

The Trend of Parameters for Evaluating Port Performance: A Systematic Literature Review

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ABSTRACT

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Sea transportation plays an essential and strategic role in the mobility of passengers, goods, and services domestically, from, and abroad. A sea port, one of the sub-systems of sea transportation, is a point or node where the movement of goods and passengers using sea modes will start, end, or make significant transfers or transits in achieving an effective and efficient sea transportation system. Port efficiency and effectiveness can be seen from the productivity and ability level to finance operational activities. Port governance is critical in port management; selecting a model or form of port management also affects port efficiency and productivity. An evaluation of the performance of port services is needed to maintain a port in prime condition. Port performance assesses several indicators, such as economic, operational, and financial aspects. This study aims to map parameters used in determining port performance. The scope of the article examined contains an evaluation of port performance from an operational, financing, and sustainable perspective. The study's two research questions are listed below. The trend port indicator parameter is first. What parameters consider when evaluating public ports? This study's limitation is 200 articles that research the commercial port. In future research, it is necessary to conduct research that examines the factors or parameters of performance measurement at ports organized by the government. The study results show that the trend of port performance parameters toward sustainable port management and guide port growth for public officials and private parties to preserve port effectiveness.

1. INTRODUCTION

Sea transportation is essential and strategically significant in transporting passengers, goods, and services domestically, from, and abroad. A seaport, one of the sub-systems of sea transportation, is a point or node where the movement of goods and passengers using sea modes will begin, end, or make transfers or transits. In addition, seaports play a significant role in achieving an effective and efficient sea transportation system [1]. Seaport is due to the advantages of sea transportation compared to other modes. Sea transportation is an efficient mode of transportation with a large carrying capacity and high cruising range that can reach inland areas. The forefront of globalization represents by shipping and seaports. Globalization as we know it now would not exist without maritime transport and accompanying advancements in transportation technologies. The international shipping industry equips around 90% of world trade [2]. The global economy depends heavily on shipping.

Intercontinental trade, bulk raw material transportation, and importing and exporting goods and cargo would not be feasible without shipping. As the seaborne business grows, lower freight costs benefit customers worldwide. Global trade transported by sea has risen rapidly in recent years. In the long run, shipping should benefit from being the mode of commercial transportation that uses the least amount of fuel

and produces the least amount of carbon [3]. United Nations Conference on Trade and Development, UNCTAD estimates the movement of goods by sea reaches 10.7 billion tons. The sea freight transport can see in the Table 1 [4]:

Table 1. Cargo by sea

Tahun	Tanker Trader	Main Bulk	Other Dry Cargo	Total (All Cargo)
2010	2.752	2.232	3.423	8.408
2011	2.785	2.364	3.626	8.775
2012	2.840	2.564	3.791	9.195
2013	2.828	2.734	3.951	9.513
2014	2.825	2.964	4.054	9.842
2015	2.932	2.930	4.161	10.023
2016	3.058	3.009	4.228	10.295
2017	3.146	3.151	4.419	10.716
2018	3.201	3.215	4.603	11.019
2019	3.169	3.225	4.682	11.076

The port can define one of the connections in the total transportation system or the transshipment of cargo/passengers from the starting spot to the intended destination, requiring at least 2 (two) different types of transportation modes. Even in current developments, ports as part of logistics activities whose existence in an area will develop economic activities. The presence of a dock with

various types of port services is inseparable from the supporting areas behind it, including the completeness of port facilities and infrastructure, as well as the existence of port management activities both from the aspect of providing and providing port services. It must be designed and managed to meet the need for port services for ships, passengers, and goods, for the present and in the future, which will continue to develop dynamically by developments in the strategic environment both nationally and internationally.

The port industry will continue to develop following economic developments. The role of ports is increasing with the shift in production locations relocated to low-cost developing countries. This phenomenon allows ports to increase their capacity to handle production and trade flows. However, it also challenges the development of port space, connection routes to land (hinterland), and environmental quality to the level of security. In addition to the fact that ship sizes and kinds are changing, ports are also directly impacted by trade activities, imbalanced container types, and increased cargo volume that exceeds port capacity. Service concerns and freight handling capacities contribute to port performance [5]. With performance data, principals can take benefit from performance reports. Managers use performance evaluation for planning and optimization [6]. The national growth rate, economic rank in the world, accessibility, citizen growth, and human index affected port performance [7]. Performance evaluation is essential for organizations to manage successfully and efficiently. The Organization's goals, client needs, and the external competitive climate are all considered [7]. Conventional measurement focuses on how effectively internal operations run instead of how well ports or terminals meet client demands.

