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Bibliometric Analysis of Research Development on Green Port Implementation in 2015-2023

Abstract: The port is one of the crucial factors in maritime logistics. Green port innovation aims to increase the efficiency of existing resources, reduce the negative impact of the surrounding environment, increase environmental management, and improve the quality of the natural environment around the port. The number of scientific publications regarding green ports proves that this topic has become a global scientific publication trend. Unfortunately, the focus or pressure points of the various publications are so varied that it is difficult to know the consistency and cohesion between discussions and Indonesia as the author's country has not done much research on the application of green ports. Therefore, this study aims to look at trends in global scientific publications regarding the application of green ports in the hope that the interrelationships between concepts and topic shifts from time to time can be identified. The method used is bibliometric analysis. The population of this study was 200 articles searched for data using the Publish or Perish (PoP) application from 2015-2023; 131 articles were obtained as samples that matched the keywords obtained. Researchers used VOSviewer software version 1.6.16 to perform co-occurrence analysis with overlay and network visualization. The results of the VOSviewer software vulnerability analysis have four themes related to the implementation of green ports, namely "regulation," "Shore power," "logistics," and "green port policy," which are still rarely researched and are the latest themes in research. This theme can be used as a reference for further study.

Keywords: bibliometric, green port, publish or perish, vosviewer

INTRODUCTION

There has been increasing attention in the last decade to the impact of port business on environmental degradation. (Ahmadi, Kusumastanto, and Siahaan 2016). Nowadays, ports around the world are facing challenges related to declining environmental quality. Still, ports are also required to continue operating to serve the increasing world trade services and become one of the chains in maritime logistics.

In balancing environmental impacts and the effective operation of ports internationally and nationally in Indonesia, it is necessary to answer with innovation and appropriate policies. Green port is the method used in answering strategic issues related to social, economic, and environmental aspects. The policies and procedures implemented during the construction, operation, and development of ports under construction with the scope of environmental considerations have evolved according to the needs of global trends (Akgul 2017). It also supports the international program established and agreed

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upon by the United Nations (UN) in 2015 on Sustainable Development Goals (SDGs) (PIANC 2014).

In the previous research, it was stated that Each port could adopt a new "greener" or "green port" strategy and improve the existing system to determine the steps in implementing the model to minimize and eliminate the potential consequences of the disposal of waste materials (Badurina, Cukrov, and Dundović 2017). This is one of the essential steps of implementing a green port. Another study explained that green port schemes integrate environmentally friendly concepts in activities, operations, and management at the port (Perawati, Nabila, and Edi 2017).

Green port innovation is expected to be a step to reduce the impact of environmental damage due to operational activities at the port. Green ports are often combined and integrated with many components, including economic, social, environmental, cultural, and other factors (Nguyen, Nguyen, and Nguyen, 2022). Where economic, social, and cultural factors must be closely linked to environmental requirements to ensure sustainable development (Okada et al., 2019). In the international scope, many ports apply the green port concept, including:

1. Port of Rotterdam, Netherlands: The Port of Rotterdam is the largest port in Europe and has implemented many initiatives to reduce its environmental impact, such as using renewable energy and recycling programs.
2. Port of Los Angeles, United States: The Port of Los Angeles has implemented a Clean Air Action Plan (CAAP) program to reduce emissions from ships, trucks, and other machinery at the port.
3. Port of Vancouver, Canada: The Port of Vancouver implemented the "Blue Circle Award" program to reward ships that meet strict environmental standards and reduce emissions.
4. Port of Singapore: The Port of Singapore has implemented various initiatives to reduce emissions, including solar power and fuel efficiency improvement programs.
5. Port of Hamburg, Germany: The Port of Hamburg has implemented a "Smart Port Energy" program that optimizes energy use and reduces emissions.

The conceptualization and implementation of environmentally friendly ports, namely green ports, is still relatively new in Indonesia (Purba 2010). However, some ports have started implementing initiatives and programs to become more environmentally friendly. The Indonesian government strongly supports the development of Port Environmental Management. This includes things like wastewater management, emission reduction, solid waste management, and the use of renewable energy. In 2022, an assessment of the implementation of green ports in several ports in Indonesia was proposed.

With the implementation of green ports that are relatively new in Indonesia, there is still a lack of research on the application of green ports. The purpose of this study is to see the development of research on the application of green ports from 2015, where there are supporting factors with the agreement between countries in the United Nations on Sustainable Development Goals (SDGs) or sustainable development, which also involves port aspects in supporting these policies and the development of research on the application of green ports at this time.

