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Systematic Literature Review Cost Efficiency with Fuel and using Onshore Power Supply

Febriyanti[1], Muhammad Thamrin[2], Lira Agusinta[3], Yosi Pahala[4]
[1]Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia
[2]Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia
[3]Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia
[4]Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia

Corresponding Author: febrijku23@gmail.com[1]

Abstract: The shipping world has now entered the zeroemission era by the IMO where members apply zero emission at the Port which aims to create a Green Port. In Indonesia, regulations on the implementation of OPS installations at the Port are contained in the Decree of the Minister of Transportation of the Republic of Indonesia number 8 of 2023 concerning the Determination of Climate Change Mitigation Actions in the Transportation Sector for Achieving the Target Contribution of the Utilization of New Renewable Energy (EBT) where the form of mitigation action is a. Implementation of OPS at the Port b. Making Regulations and Monitoring OPS Implementation so that the success indicator is reduced ship fuel consumption while docked at the Port. The coding used in this research is Green Port, Cost and Enviromental Benefit, Cost Efficiency, Renewable Energy, Saving Cost of the Ship Maintenance, Saving the cost of Fuel.

Keywords: OPS, Greenport, Cost and Environmental Benefit

INTRODUCTION

Based on data Decree of the Minister of Transportation Number KM 8 of 2023 concerning Determination of Climate Change Mitigation Actions in the Transportation Sector to Achieve Nationally Determined Contribution Targets, to become a reference for implementing endeavors to mitigate climate change in the transportation sector. It was also informed that the GHG emission reduction target as the Ministry of Transportation's Main Performance Indicator (IKU) listed in the Ministry of Transportation's Strategic Plan for 2020-2024 is 4.61 million tons of CO2 in 2023 and 5.13 million tons of CO2 in 2024. The following are 2015-2021 Transportation Sector GHG emission reduction recapitulation data:

Table 1. Recapitulation of GHG Emission Reduction in the Transportation Sector 2015-2021

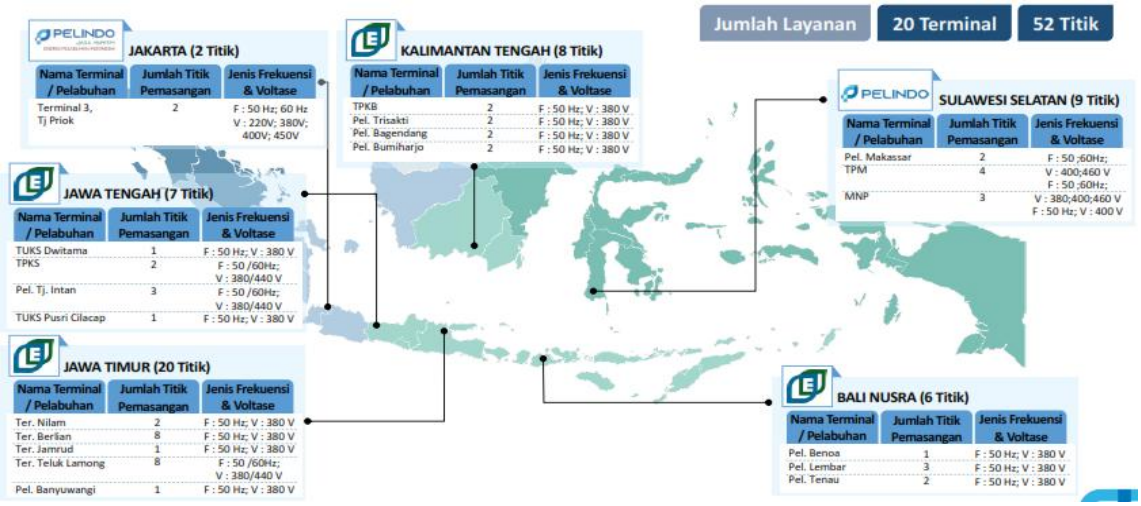
Transportation Subsector	2015	2016	2017	2018	2019	2020	2021
Land	315,975	367,624	369,435	676,798	1,756,267	897,493	771,269

Sea	133,212	139,945	147,668	4,392	37,250	48,281	67,023
Railway	1,418,000	1,317,000	1,705,720	2,307,863	2,857,722	1,305,763	1,888,867
Air	0	0	0	6,847	28,886	531,826	646,704
Total Emission Reduction (Ton CO2e)	1,867,187	1,824,569	2,222,823	2,995,900	4,680,124	2,783,363	3,373,863