In contrast to other means of transportation like air, road, and rail, Brooks and Cullinane [8] believe that port literature has placed a more significant emphasis on external viewpoints like client orientation, reliability, and service. Port literature has narrowly concentrated on measuring efficiency. According to the study of Bichou [9], focusing solely on efficiency or effectiveness is not the only performance improvement method. Port performance measurement methods are rarely utilized to capture efficiency and external energy and are also recommended by Panayides [10]. A performance evaluation of the port is necessary. To increase port productivity and dependability services. Guidelines for enhancing port competitiveness can be drawn from the findings of port performance measurements [11]. Vaggelas [12] establishes criteria for measuring port performance: availability when needed, accessibility, connectivity, infrastructure quality, service time, and cost. The dominant factors that become customers should consider satisfaction, flexibility, pricing, and response time while choosing ports. Performance at seaports serves a combination of public and private objectives for policymakers. A greater willingness exists among public policymakers for Performance evaluation is crucial for the Organization's management to be efficient and effective. Measures linked to cargo rate, loading/unloading, quality storage, and inland conveyance are necessary to assess the port's performance. Port productivity and the many port performance metrics are closely related. Consequently, the port's productivity determines by its performance [13]. Existing studies mainly examine performance indicators at commercial ports. To explore knowledge about port performance evaluation and investigate whether the performance parameters of commercial and non-

commercial ports are the same. According to the World Bank [14], there are 4 (four) models for port management functions. The management model appears from the provision of port services, asset ownership, and labor, which explain as follows:

1) Service port model

While port operators operate according to this widely-used model, the Port Authority maintains jurisdiction over the land, and all other property, involving both flexible and permanent property, and supports all administrative responsibilities.

2) Tool port model

The operational tasks under this paradigm, while the commercial operator offers additional port services, the Port Authority manages its port equipment.

3) Land Lord port model

Under this model, port authorities act as regulatory bodies and Land Lords, while private companies carry out port operations (particularly cargo handling).

4) Fully privatized ports model

Fully privatized ports (often in the form of private service ports).

The level of port services affected the port management model. In the landlord model, for example, the port is operated by the non-government operator, and the government, as the landlord or regulator, will oversee the service level of port performance, while in the public port model, the government becomes the regulator as well as the operator so that monitoring of port performance is very lacking. Mickiene and Valioniene [15] assess the performance of state-managed ports and port activity's impact on the overall economy. The link between governance effectiveness and added value quantifies through effectiveness and achievement metrics and the impact of socioeconomic variables on the overall economy. In the opinion of Brooks and Pallis [16], a theoretical structure should be established that incorporates numerous significant port aspects of performance to enable port evaluation and change of current government models. The study suggests that evolution is a process in which performance dramatically impacts realignment and, possibly the most significant aspect, reform of the existing governance frameworks. This study aims to map parameters used in assessing port performance. The scope of the article examined contains an evaluation of port performance from an operational, financing, and sustainable perspective. Most research uses environmental performance indicators to minimize pollution and other negative impacts. By differentiating the port management model, this study intends to address multiple port utilization evaluation-related future research concerns and the current situation in the field.

2. LITERATURE REVIEW

Port governance reforms such as devolution can increase port productivity [17]. The Port Authority has transformed from simply carrying out organizational functions to becoming more autonomous and able to act commercially [8, 13]. Numerous countries have implemented institutional reforms in the port industry, such as privatization, corporatization, and the separation of the government's port operation function. Both port efficiency and service quality are to be improved by these measures. The performance of port

utilities, which is still low, needs to be improved. Port productivity assesses through several indicators. Port performance indicators improve port performance, utility, and material for evaluating port development [2]. Ha et al. [18] divide port performance into 6 (six) clusters: core activities, supporting activities, financial capabilities, user happiness, multimodal integration, and sustainability. In realizing a sustainable port, port performance assessment is not limited to its productivity but needs to pay attention to social and environmental aspects (contribution to the surrounding community). Considering the multi-dimensional nature of sea transportation logistics is essential, which creates connections with institutional, economic, social, and environmental factors. It is also necessary to have a solution-based approach to the logistics process and supply chain orientation [16, 19]. Measurement and index processes, financial impact studies, and practical limits techniques are the three types of methodology utilized in port performance assessment [9]. Port efficiency measures by comparing the port's fundamental data output with its intended output or evaluating its technical efficacy or cost-effectiveness [20]. In contrast, port performance evaluation is essential for managing stakeholder relationships and achieving a sustainable competitive position. The intended or expected performance dimension must be assessed [18].

Nevertheless, an object, product, process, or other significant component can have one or more elements, which are quantified numerically using an indicator of efficiency or measurement. It must support evaluation and comparison to goals, benchmarks, and prior information [9]. Port performance perceptions have evolved along with port development over time. The contributions they made to the idea of port performance led to the creation of fundamental publications in the literature.