METHODS

This research uses the bibliometric review method. A bibliometric review is a research method used to analyze a collection of literature or references related to a particular topic (Ellegaard and Wallin, 2015). This method involves collecting data from various sources such as journals, conferences, and books. Then, this data is analyzed using bibliometric techniques to generate useful information about patterns and trends in scientific publications related to the research topic. This method was chosen because it can

present an overview of an area of research that can be identified from journals (Merigó and Yang 2017).

The existing data collection uses the Publish or Perish (PoP) application, on March 6, 2023, which uses the Google Scholar database. Publish or Perish is used to obtain information related to citations, which are then analyzed and converted into a number of statistics (Aulianto, Yusup, and Setianti 2019).

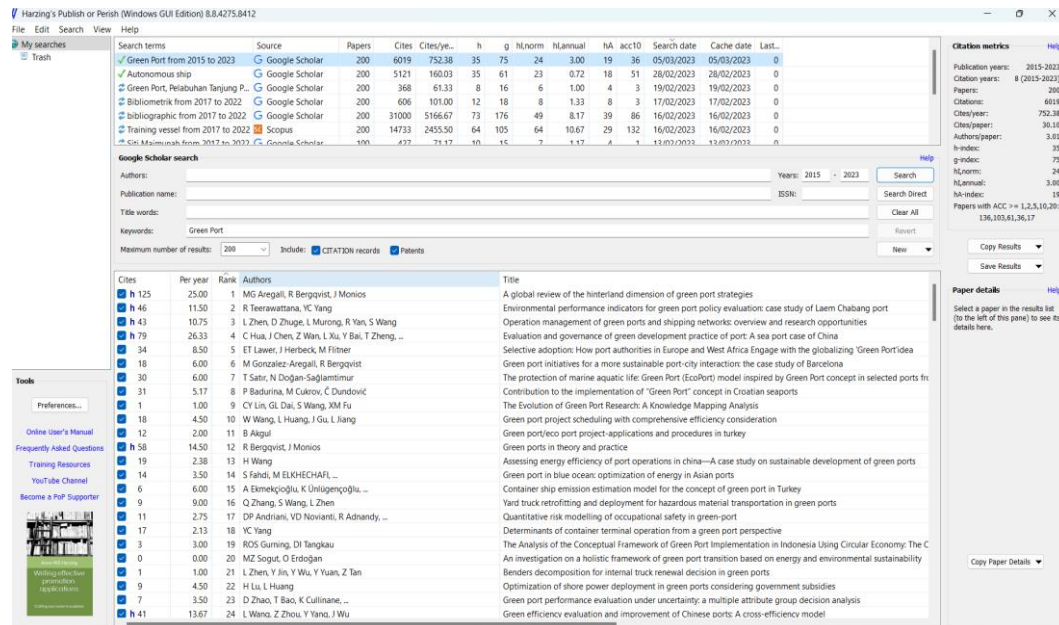


Figure 1. Google Scholar Database Search Through PoP
Source: Author's analysis.

Figure 1 is the first step in collecting the Google Scholar database through PoP using the keyword "green port," the publication name used is "journal," and the year of publication of the article is "2015 - 2023". From the data search results using PoP, 200 articles were obtained, which are the population of this study. This data is stored in Microsoft Excel for the next stage of data processing and in RIS form for use in VOSviewer software. VOSviewer is a software used to build and visualize bibliometric networks (Aulianto, Yusup, and Setianti 2019). VOSviewer is used in mapping to search for trends in international scientific publications with Google Scholar databases related to green port implementation based on keywords.

RESULT AND DISCUSSION

The definition of bibliography is a publication that lists documents either "published" in the form of books or magazine articles as well as in other forms of literature related to the field of science or a person's work. The article (Tupan et al. 2018) defines bibliometric analysis as an analysis study of a research works bibliography where it is assumed that researchers should communicate the results of their research. In another sense, Bibliometrics is one indicator that measures scientific research development (Kriswanto et al. 2019).

The bibliometric analysis results of this study refer to one stated by Donthu (Donthu et al. 2021). In this reference, there are two analyses: performance analysis in the form of several publications per year, articles, journal rankings, and countries with the highest number of articles; and science mapping using VOSviewer in the form of Circles Network Visualization, Frames Overlay Visualization, and Density Visualization. Analysis using VOSviewer has advantages over other analysis applications. This program uses text mining functions to identify noun phrase combinations relevant to mapping and integrated clustering approaches to examine data co-citation and co-occurrence networks (Mulyana

and Maha 2021). Co-occurrence can statistically discover research topics, and Co-occurrence Analysis is simply the counting of paired data within a collection unit. (Sidiq 2019).