Source: Ministry of Transportation (2023)

In connection with the enactment of Presidential Regulation Number 98 of 2021 concerning Organizing Carbon Economic Values to Achieve Nationally Determined Contribution Targets and Control of Greenhouse Gas Emissions in National Development, it is necessary to take steps to achieve the Nationally Determined Contribution (NDC) target Sea Transportation Subsector in implementing climate change mitigation. One of them is by implementing the utilization of onshore power supply (OPS) facilities at ports for ships sailing in Indonesian waters.

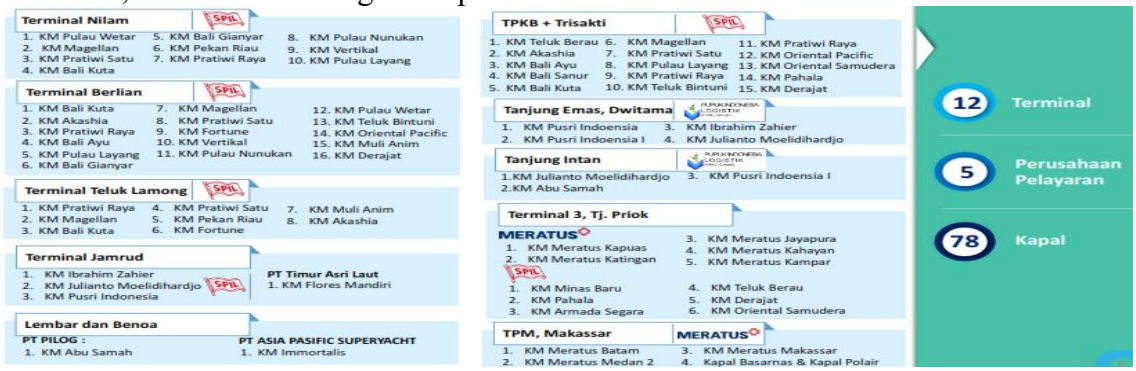
The utilization of Onshore Power Supply (OPS) has become one of the climate change mitigation actions from sea transportation which has reported its GHG emission reduction achievements to the Ministry of Environment and Forestry (KLHK) since 2019. This can be seen from Pelindo's data where the terminals are available onshore Power Supply (OPS) as follows:



Source: Pelindo (2023)

Figure 1. Available Onshore Power Supply (OPS) terminals

Based on the data of Figure 1.1. shows that the number of services from 20 terminals has reached 52 points, therefore it needs to be maximized again. Apart from that from shipping companies and fleetsuseThe new OPS is 5 shipping companies with 78 ships from 12 terminals, with the following description



Source: Pelindo (2023)

Figure 2. Shipping Companies and Fleets that have used OPS

Pelindo, in the case of Port Business Entities, must provide adequate Onshore Power Supply (OPS) facilities for the operational needs of ships while docking and carrying out port activities so that they do not use power sources from combustion engines on board ships, and document usage data The Land Electricity Facility / Onshore Power Supply (OPS) and report it to the Director General of Sea Transportation periodically every year.

In this research, researchers focused on comprehensive and systematic mapping with visualization that can provide understanding more easily. The mapping will focus on looking for trends in issues related to fuel efficiency costs and using onshore power supplies when ships dock at Indonesian ports.

Literatur Review

Transportation Management

Transportation management as an effort to achieve predetermined goals with transportation service revenues by transportation companies in such a way that, with applicable tariffs, it can fulfill the interests of facing three main tasks, namely preparing plans and programs to achieve the overall goals and mission of the organization; increase the productivity and performance of the company; and social impact and social responsibility in operating urban transport, (Deveci, Dragan & Ilgin, 2022).

Green Port

There are regulations governing the impact of port operations on the environment followed by developments in research to use the green port concept. According to Darbra et al (2005) The green concept basically presents three perspectives, namely in the planning, development and operation of ports by including energy protection, environmental defense and ecological care (Canbulat, 2014).