Increased port productivity will affect the increase in port revenue. It is necessary to optimize existing resources—the complexity of the parameters for increasing port productivity resolves by making a single decision. Multiple objective tools can help decision-makers rationalize the distribution of available resources through models for many specific goals simultaneously [21]. González Laxe et al. [22] identified sustainable port performance indicators, including economic, social, and environmental indicators. The economic dimension reflects the critical metrics of the firm's organizational structure. Value creation, productivity, financial health, degree of investment, and service quality are all given priority. The social dimension of the goal is to contribute to the region around the port and the growth of its human resources. The variables are equality, training, and knowledge management. The environmental dimension involves protecting nature, optimizing natural resource management, the effects of ecological activities, and monitoring the Port Authority's measures to mitigate their impact on the port population and the surrounding area. Environmental quality, clean energy use, and environmental management systems are ecological variables.

Even though port performance seems to be gaining popularity, there is limited research on sustainable port performance or its relation with the port model. As was already mentioned, it is evident that comprehensive literature reviews, even to date, in the field of port sustainability have not yet addressed social and economic factors. This topic is covered in this work.

3. METHOD

This study used the Systematic Literature Review (SLR) method by selecting articles, using inclusion criteria, and using more objective analytical methods. The article selection procedure uses the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) article selection step. SLR is a structured, clear, comprehensive literature review that identifies, assesses, and collects data from research other researchers have conducted [23]. With the SLR method, researchers identify articles and carry out organized studies, each procedure following predetermined steps. A systematic literature review makes an essential contribution to research. Systematic reviews can indicate future updates to improve previous research. Systematic reviews can answer research questions that individual research cannot respond [24]. Information and statistics related to port performance measurement are the study's subjects. Port performance is crucial for port managers, operators, the government, and other stakeholders. The author tries to present a thorough evaluation, but due to limitations, the things evaluated in the article are limitations to methods, then indicators, and also bibliometry. Based on the problems described and the existing port performance phenomena, the following research to answer the research objectives questions:

Research Question 1: How is the trend port performance indicator?

Research Question 2: What indicators use for public port evaluation?

Research Question 3: What is the future research agenda?

Quality Assessment (QA) or the quality of the assessment is the data found in the SLR research method will evaluate based on the questions. The quality assessment criteria include the following:

- 1) The paper journal published in 2009-2022
- 2) Does the selected journal paper contain port Performance?
- 3) Does the journal full text and indexed?

After determining the research question, the next step is conducting a search process. The search process obtains information and data relevant to the research question. Data and information searches using the Scopus and Google Scholar search engines, downloaded via Publish or Perish and stored in the Mendeley software. This study will use the PRISMA, which stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses, to formulate the problem. Identification, screening, eligibility, and inclusion are the four processes listed in the PRISMA procedure. The steps in the PRISMA protocol are shown in the following figure (Figure 1).

In the initial stage of identification, an article search was carried out from the Scopus and Google Scholar databases using the keywords (port performance) AND (Type OR Challenge) AND (port indicator) in the last 12 (twelve) years, from 2009 to 2022. From the search results obtained several articles with the following details (Table 2):

Table 2. Results of database search

No	Database	Total
1	Google Scholar	200
2	Scopus	200

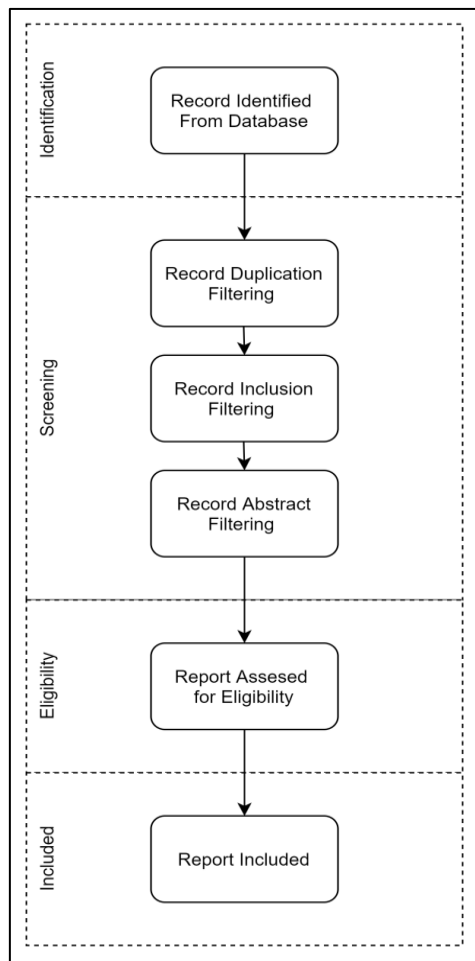


Figure 1. PRISMA diagram

For the next stage, screening by filtering the articles obtained from keyword searches. Namely duplication screening, inclusion screening, and filtering based on abstracts. Duplication screening eliminates literature that appeared in the Scopus and Google Scholar databases. Duplication filtering using title and author filtering. After screening based on the criteria, the following results (Table 3):