Global Publication Trends

Google Scholar is a database with scientific literature data from various journals and publishers within and outside the country. It provides freedom of access and information on its publications, accelerating the spread of science. (Khoirunissa and Winoto 2022). From the Google Scholar database, using the criteria as stated in the research method section, the author searched for data with a maximum of 200 document results with the keyword "green port." From these 200 results, 131 articles were obtained from publications related to the research theme. As for the 131 articles, the analysis results of studies from 2015 to 2023 are as follows:

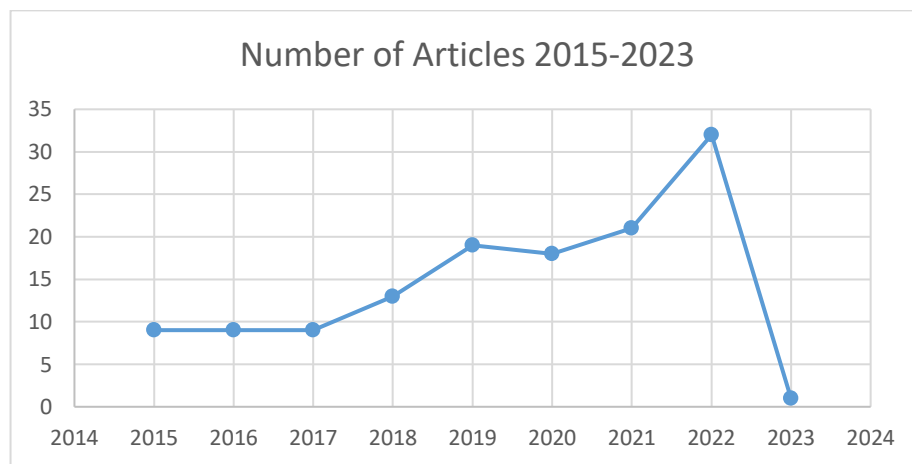


Figure 2. Growth in the number of scientific publications per year

It can be seen in Figure 2 that the number of articles from 2015 to 2023 is not too fluctuating. Moreover, the increase and decrease in the number of articles is insignificant. In 2022, the highest number of articles was obtained, namely 32 articles. In the first quarter of 2023, research on green ports still shows 1 article published on the Google Scholar database. By looking at the trend of the number of publications each year, research related to green ports tends to continue to grow along with the development of green port innovations widely implemented in various countries.

Articles in the Google Scholar database are widely used as reference material in other studies. The more the number of citations of an article can be interpreted, the more the research is widely used as a reference in other studies. The search results using PoP obtained 1864 citations from 131 articles from 2015-2023. Articles with the highest number of citations are presented in Table 1.

Table 1. Articles with the Most Citations

No	Author Name	Article Title	Year	Publication	Number of Citations
1	Iris & Lam	A review of energy efficiency in ports: Operational strategies, technologies, and energy management systems	2019	Renewable and Sustainable Energy Review	233
2	Davarzani et al..	Greening ports and maritime logistics: A review	2016	Transportation Research Part D: Transport and Environment	225

No	Author Name	Article Title	Year	Publication	Number of Citations
3	Hua et al.,	Evaluation and governance of green development practice of port: A sea port case of China	2020	Journal of Cleaver Production	79

The data in Table 1 shows that the article "A Review of Energy Efficiency in Ports: Operational Strategies, technologies and Energy Management Systems (Iris and Lam 2019) and Greening Ports and Maritime Logistics: A Review (Davarzani et al. 2016) are the articles that have the highest number of citations, 233 and 225 citations respectively—followed by an article entitled Evaluation and governance of green development practice of port: A sea port case of China (Hua et al. 2020) which has 79 citations.

Country Contribution

From the available data, there are ten countries/territories that contributed to global scientific publications on green port implementation from 2015 to 2013. The United Kingdom published the most scientific publications, with 50 documents. Followed by Singapore with 15 documents and the United States with 12 documents.