Harbor

Law of the Republic of Indonesia Number 17 of 2008 concerning Shippingand Government Regulation of the Republic of Indonesia Number 31 of 2021 concerning the Implementation of the Shipping Sector states that “a port is a place consisting of land and/or waters with certain boundaries as a place for government activities and business activities used as a place for ships to dock, board passengers and/or or loading and unloading of goods, in the form of ship terminals and berths equipped with shipping safety and security facilities and port supporting activities as well as places for intra- and intermodal transportation”.

Onshore Power Systems

According to (Yustiano, 2014), it is found “shipping activity is an energy efficient way to move goods and people. But with the large emissions produced by ships, in the form of Sulfur Dioxide (SO2), Nitrogen Oxide (NOx) and other air pollution particulates, it is necessary to measure ship emissions and implement ways to reduce them, especially emissions at ports. The majority of ship emissions are released into the air up to a distance of 400 km towards land. The port area is of course also exposed to ship emissions, mainly due to the use of ship auxiliary engines for their energy needs. Container ships can use up to 6 MW of energy while operating in ports, Ro-Ro ships need 1 to 3 MW and cruise ships need up to 10 mW. While the time needed by ships while in port ranges from several hours to several days”. In a global emissions perspective, ship emissions represent 6% of SOx, 15% of NOx, and 3% of CO2 (Samosir, Markert & Busse, 2017).

Based on IMO MEPC.I/Circ.794 issued on October 9, 2012 states that “On Shore Power Supply (OPS) is a tool to improve air quality in ports and port cities, to reduce emissions from air pollutants and reduce noise, reduce carbon dioxide produced by ships when they are docked at the dock by replacing the electricity on the ship which is usually

turned on from the ship's auxiliary engine with electricity supplied from the dock" (IMO, 2012).

Ship Fuel Costs

To be able to drive a ship's engine, of course a ship needs fuel, both for the main engine and the ship's auxiliary engines. Until now, the main fuel used in ship engines still depends on fuel oil (BBM). In fact, the biggest operational costs for operating a ship are fuel costs which can reach 47%, then costs for ports are 46% and DO (Delivery Orders) are 7% (Gurning in Valentito F. et al 2012) factors that are very influential in ship's fuel consumption is the workload of the ship's engine itself. Due to the high cost of this fuel, shipping companies are searching for other options of reducing these costs, including technical strategies such as utilizing efficient ship engines, utilizing high efficiency propellers, etc. Another strategy of reducing fuel costs is to utilize onshore power supply facilities at ports. Thus, ships no longer need to turn on their engines during the activities of loading and unloading or while docking at the wharf.

METHOD

Systematic Literature Review is a summary of research literature that answers specific research questions from a relevant body of research. The aim of this SLR is to synthesize the results of previous research so as to gain insight and obtain ideas and originality from relevant research.

Systematic Literature Review (SLR) as qualitative research is used to map other research that uses project based learning in English education. The procedures carried out in this research were 1) Data collection on the SCOPUS database, 2) Data sorting, 3) Data coding, 4) Data visualization and 5) Data interpretation and analysis. The method used is according to the PRISMA Protocol (Preferred Reporting Items for Systematic Reviews and Meta-analyses) (Matthew et al., 2021).

After getting information about the highest quality journal from the keyword "Onshore Power Supply (OPS) on Port" we open I twww. connectedpapers to view the Graph Visualization associated with that journal. The bolder / thicker the journal is, the journal is related to the journal we are referring to. The next step is to search for journals related to this research topic in databases (Google Scholar, Elseiver, and Sciencedirect). And entered into citation management (Mendeley)

In the first stage, data collection was carried out using the SCOPUS database sources which were considered to have updates, and the results were useful for studies in each science. There are 43 articles detected in the SCOPUS database with search keywords *Onshore Power Supply on Port*s as a title, *Onshore Power Supply on Port* in abstract, and *Onshore Power Supply on Port*o n abstracts. The range of research data taken is 2018-2023. The second stage of data sorting is carried out based on table 3 with the following details:

Table 2 Data Selection

No	Focus	Exception
1.	Search keywords in Google Scholar, Sciencedirect, and Elseiver Databases. Title : Onshore Power Supply (OPS) on Port N = 50, Journal Source, Year interval: 2018 – 2023 (Last 5 Years).	Non-Journal sources (Thesis, Conference Contents, etc.), Journal Articles not from the 2018 – 2023 interval
2.	Open Access Articles (50)	N = 7
	N = 43	
	The total number of articles studied was N = 43	

In the third stage of data coding, at this stage the researcher assigns tags/coding to each paper produced in the second stage. Data coding includes the topics studied, methods

used, year of research, research results, research objectives and implications. Data coding was carried out using NVIVO 12 software and produced 60 nodes (Dhakal, 2022). In the fourth stage, the researcher conducted data analysis based on the formulation of the problems in this study and continued with data visualization to form a project map. Data visualization in the form of the project map will be analyzed and interpreted as research results to answer the problem formulation in this study.