Table 3. Results of duplication filtering

No	Database	Total
1	Google Scholar	196
2	Scopus	200

In the next step, filter based on the type of literature. The selected literature is a journal article, for articles such as books and proceedings; the others eliminate from the list. The selection by inclusion uses the publish or perish application to filter titles based on keywords. Then the results are extracted into a spreadsheet to check whether the type of research is a book, journal, or proceedings. The articles examined are from journals with a reputation for maintaining the quality of this research. These are the findings of the inclusion screening (Table 4):

Table 4. Results of inclusion filtering

No	Database	Criteria	Total
1	Google Scholar	Article	136
2	Scopus	Article	162

After screening the type of literature, the results filter again based on the criteria of having a DOI. With this screening criteria, the following results (Table 5):

Table 5. Results of inclusion filtering

No	Database	Criteria	
		NON DOI	DOI
1	Google Scholar	24	112
2	Scopus	3	159

The screening results of the articles show the screening stage by reading the abstract to evaluate the suitability of the article content with the research objectives. The context of the port performance indicator uses to filter abstracts. The literature based on an abstract screening shows in the following table (Table 6):

Table 6. Results of abstract filtering

No	Database	Criteria	Total
1	Google Scholar	Abstract	5
2	Scopus	Abstract	19

In the eligibility stage, articles that pass the screening will download, reviewed, and analyzed to resolve research queries. Abstract checking makes it easier to select whether the article under study contains port performance. Abstract screening looks at the keywords included, for example, loading port performance, port governance, and port productivity. Then the following abstract criteria is the research content related to port performance evaluation (Table 7 and Table 8).

Table 7. Result of relevant literature from Google database

No	Authors	Years
1	Kuo-Cheng, Kuo Wen-Min, Lub, Minh-Hieu, Leb	2020
2	MMO Pinto, DJK Goldberg, JSL Cardoso	2017
3	C.A. Schipper	2017
4	M Puig, A Michail, C Wooldridge, RM Darbra	2017
5	Michaël Doom, Larissa van der Lugt, Peter W.de Langen	2013

Table 8. Findings from the Scopus database of relevant literature

No	Authors	Years
1	J.J. Stanković	2022
2	V. Rodrigues	2022
3	A. Vega-Muñoz	2021
4	H.C. de Oliveira	2021
5	O. Duru	2020
6	K. Dayananda Shetty	2020
7	J. Rezaei	2019
8	R. Teerawattana	2019
9	T. Muangpan	2019
10	G.K. Vaggelas	2019
11	A. Di Vaio	2018
12	M.H. Ha	2017
13	M.H. Ha	2017
14	M. Puig	2017
15	P. Antão	2016
16	M. Puig	2014
17	T.C. Lirn	2013
18	P. De Langen	2013
19	J.S.L. Lam	2013
20	S.H. Woo	2011

At the included stage, based on the feasibility analysis results, which refer to the research questions, 24 articles were obtained, which will be studied further. The 24 articles consist of 5 (five) articles from the Google Scholar database and 19 (nineteen) articles from the Scopus database. Literature relevant to the research question arranges in a table based on the year of publication, title, and author.

4. RESULT

This section will discuss three topics: the literature profile, research method, indicator for port performance measurement, and types of port models.

4.1 Profile literature

The quartile distribution of the journal, the year of publication, and the journal name are the data assessed in the literature profile. The articles in the search database were published from 2009 to 2022, according to the identification and screening of publications having port performance. The year with the most port performance research was 2017. After 2016, there was a tendency toward more studies on this topic. In 2009, 2010, 2012, or 2015, there was no discussion of port performance in pertinent articles. The research trend is towards assessing port performance that pays attention to the environment so that many performance measurements add indicators related to sustainability. The trend of articles that appear is also more in journals with environmental and sustainability topics, so these two findings can slightly answer research questions related to the direction of research trends (Figure 2).

Charts by Year of Publication

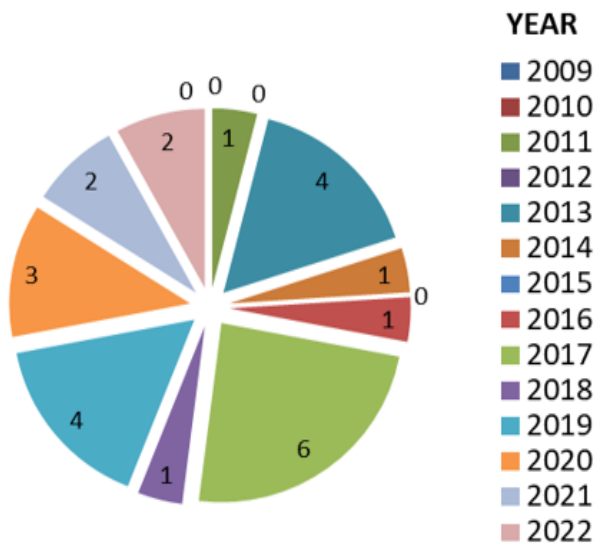


Figure 2. Literature profile by year of publication

Selected articles were then grouped based on Scopus journal rankings. Journal rankings check through the Scimago database. The grouping results found 13 (thirteen) reports in the Q1 rank, 9 (nine) articles in the Q2 rank, and 3 (three) in the Q3 rank. The following graph (Figure 3) shows the Scopus index-based distribution of literature:

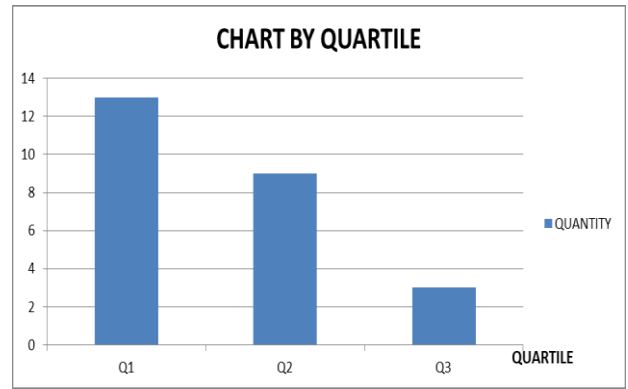


Figure 3. Literature profile by quartile index of Scopus

The following graphic shows a map of selected literature based on journal distribution. Chosen publications publish in several periodicals. Journals of sustainability, Ocean and Coastal Management, and Transportation Research each published 2 (two) articles. The distribution of journal article publishers shows as follows (Figure 4):

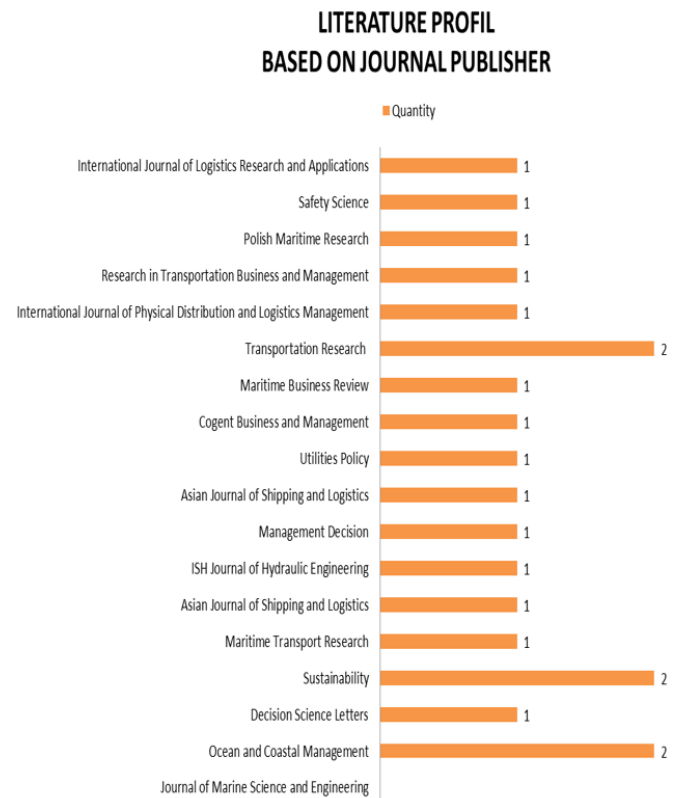


Figure 4. Literature profile by journal publisher

4.2 Research method

Technical analysis uses the 25 articles selected. Content analysis is a popular study technique in port performance studies. The method of content analysis uses in 3 (three) investigations. Comparative analysis is another technique that frequently employs by chosen publications. The comparative analysis method applies in two studies. Examining two or more objects, identifying their similarities and differences, and determining how they compare are all components of comparing and analyzing things. Data, goods, procedures, and systems are just a few examples of the many things this

technique does. To compare and analyze port performance effectively, it is clear about the criteria used for the comparison. A variety of factors can impact Seaport's performance, and the individual elements that are most crucial will vary depending on the analysis's objectives and environment. Here are some general characteristics that may be relevant when comparing the performance of different seaports. The amount of goods a port can handle is called its cargo handling capacity. A given time can be an essential factor in its performance. The number of vessels that can be loaded can use to quantify and unload cargo capacity and the speed at which these operations perform. Infrastructure: The quality and capacity of the infrastructure at a seaport, including docks, cranes, and storage facilities, can impact its performance. Location: The location of a seaport can be a critical factor in its implementation. Ports closer to major shipping lanes or markets may have an advantage over those farther away. Connectivity: The connectivity of a seaport, including its connections to other modes of transportation and major cities and markets, can impact its performance. Efficiency: The efficiency of a port, including the speed and effectiveness of its cargo handling operations, can affect its performance. Cost: Using a port, including cargo handling and storage fees, can impact its performance.