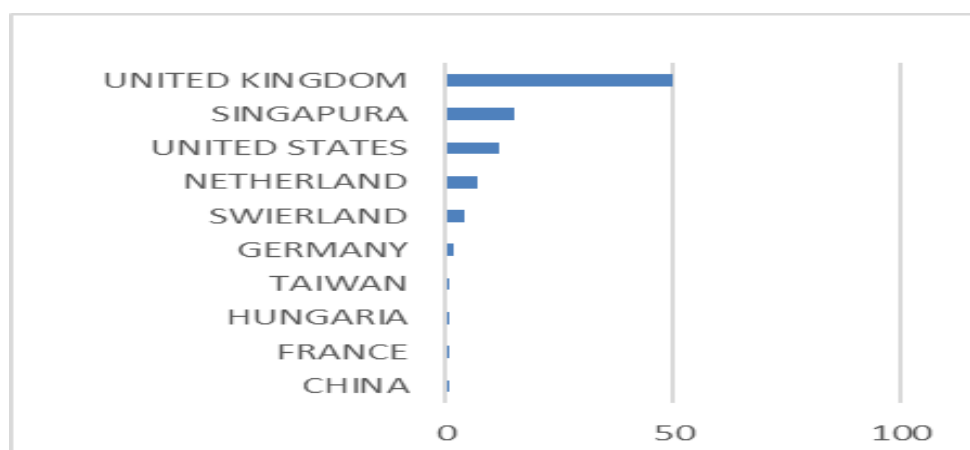


Figure 3. Number of Documents by Country

Google Scholar-indexed articles on green port implementation are written in international journals. The seven journals with the highest number of articles are presented in the following table.

Table 2. Journals that have the most articles about green port implementation

No	Journal Name	Number of journals
1	Process Integration Optimization for Sustainability	15
2	Transportation Research Part D: Transport and Environment	6
3	Maritime Policy and Management	5
4	Journal of Marine Science and Engineering	3
5	Journal of Cleaner Production	3
6	Research in Transportation Business and Management	2
7	International Journal of Shipping and Transport Logistics	2

Table 2 shows the trend of Google Scholar-indexed journals with the highest number of articles related to green port implementation. Process Integration and Optimization for Sustainability has the most articles on green port implementation, with 15 articles. The seven journals in Table 2 can be used as the best reference for green port implementation.

Mapping using VOSviewer

The database in the PoP application is stored in the form of RIS, which is then processed in the VOSviewer software to get the results of bibliometric analysis. After the RIS data is entered into the VOSviewer software, 496 terms are obtained, with 65 being the closest. A display is obtained by selecting the minimum number of occurrences of recurring words used in 2 terms, as shown in Figure 4.