RESULTS AND DISCUSSION

There are 6 coding categories from this research namely Cost and Environmental Benefit, Cost Efficiency, Green Port, Renewable Energy, Saving Cost of the Ship machine maintenance, and Saving the cost of the Fuel. Of the six coding research topics, the SLR results from this study, the most talk about the results of "Cost and Environmental Benefit" means that there is a price to be gained when talking about the installation of OPS (Onshore Power Supply) at the Port and the environmental benefits obtained as much as 58x , 51 x Renewable Energy, 43 x Green Port, 32 x Cost Efficiency, 28 x Saving the cost of the ship machine maintenance, and 4 x Saving the cost of the Fuel.

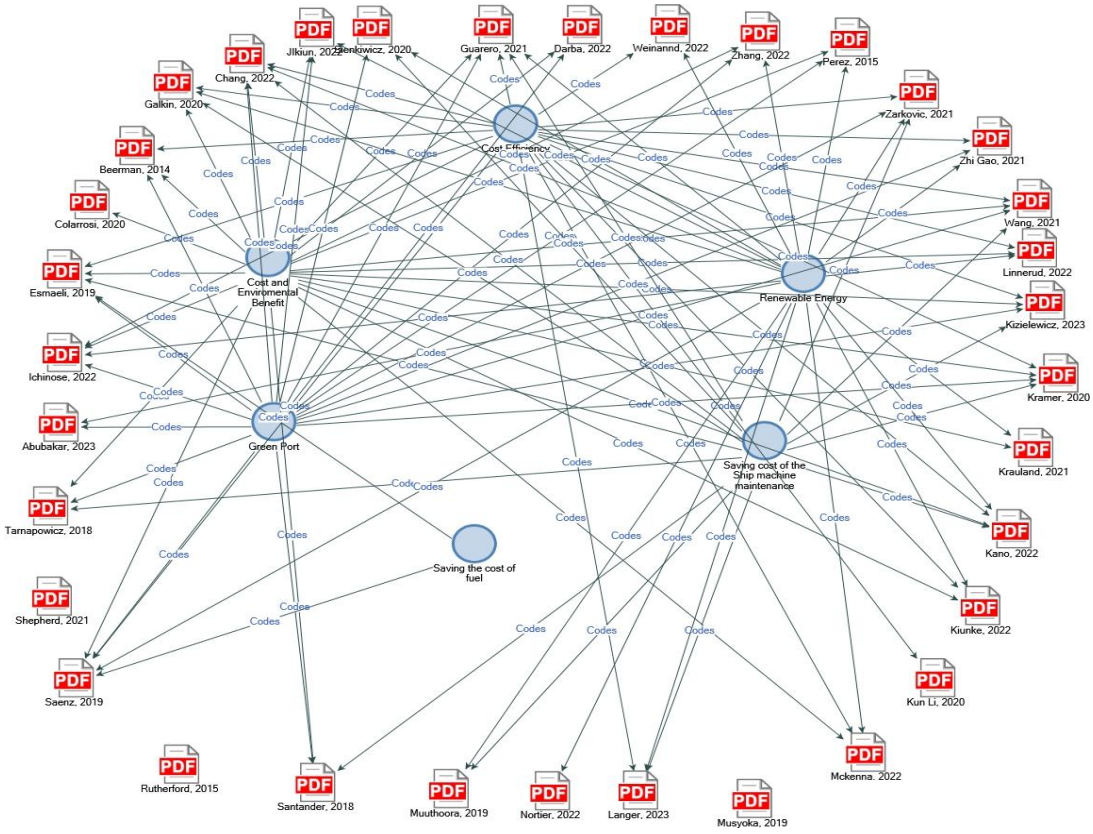


Figure 3 Synthesis Results of SLR Project Map

From Figure 3, it can be observed that all the outcomes of the SLR research are interconnected with the 6 categories selected, meaning that the selection of the contents of the coding is suitable and appropriate.

