)
[15] Yuan, Zhao., Han, Yuan., Zhixiang, Zhang., Qizhi, Gao. Performance analysis and multi-objective optimization of the offshore renewable energy powered integrated energy supply system. Energy Conversion and Management, doi: 10.1016/j.enconman.2024.118232 (2024)
[16] https://www.pelindo.co.id/media/187/jalin-kolaborasi-pelindo-jasa-maritim-tandatangani-mou-untuk-dekarbonisasi-pelabuhan [accessed 19 March 2024]

[17] Surat Edaran (SE) No SE-DJPL 22 Tahun 2022 tentang Penggunaan Fasilitas Listrik Darat (*Onshore Power Supply* (OPS)) Di Pelabuhan Bagi Kapal Yang Berlayar Di Perairan Indonesia.
[18] BJTI annual report 2021