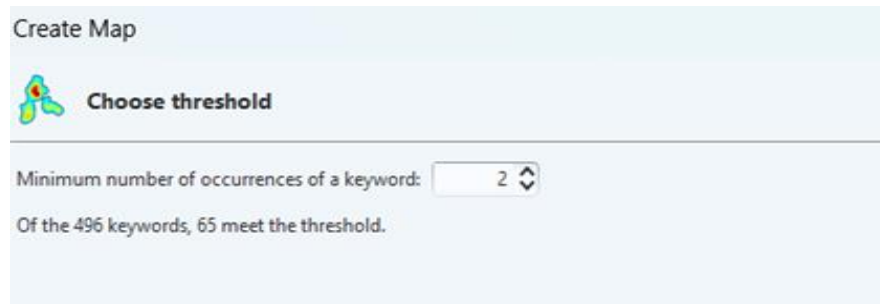


Figure 4. Create Map VOSviewer

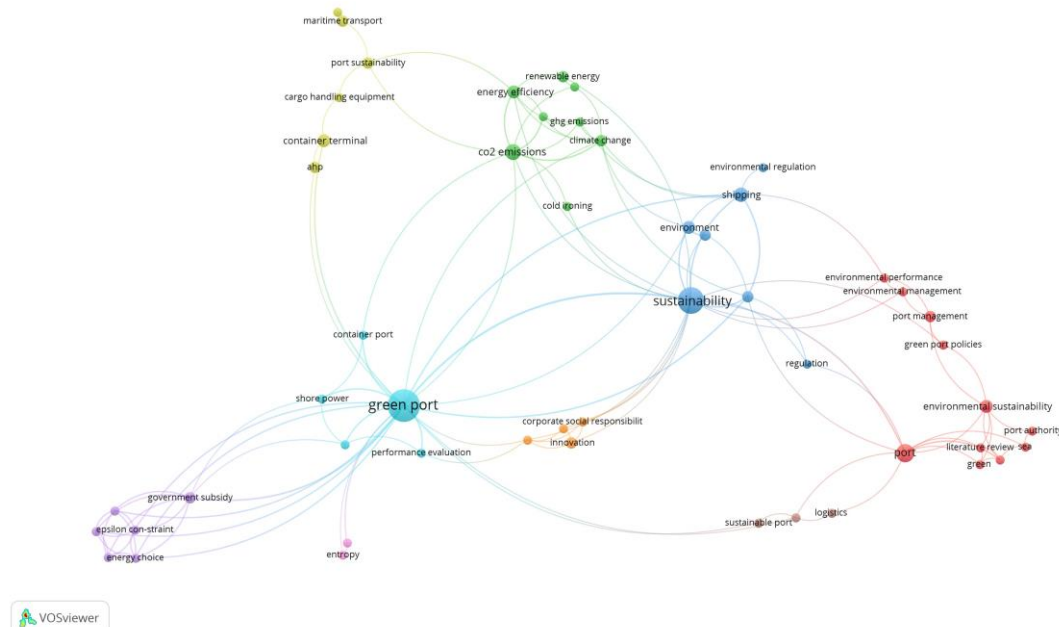


Figure 5. Circles Network Visualization

The results of the Circles Network Visualization analysis of VOSviewer software in Figure 5 obtained the results of 7 clusters consisting of 41 themes related to the use of ICT in mathematics learning, namely:

1. Cluster 1 (Light Blue) consists of 4 themes: Green Port, Container Port, Shore Power, and Performance Evaluation.
2. Cluster 2 (Dark Blue) consists of 5 themes: Sustainability, environment, regulation, shipping, and environmental regulation.
3. Cluster 3 (Green) consists of 6 themes: CO2 emission, climate change, GHG emission, energy efficiency, cold ironing, and renewable energy.
4. Cluster 4 (in yellow) consists of 5 themes: AHP, Container terminal, Cargo handling equipment, Port sustainability, and maritime transport.
5. Cluster 5 (purple) consists of 6 themes: Government subsidy, entropy, energy choice, epsilon constraint, and literature review.

6. Cluster 6 (red) consists of 11 themes: Port, green, literature review, Port Authority, environment sustainability, green port policies, port management, environment management, environment performance, sustainable Port, and Logistics.
7. Cluster 7 (Orange) consists of 3 themes: Innovation, corporate, and social Responsibility.

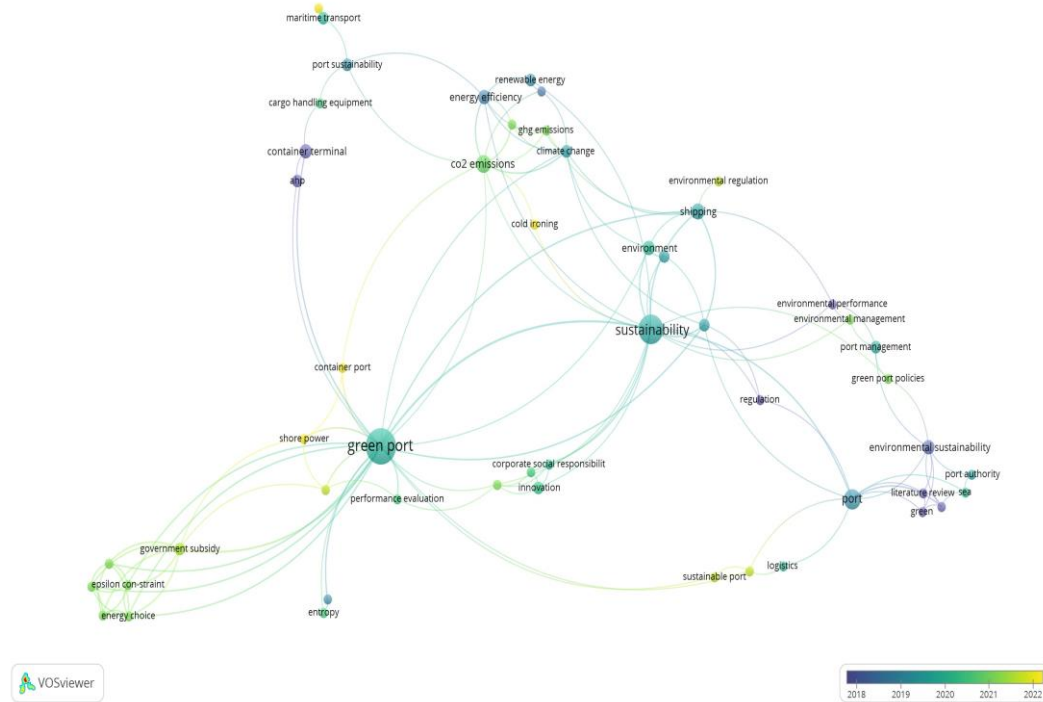


Figure 6. Frames Overlay Visualization

The results of the Frames Overlay Visualization analysis of VOSviewer software in Figure 6 show the theme trends of writing articles in Google Scholar-indexed journals by year. The theme trend of writing articles related to Green Port Implementation Research from 2015 to 2023 is characterized by blue, tosca, dark green, light green, and yellow.