1. Systematic Literature Review descriptive coding analysis from this study are:
   a. Cost and Environmental Benefit : 58
   b. Renewable Energy : 51
   c. *Green Port* : 43
   d. *Cost Efficiency* : 32
   e. Saving the cost of the ship machine Maintenance : 27
   f. Saving the cost of fuel : 4

2. From the search for sources of researched articles (a total of N = 50) from sources (Google Scholar, Elseiver, and Sciencedirect), A = 43 were studied, B = 7 (not in accordance with research requirements). Requirements for the research file under study
   a. Research Interval (2018 – 2023)
   b. Is a Research Journal (national or International with a high H Index)
   c. In accordance with the search topic/keyword (Onshore Power Supply (OPS) on Port)

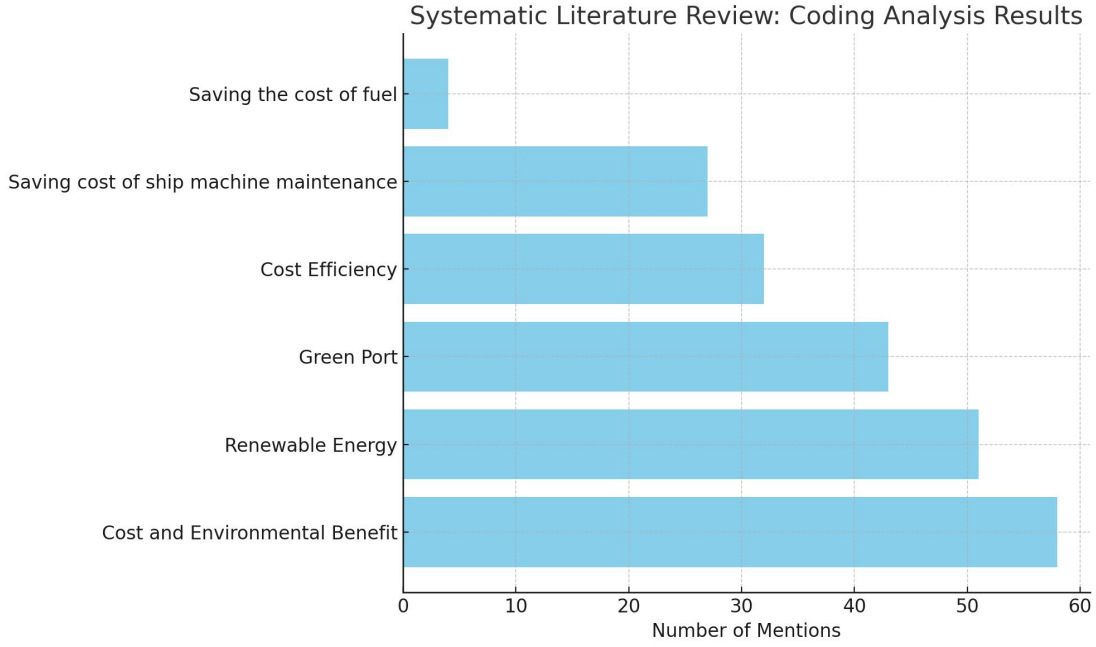


Figure 4 Graph Result SLR

In line with the results of this research which states a connection *Onshore Power Supply on Port* research conducted by (Bakar et al., 2023), (Tai & Chang, 2022), (Colarossi & Principi, 2020), (Darbra et al., 2022), (Esmaeli, 2023), (German-galkin & Tarnapowicz, 2020), (Guerrero et al., 2021), (Ichinose et al., 2022), (Jikiun et al., 2023), (Kano et al., 2022), (Kiunke et al., 2022), (Kizielewicz, 2023), (Krämer & Czermański, 2020), (Krauland et al., 2021), (Li & Du, 2020), (Langer et al., 2023), (Linnerud et al., 2022), (McKenna et al., 2022), (Musyoka, 2019), (Muthoora & Fischer, 2019), (Nortier et al., 2022), (Rutherford et al., 2015), (SÁENZ, 2019), (Santander et al., 2018), (Shepherd et al., 2021), (Sienkiewicz & Ryndzionek, 2020), (Tarnapowicz & GERMAN-GALKIN, 2018), (Wang et al., 2021), (Weinand et al., 2022), (Zarkovi et al., 2021), (Zhang et al., 2022), dan (Gao et al., 2021) which revealed the Onshore Power Supply or OPS reduced emissions from ships anchored in ports. Historically, OPS adoption has been low, and research shows that potential adopters of OPS face complex barriers.

