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A Bibliometric Analysis: Mapping the Evolution of Maritime Supply Chain Research Trends Across Academic Tides

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ABSTRACT

The maritime industry has been vital in facilitating and enabling economic development and global trade. Although the industry and its supply chain are not new concepts, they have gained significant attention from academic researchers over the past decade. As a result, numerous scholarly explorations and investigations have been published. This study aims to analyze publication trends, scientific impact, and existing themes and address gaps within maritime supply chain publications. a bibliometric method is applied to 382 articles extracted from two popular databases, Scopus and Web of Science. The study uncovered a growing focus on the maritime supply chain, with particular attention given to maritime logistics. The literature revealed several recurring themes: blockchain integration, supply chain risk management, and green logistics. However, there is still a need for more empirical investigation into sustainable performance, especially in areas like the green maritime supply chain. Future studies should expand on existing conceptual explorations and incorporate empirical investigations. The findings have two main benefits: they provide researchers with opportunities for further investigation and enable policymakers and port authorities to monitor global maritime supply chain trends and progress. By doing so, they can learn from others' initiatives and improve their current practices.

Keywords: *bibliometric, maritime green supply chain, maritime logistics, maritime supply chain, shipping supply chain*

1. INTRODUCTION

The maritime industry has been playing an essential role as the facilitator and enabler of prosperity in the context of economic development as well as global trade (Jiang *et al.*, 2023; Nguyen *et al.*, 2023). Evidently, the maritime industry is critical as more than 80% of international trade in view of volume is transferred by sea, hence contributing pointedly to economic growth in many economies and regions worldwide (Fratila *et al.*, 2021; Wen *et al.*, 2022). Due to the fast development of international trade, the maritime supply chain has become one of the most significant complex networks (Jiang *et al.*, 2023). Indeed, it is different from ordinary supply chains, as it has ports at its centre and effectually integrates shippers, shipping companies, inland transport service providers, freight forwarders, and other service bumps to complete the goods supply activity (Narasimha *et al.*, 2021). In addition, many stakeholders are engaged in this chain, including shipping lines, shippers, port operators and authorities, marine and cargo insurers, hinterland transport operators, and banks with interconnected working links reflected in different processes (Nguyen *et al.*, 2023). Henceforth, the interaction and coupling between processes and stakeholders are highly increasing and over-dependence on broader and deeper global chains, aided by the importance of the maritime supply chain (Narasimha *et al.*, 2021). Therefore, concerns

from both policymakers and market players are growing along with the focus of academic researchers. Both practitioners and academics have collaborated to devise many methods for enhancing and regulating supply chains. These methods aim to address the intricate problems and obstacles encountered by contemporary and dynamic industries and economies. The supply chain management (SCM) field encompasses numerous research fields, such as supply chain coordination, resilience, reverse logistics, integration, financing, and green supply chain (Yalcin *et al.*, 2020). Sivula *et al.* (2020) conducted a study to investigate the implementation of blockchain technology in the supply chain operations of three organizations. Their findings revealed a promising outcome: blockchain technology was successfully applied to supply chain management across various business sectors, resulting in improved services and greater transparency.

Recently, academic researchers have acknowledged the importance of maritime supply chains in global trade and are putting their efforts into exploration and investigation to identify issues, solutions, and ways to enhance the effectiveness as well as efficiency of maritime supply chains (Jiang *et al.*, 2023; Narasimha *et al.*, 2021; Psaraftis & Kontovas, 2010; Tran & Lam, 2022; Y. *et al.*, 2020; Yang, 2019). In addition, green supply chain management practices are also crucial phenomena in the maritime supply chain, which aim to improve sustainable economic, environmental, and social performance in the context of port operations (Chou *et al.*, 2022; Fernando *et al.*, 2019; Jasmi *et al.*, 2020). However, advanced technologies, such as the Internet of Things (IoT), Blockchain, Artificial Intelligence (AI), Big Data Analytics, Autonomous Vessels, Remote Monitoring and Control Systems, and Predictive Maintenance, are critical in transforming the maritime supply chain. Integrating the Internet of Things (IoT) in the supply chain has revolutionized operational efficiency by enabling real-time connectivity for millions of shipments. In a study, Batwa and Norrman (2020) identified five key applications of blockchain techniques in supply chain management: digitalization, traceability, integration, compliance, and finance. With this connectivity, shipment tracking, tracing, and visibility have been significantly improved, as Ben-Daya *et al*. (2022) noted. Another study by Kang *et al.* (2024) explored adopting digital technology to improve the resilience of the building supply chain during the COVID-19 pandemic. The findings highlighted the importance of focusing on supply chain disruption when using digital technology during the pandemic. Furthermore, the study revealed that digital technology was crucial in enhancing supply chain resilience and market performance. The research provides a detailed explanation of the additional implications of this phenomenon. By enhancing efficiency, sustainability, and competitiveness, these smart technologies are helping to create “smart ports” that enable optimized logistics processes and seamless connectivity. However, recent disruptions, including the COVID-19 pandemic, geopolitical tensions, natural disasters, and supply chain bottlenecks, have underscored the vulnerabilities and interdependencies within the maritime logistics network. To enhance resilience, it is essential to adopt advanced technologies like IoT, blockchain, AI/ML, and cloud computing to enable real-time monitoring, data sharing, and predictive analytics (Dzikriansyah *et al.*, 2023; Jasmi *et al.*, 2020). Moreover, the maritime industry must prioritize energy efficiency measures and adopt low-carbon technologies to reduce CO2 emissions and address environmental concerns since ships heavily rely on fossil fuels, leading to severe environmental and health consequences (Mohiuddin *et al.*, 2024).