Rodrigues combines comparative analysis with environmental performance indicators from the Global Reporting Initiative's unified criteria to assess the performance of several European seaports. Puig et al. [25] compare one port's environmental performance to others to identify best practices and areas for improvement. Many ports conduct environmental impact assessments to evaluate the potential impacts of their operations on the surrounding environment. Comparing the results of these assessments can help to identify those ports that are taking a proactive approach to minimize their environmental impacts. It may be feasible to measure the environmental performance of various ports to improve the overall environmental performance of the global port sector and find best practices.

The other papers use research methods such as JJ Stankovic uses the Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE) and the Multicriteria Decision-making (MCDM) framework as an integrated entropy method in the weighting segment. Two articles use Analytical Hierarchy Process, two articles use descriptive methods, and the other are Delphi, Data Envelopment Analysis (DEA), and Balance Score Card.

One exciting article discusses connectivity as an indicator of port performance. Paper P De Langen discusses intermodal connectivity. Intermodal connection significantly impacts the efficacy and efficiency of moving goods through a port and into the hinterland, making it a crucial component of a port's overall performance. The following are some potential indicators of port performance that influence intermodal connectivity, The volume of cargo that moves through the port over a given period. A port's throughput may increase by more effective cargo handling and shifting costs related to port operation. This action makes possible through improved intermodal connection. Improved intermodal connectivity can help reduce costs by decreasing the time and resources required to transport cargo from the port to the hinterland. In general, intermodal connectivity is essential to a port's effectiveness, and investing in infrastructure and services that support solid intermodal connections can help improve the port's efficiency and effectiveness. Several methods used in

port performance research are diverse; each study has strengths and weaknesses. Comparative analysis has several drawbacks. The selection of cases in comparative analysis can introduce bias if the claims are not representative or chosen based on subjective criteria and rely on the availability and quality of data for the issues compared. While the PROMETHEE, MCDM, and AHP method has, strengths are sensitivity analysis, pairwise comparison validation, and comparative analysis of results. This assessment method is more suitable using the multicriteria analysis method because this method compares by weighting and considers stakeholders' opinions.

4.3 Types of port performance indicators

A port's performance evaluates using a wide range of performance metrics. Port performance indicators include, for instance. Carrythrough rate: This measures the cargo a port handles in a given period and can consist of imports and exports. Vessel calls: This counts the number of ships visiting a port in a given period. Berth utilization: This measures how efficiently the berths at a port are being used and calculates the time a vessel occupies a berth. An indicator of a port's accessibility to other forms of transportation, such as rail and trucks, is called intermodal connectivity. Customer satisfaction is a measure of the satisfaction of the customers of a port, including shipping companies, cargo owners, and other stakeholders.

Tracking and analyzing these and other performance indicators makes it possible to understand a port's performance better and identify improvement areas. From Scopus articles processed with NVivo, the average article discusses performance indicators from an environmental standpoint. This discus looks like Figure 5. These sustainability port performance indicators provide a comprehensive framework for assessing ports' triple bottom line (environmental, social, and economic) performance and guiding sustainable development strategies. They help ports track progress, identify areas for improvement, and demonstrate their commitment to sustainable practices. These indicators help measure the progress and effectiveness of sustainability initiatives and provide insights into the overall performance of ports in achieving sustainable outcomes. Not much research conducts on social indicators, and the indicators used are also unclear, so this could be an opportunity for future research.



Figure 5. NVivo word cloud

4.4 The trend of sustainability port performance

Modern indicators involve incorporating all aspects of operations and aligning with the Organization's goal, although recent port performance indicators emphasize specialized "efficiency" measurements. Based on previous research reviews, a good port indicates a productivity level. Port governance is critical in port management; choice management affects port efficiency and productivity of the port model. Port productivity involves performance indicators, including operational, social, and environmental performance. Resource optimization can achieve various objectives to enhance port efficiency. The purpose of the port is to increase productivity, increase port benefits for the surrounding area, and minimize environmental impact. Refers to sustainable business goals, namely a balance between company profits, port stakeholders, and environmental effects, which, when applied by the three pillars: environment, profit, and human. Of the 24 (twenty-four) selected articles, sustainability is the port performance kind most mentioned. "Sustainable port performance" refers to a port's ability to do business that satisfies current demands without impairing the next generation's capacity to meet their needs which requires considering economic, social, and environmental factors while developing and running a port. There are several ways in which a port can strive for sustainable performance, including:

1. Reducing greenhouse gas emissions: Ports can reduce their carbon footprint by increasing cargo handling equipment, investing in renewable energy sources, and encouraging low-emission vessels.
2. Protecting water quality: Ports can preserve the quality of nearby waterways by minimizing discharges of pollutants, managing stormwater runoff, and implementing best practices for waste management.
3. Promoting sustainable transport: Ports should encourage the adoption of sustainable forms of rail and inland waterways transportation to lessen the environmental impact of shipping.
4. Supporting local communities: Ports can work to provide for the desires, requirements, and interests of nearby community's economic opportunities and engage in meaningful dialogue with stakeholders.