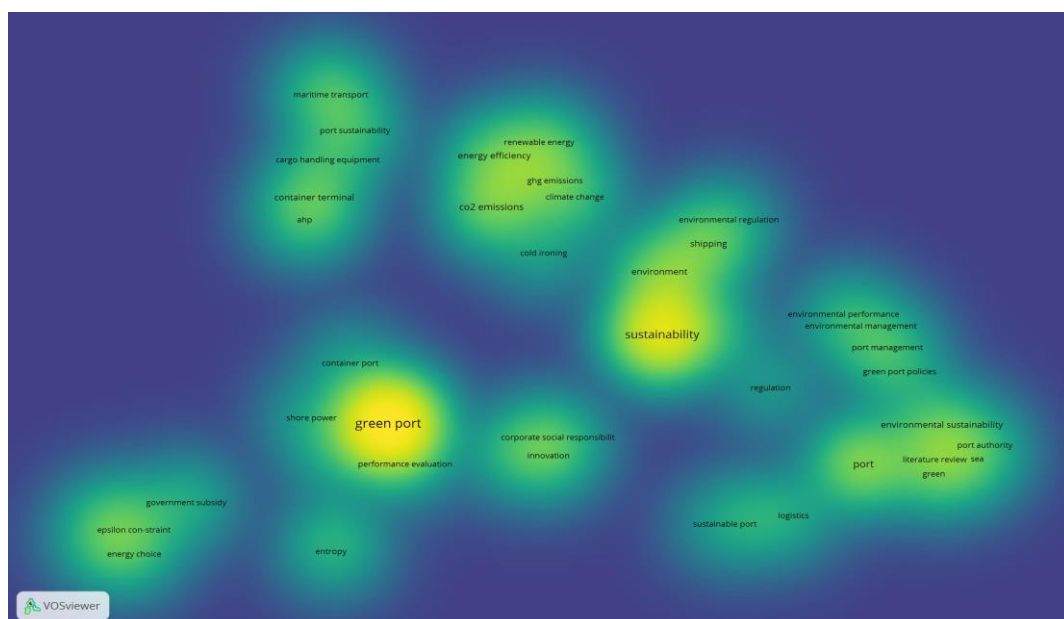


Figure 7. Density Visualization

The results of the Density Visualization analysis of VOSviewer software in Figure 7 display the density where a bright yellow indicates the density of research themes. The brighter the color of a theme, the more research has been done. The dimmer the color is, the theme is rarely researched (Al Husaeni and Nandiyanto 2021). Other dimly colored themes such as "regulation," "shore power," "logistics," and "green port policies" are themes that can be used as references for future research.

From the analysis using VOSviewer on research related to the application of green ports, it is found that existing research from 2015 to 2023 has many general themes, such as environment and sustainability. The focus of research on the application of green ports specifically is still not much done, so research related to green ports can be an interesting topic to research at this time.

Indonesia has currently implemented green ports in several ports. From the analysis of existing research, Indonesia is not included in the top 10 countries with the number of studies related to implementing green ports. This is a big challenge to conduct research on the implementation of green ports at ports in Indonesia to determine the suitability of the implementation of green ports that have taken place.

CONCLUSION

From the discussion, it can be concluded that global scientific publications related to research trends in applying green ports in Google Scholar-indexed journals in 2015-2023 are not too volatile. The increase in the number of studies each year tends to be stable and insignificant. Singapore is the country that contributes most to global scientific publications that discuss the application of green ports. Process Integration and Optimization for Sustainability has the most articles on green port implementation. The journals with the most citations about green port implementation are Renewable and Sustainable Energy Reviews, Transportation Research Part D: Transport and Environment, and Journal of Cleaner Production. The results of the mapping analysis using VOSviewer software have four themes related to the application of green ports, namely "regulation," "Shore power," "logistics," and "green port policies," which are still rarely researched and become themes of novelty in research. This theme can be used as a reference for further investigation.

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