Although much research has been conducted on maritime supply chain management, a gap exists in comprehending this field's constantly evolving trends and dynamics. Previous studies have mainly concentrated on specific aspects of maritime logistics or supply chain operations. However, a dearth of comprehensive analyses surveys the research landscape and highlights emerging patterns. While individual studies have provided valuable insights, conducting a systematic literature review is imperative to consolidate existing knowledge and pinpoint areas that warrant further exploration. Prior studies have scarcely emphasized maritime supply chain studies using bibliometric analysis. Two studies related to maritime were observed in the Web of Science and the Scopus database. Bolbot *et al.* (2022) employed a bibliometric study to explore the literature on maritime cybersecurity using only the Scopus database. Henceforward, Weerasinghe *et al.* (2023) emphasized container terminal operations through a bibliometric analysis using the Scopus database. This study aims to explore Scopus and Web of Science databases to gauge academic articles, particularly on the maritime supply chain domain, to fill the gaps. The findings of this study benefit twofold: first, academic researchers may be able to continue further investigations by using the scopes for further studies. Second, policymakers and port authorities can observe the global maritime supply chain's progressive mechanisms and trends. Thus, they can measure the initiatives taken by others to improve their current maritime supply chain practices.

The paper is divided into several sections. The introduction provides an overview of prior research on maritime supply chains. Next, a section is devoted to the methodology of bibliometric analysis based on a literature review. The subsequent section presents the results, including performance analysis, scientific impact, and science mapping. After that, a discussion and future studies section is provided. Lastly, the conclusion underscores the limitations and offers recommendations for future research.

2. METHODOLOGY

The aim of this study, as labeled applying the goal-question-metrics approach (van Solingen *et al.*, 2002), is to explore existing scholarly documents characterizing maritime supply chains with the aim of characterizing maritime supply chains or maritime logistics (research progress, relevant variables, data, methods, tools, and findings) from the viewpoint of academic researchers. To assess these attributes, this study carried out the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher *et al.*, 2015). Although there are several ways to conduct literature review techniques (Booth *et al.*, 2021), this study preferred PRISMA because it is a broadly applied, systematic, easy-to-follow technique (Moher, 2009). The steps followed based on the PRISMA methodology are exhibited in **Figure 1**.

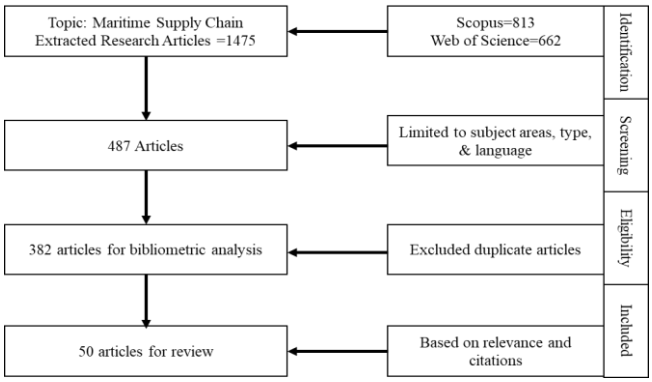

Figure 1 The flow of the data extraction process for bibliometric analysis and literature review

2.1 Identification

This study selected two online databases as search sources: The Web of Science (WoS) and Scopus. These databases were selected for their creditworthiness related to extensive collections, availability (full text), quality, and versatility (export apparatus). Several keywords were identified about the main overarching topics of this study, namely 'maritime supply chain' referred to by earlier studies (Jiang *et al.*, 2023; Panayides, 2006). The keywords were chosen based on terms alike (e.g., "Maritime supply-chain" or "Maritime green supply chain" or "Maritime logistics" or "shipping logistics" or "shipping supply chain). A total of 1475 research articles (WoS = 662 & Scopus = 813) were identified from both databases.