By taking these and other steps, ports can work to improve their sustainability performance and contribute to a more sustainable future. One trend in sustainable port performance improvement is an increased focus on environmental sustainability which involves implementing measures to reduce the port's environmentally harmful practices, including lowering greenhouse gas emissions, reducing trash, cleaning up pollution, and safeguarding ecosystems and biodiversity. Ports, for example, to reduce their reliance on fossil fuels and carbon footprint, businesses may invest in alternative power sources such as wind, Sunlight electricity, or tide energy. This energy is congruent with SDG 7, which aims to provide everyone with reliable, sustainable, and renewable energy. Another trend is using digital technologies and automation to increase effectiveness and lessen the effects on the environment port operations. By using data analytics to optimize cargo handling and movement, implementing automation in cargo handling and other processes, and using digital platforms to streamline operations and communication, ports can reduce their energy consumption and greenhouse gas emissions. This object correlates with SDG 9; It aspires to build durable structures, encourage equitable and

environmental industry, and nurture innovation. Collaboration and partnerships with government agencies, local communities, and environmental groups are also crucial for improving port performance and achieving the SDGs. By engaging with these groups and seeking their input, ports can build support for their operations and work towards a more sustainable future. This action aligns with SDG 17, which calls for partnerships to achieve the SDGs. For example, ports may collaborate with local communities to develop sustainable development plans that consider the community's needs and concerns or work with environmental groups to implement measures to protect ecosystems and biodiversity in the port area.

Sustainable procurement practices are another trend in port performance improvement that can help reduce port operations' environmental impact and contribute to the demand for more sustainable goods and services. By prioritizing suppliers that meet sustainability standards, reducing waste and pollution in their supply chains, and promoting environmentally-friendly products and materials, ports can support the achievement of SDG 12's objective to promote sustainable consumption and production patterns. For instance, ports may create procurement guidelines prioritizing environmentally friendly goods and materials or cooperate with suppliers to implement sustainable sourcing techniques. Implementing a sustainable port can face several obstacles affecting its performance and sustainability. The following are some common obstacles that we may encounter in implementing sustainable ports. Implementation of sustainable ports often requires significant financial investment. Ports need to allocate funds to build environmentally friendly infrastructure. A lack of awareness and understanding of the importance of sustainable ports can hinder changing the operational paradigm and implementing more sustainable practices. Regulatory Limitations and Policies may not be fully available yet. Ports may struggle to overcome challenges and change existing operational models without explicit regulatory frameworks or strong incentives to implement sustainable practices. Implementing sustainable practices at ports involves close collaboration and cooperation between various stakeholders, including governments, port operators, local communities, and environmental organizations. These challenges include difficulty reaching an agreement, conflicting interests, and complex coordination between parties. Some sustainable practices in ports may require sophisticated technology or extraordinary infrastructure Resistance to Change: Adopting sustainable ports can be hampered by opposition to adaptation, which is a significant obstacle. Some parties may be reluctant to change existing operational models or face the uncertainties and risks of transitioning to sustainable practices. A holistic approach is needed to overcome these obstacles, involving collaboration between the stakeholders. Governments, ports, industry, and civil society organizations need to work together to overcome barriers and create frameworks that support the implementation of sustainable ports.

Overall, these trends in sustainable port performance improvement can help ports to achieve Sustainable Development Goals by reducing their environmental impact, improving efficiency, and collaborating with stakeholders to align with broader sustainable development goals. By adopting these practices, ports can accelerate the transition to a more sustainable future.

4.5 Future agenda port model as subject to research

The average research study is on commercial ports; the ports that have a study lot are in the European region; one article researches port functions; it is easy to divide the research subjects into a container, non-container, and multipurpose ports, for non-commercial ports not available. Most studies on measuring port performance emphasize container ports, as already indicated. Concerning port efficacy outside of the container market, this study intends to establish a framework used in various port markets. Port governance refers to how a port operates and the policies and processes put in place to ensure its effective operation. There are many different models of port governance, including public ownership, private ownership, and public-private partnerships, each of which has advantages and disadvantages [15]. A government body or authority owns and runs the port according to public ownership models. This model can provide a stable and long-term funding source for the port, as the government can invest in infrastructure and equipment. However, it can also be subject to political interference and may not be as responsive to the needs of customers and other stakeholders as a privately-owned port.