According to the SLR analysis, this research provides a framework to categorize barriers and drivers in OPS implementation and identifying potential areas for researches in the near future. Mapping of Onshore Power Supply provides a view of the tendency of researchers in their field so that it can make an understanding of the literature to support future research. The increasing number of studies in the field of sea transportation, especially Onshore Power Supply with Port Integration and focusing on policy makers and service users are the findings of this research. Not only that, it is found that the Onshore Power Supply on Port in the scope of transportation and port is dominant for research on Cost and Environmental Benefit. Research tends to assess the economic and environmental benefits of implementing OPS. This includes the potential for reducing operational costs and positive impacts on the environment. Cost Efficiency The study also looked at the cost efficiency of implementing OPS. This includes an analysis of the initial investment, long-term operating costs and potential savings. Green Port The concept of a green port or "green port" is the focus, with OPS as one of the solutions to achieve this goal. Renewable Energy Research has

also highlighted the use of renewable energy in OPS, which can help reduce environmental impact further. Saving Cost of Ship Machine Maintenance: The application of OPS can reduce the number of working hours and pressure on ship engines, resulting in savings in maintenance costs. Saving the Cost of Fuel: The use of ground electricity from OPS reduces dependence on fossil fuels,

This research has proposed possible ways to overcome some obstacles, but the intricate nature of OPS emphasizes the importance of a cooperative effort to tackle it effectively. Furthermore, with growing regulatory demands, further investigation is required into the broader impacts of OPS and how strategies like incentives, pricing structures, and business models can help reduce the significant costs associated with its implementation.

The development and implementation of Onshore Power Supply (OPS) in ports in Indonesia has become a topic of increasing importance in recent years. OPS is a solution adopted to reduce greenhouse gas emissions and air pollution generated by ships docking in ports, by replacing the use of ship's internal combustion engines with ground power supply when the ship is in dock. In Indonesia, the implementation of OPS in ports is still in its early stages, but efforts to develop and implement these solutions continue to increase

CONCLUSION

The trend of using OPS (onshore power supply) in ports is increasing. Because apart from supporting activities towards a Green Port (environmentally friendly port). The benefits of installing OPS at ports are that it can reduce greenhouse gas emissions, save on operational costs from buying fuel, and save on ship engine maintenance costs. (Pelindo, 2022). Therefore, the installation of OPS must be made into a general policy so that it can be implemented in world ports considering the great benefits that can be felt by ship fishing activities at ports. The first legislation in the world was attached to (IMO 2012), the International Maritime Organization. In Indonesia, regulations regarding the implementation of OPS installations at ports are contained in the Decree of the Minister of Transportation of the Republic of Indonesia number 8 of 2023 concerning Determination of Climate Change Mitigation Actions in the Transportation Sector to Achieve Contribution Targets for the Utilization of New and Renewable Energy (EBT) where the form of mitigation action is a. Implementation of OPS at the Port b. Making regulations and monitoring the implementation of OPS so that indicators of success reduce ship fuel consumption while docked at the port. This research method is descriptive qualitative using SLR (Systematic Literature Review) analysis in the NVivo 12 application. The coding used in this research is Green Port, Cost and Environmental Benefit, Cost Efficiency, Renewable Energy, Saving Cost of the Ship Maintenance, Saving the cost of Fuel. Making Regulations and Monitoring the Implementation of OPS so that indicators of success reduce ship fuel consumption while leaning at the Port. This research method is descriptive qualitative using SLR (Systematic Literature Review) analysis on the NVivo 12 application. The coding used in this study is Green Port, Cost and Environmental Benefit, Cost Efficiency, Renewable Energy, Saving Cost of the Ship Maintenance, Saving the cost of Fuel. Making Regulations and Monitoring the Implementation of OPS so that indicators of success reduce ship fuel consumption while leaning at the Port. This research method is descriptive qualitative using SLR (Systematic Literature Review) analysis on the NVivo 12 application. The coding used in this study is Green Port, Cost and Environmental Benefit, Cost Efficiency, Renewable Energy, Saving Cost of the Ship Maintenance, Saving the cost of Fuel.

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