2.2 Screening

The screening process was conducted to include the most relevant research publications related to maritime supply chains (Bolbot *et al.*, 2022) generalization. Accordingly, the search choice was limited to research articles published in the contexts of Transportation, Operations Research, Management Science, Management, Business, Social Science, and Accounting. Further, the identified research articles were limited to journal articles to gain empirical generalization. Finally, the research articles were included and written in English. After screening the identified research articles, a total of 487 research articles (Scopus = 205 & WoS = 282) were extracted from databases.

2.3 Eligibility

The screened articles were scrutinized, and the appropriate ones were considered for bibliometric analysis during the eligibility analysis. This method used Microsoft Excel to merge both data files and identify and remove duplicate articles from the merged data file. A total of 105 duplicate files were found and removed from the data file.

2.4 Included

A total of 382 research articles underwent bibliometric analysis to meet the study's objectives. Additionally, approximately 50 research articles were selected based on their global and local citations, as well as recent articles that garnered a significant number of citations. These selected articles were subjected to critical review in order to complement the bibliometric findings and facilitate a thorough discussion aimed at identifying current trends and potential areas for future research.

2.5 Bibliometric Analysis

Bibliometric analysis is a scientific technique for systematic literature review conducted quantitively (Aria & Cuccurullo, 2017; Donthu *et al.*, 2021; Islam *et al.*, 2022). Even though it is critically known for computing scholarly production and assessing its impact and quality, it is also helpful for analyzing and displaying research's conceptual, intellectual, and social structure and its dynamic and evolving aspects (Aria & Cuccurullo, 2017). In this process, it intends to designate how particular areas and domains are structured and evolved (Aria & Cuccurullo, 2017; Khan *et al.*, 2024; Ramli *et al.*, 2022). In an alternative way, it assists in identifying research publications (performance analysis), maps the science (science mapping), and is helpful given research synthesis (Aria & Cuccurullo, 2017; Choudhury, 2023).

Performance analysis refers to the publication trends in a specific research domain, including descriptive statistics on scientific publications and annual production growth. With these analyses, this study enables us to explore the publication trends on maritime supply chains and the prediction of future growth. Meanwhile, science mapping unveils the scientific influence, networking, and existing themes in the research domain (Ahmad *et al.*, 2023; Donthu *et al.*, 2021; Islam *et al.*, 2022)This mapping includes several analyses: citation analysis, co-authorship, and collaboration mapping, and co-occurrence mapping of keywords, which are crucially considered in the bibliometric analysis.

Citation analysis refers to the citation of one scholarly article to another, which enables the configuration of intellectual associations or knowledge sharing between articles considered influential or high-impact publications (Donthu *et al.*, 2021; Islam *et al.*, 2022). Co-authorship mapping demonstrates the collaboration between scholars to investigate a particular research area to produce scholarly output and publish jointly. It helps to identify the existing themes and, most importantly, the cluster of authors that are emphasizing particular themes. Another collaboration mapping that includes the corresponding authors' affiliated countries presents the more focused geographical location. It helps identify the relevant countries connected to a research focus on that area. As a result, these mappings enable us to find the most focused countries, the chain of authors continuously emphasizing different themes under the same research area. However, the most essential attribute of the bibliometric analysis is the co-occurrence mapping of keywords (Mostafa, 2020). This analysis entails configuring the key themes, variables, and domains of a particular area of research (Su & Lee, 2010). Keywords are provided to determine the critical field of the research paper, while keyword mapping is used to visualize how often those keywords appeared in the given area (Alam *et al.*, 2021; Ramli *et al.*, 2022). Therefore, this study has included this analysis as well to identify thematic clusters in maritime supply chain articles.

3. RESULTS

3.1 Performance Analysis

Descriptive Statistics

Table 1 presents the descriptive statistics of analyzed articles relevant to maritime supply chains or logistics. As mentioned earlier, 382 (to the date of extraction of data)

articles were considered for bibliometric analysis. To create a clear image of publication trends, the publications enlisted in 2024 were excluded from the descriptive statistics. However, other analyses considered a total of 382 articles to attain the updated scenarios until the analysis date. A total number of 368 articles were published in 127 journal sources from 2005 to 2023. More than 16% of the annual production growth of publications can be observed, with nearly 21 citations per article. A total number of 809 authors contributed, whereas only 24 authors solely authored articles, and the rest were written in collaboration. A remarkable observation is the international co-authorship (29.89%), which signifies global cooperation in maritime supply chain scholarly works.