Private ownership models involve the port owned and operated by a private company, which may be a standalone firm or a subsidiary of a giant corporation. Private ownership can provide greater financial flexibility and allow the port to be more responsive to market demand, as the company can make investment and operational decisions based on profitability. However, it can also be more vulnerable to market fluctuations and may not prioritize social and environmental concerns as highly as a publicly-owned port.

Collaboration between the public and commercial sectors is involved in the ownership and operation of the port through public-private partnerships. Due to the public sector's ability to provide stability and long-term finance, this approach can benefit both public and private ownership. In contrast, the private sector brings expertise and focuses on efficiency and profitability. However, it can also be complex to manage and may require careful negotiation and agreement on the roles and responsibilities of each partner.

Regardless of the governance model, ports need clear and transparent policies and procedures to manage them effectively. These include establishing a transparent decision-making process, setting performance targets and indicators, and implementing systems for monitoring and evaluating the port's performance.

In terms of performance indicators, a port's effectiveness and efficiency assess with three categories such as operational, social, and environmental performance.

Operational performance indicators focus on the core activities of the port, such as cargo throughput (the amount of cargo handled by the port). Container stay time is when containers spend at the pier before being loaded onto a truck or vessel for transfer. The vessel turnaround time is the length of time that it requires for a ship to accomplish its tasks in a port and sail. Other operational performance indicators might include productivity (the port's efficiency in handling cargo and vessels, typically expressed as the volume of cargo handled per worker or hour) and customer satisfaction (the degree of pleasure of the port's clients, which may include shipping companies, cargo owners, and other stakeholders). Social performance metrics emphasize how the port affects the local population and workforce. Social performance could

involve providing communities with jobs, providing port employees with training opportunities, and putting health and safety laws into effect.

Environmental performance indicators focus on the port's environmental impact and efforts to minimize pollution and other negative consequences. Ecological might include energy efficiency, waste management, and pollution prevention measures.

Finding ways to use the port's resources (such as land, labor, and equipment) more effectively and efficiently to boost performance is a critical component of resource optimization, another crucial facet of port administration, including improving processes and procedures, investing in new technology and equipment, and identifying opportunities for collaboration with other stakeholders. For example, a port might implement a more efficient cargo handling system or invest in energy-efficient equipment to reduce costs and improve productivity. In general, using performance indicators and selecting a governance model is crucial.

5. CONCLUSIONS

Port performance evaluation has to study how to measure. This study is evident from the numerous research classified as port performance. All research objects are commercial ports. There has been no research examining the performance of non-commercial ports. The research trend for measuring port performance began to develop after 2017. The research trend is toward measuring sustainable port performance; many studies have included environmental factors in assessing port performance. The answers to the first research question: How is the port performance measurement research? Sustainable port performance has essential implications for port managers and authorities in policy making. Sustainable port performance requires the adoption of policies that support sustainable practices. Port managers and port authorities need to develop policies that promote energy efficiency, emission reduction, good waste management, protection of marine ecosystems, and use of green technologies. Sustainable port performance encourages greener technologies and innovation in port operations. Port managers and authorities must identify appropriate technologies to improve energy efficiency, reduce emissions, manage waste, and improve operational safety. Implementing these technologies and innovations requires ports, government, and the private sector collaboration.

For the second research question, no analysis measures the performance of non-commercial ports, so this needs to investigate further. The methods widely used in port performance measurement research are comparative and descriptive. This study's limitation to 200 articles and use of only 2 (two) database sources makes it weak. This study is also limited in using keywords, and future studies can expand the use of keywords to create better research. Besides, this research has limitations in selecting inclusions that can develop in future research. In future research, it is necessary to conduct research that examines the factors or parameters of performance measurement at ports organized by the government. The association between a port's administration and the effectiveness and efficiency of its operations refers to the nexus between port governance and performance. Whether publicly or privately owned, a port's governance structure can significantly impact how well it performs [6]. Because it dictates the procedures and policies to ensure the port runs

smoothly and effectively. For instance, a privately owned port may be more responsive to market demands and have more stable and long-term funding than a government-owned port, which may also be more susceptible to political influence.

On the other hand, a privately-owned port may be more flexible and responsive to market demand. Still, it may be more vulnerable to market fluctuations and not prioritize social and environmental concerns as highly as a publicly-owned port. To optimize performance, it is important for ports to carefully consider the governance model most appropriate for their specific needs and circumstances and to regularly review and assess their governance structures to ensure that they effectively support the port's operations. The port may involve implementing clear and transparent policies and procedures, setting performance targets and indicators, and regularly monitoring and evaluating the port's performance. The following research opportunity is measuring sustainable port performance because the port's contribution to the greenhouse effect and the challenge of climate change is relatively significant. Another future research opportunity is possible to investigate how the port model and port performance measurement are associated, and there are still opportunities for research in assessing port performance indicators related to sustainability.

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