Table 1 Descriptive statistics of analyzed articles

Variable	Description	Result (2005-2023)
Documents	Number of total articles	368
Sources	Journal sources	127
Period	Timespan	2005:2023
Annual growth rate	Scientific production growth	16.24%
Document/age	Document average age	5.72
Citations/document	Average citations per article	20.54
Authors	Total contributing authors	809
Single authored doc	Solely authored articles	24
Multi-authored doc	Collaborated authored articles	344
Co-Authors/doc	Average co-authors per article	3
International co-authorship	International collaboration of authors to produce articles	29.89

Scientific Production

The active exploration of the maritime supply chain or relevant study started before 2005. Since 2005, an upward trend has been acknowledged in the evolution of research relevant to maritime supply chains or logistics (**Figure 2**). Markedly, in the 20 years of productivity trend, scholarly activities increased after 2012. This may be due to the rise of concerns in the blue ocean economy. The continued interest in maritime supply chain or logistics resulted in the highest annual scientific production incurred in 2023. It can be envisioned that the growth trend will likely remain in the future due to the gradual focus on maritime shipping, supply chain, logistics, etc., by academics and policymakers. Besides, average citations per article have increased tremendously in earlier years. However, the growth has dropped in recent years because the citations depend on publication times. In recent times, a large number of publications have been incurred, which may affect the near future. In a similar vein, the average citation per year has also slowed down in recent times.

3.2 Scientific Impact

Citation Analysis

This study presents the citation analysis based on the number of citations received from published articles on the maritime supply chain. Articles with many citations denote a high influence that engrosses many citations and the circulation of knowledge. The citation analysis is divided into two different contexts: global citation assesses the citations of an article attained from articles limited in the entire database (e.g. Scopus or WoS), and local citation refers to the attainment of citations from understudied articles (382 articles) (Aria & Cuccurullo, 2017). Most of the time, global citations could come from other disciplines or subject areas, while local citations assess the impact of analyzed article collection (Alam *et al.*, 2021; Aria & Cuccurullo, 2017).

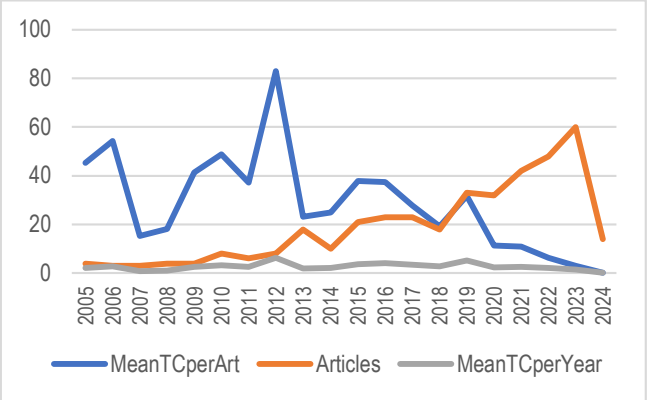

Figure 2 Scientific production
Note: Articles - number of articles, MeanTCperArt – total citations per article, MeanTCperYear – total citations per year

Global Cited

Table 2 presents the top ten globally cited articles in the area of the maritime supply chain. The topmost influential article by Rai *et al.* (2012) dispersed knowledge relating to IT capability, associating the cocreation of relational value in interfirm relationships. This article identified a set of IT functionalities, namely single-location and multilocation shipping, visibility of supply chain, and financial settlement, that can manage the drifts of information, physical goods, and finances across places through interfirm logistics methods. Psaraftis and Kontovas (2010) influenced the knowledge by developing some models to enfold the trade-offs between policies and maritime logistics to decrease the environmental impacts of shipping. Henceforth, Yang (2019) influenced digital maritime supply chain scholars by evaluating blockchain applications' effects on the intention to use in maritime shipping. The findings suggested that the intention to use blockchain applications was derived from the task of customs clearance and management, standardization and platform development, and digitalizing and easing paperwork. By reviewing green ports and maritime logistics literature, Davarzani *et al.* (2016) created opportunities to study this topic further.

Barnes and Oloruntoba (2005) stated that the intricacy of the interface among ports, maritime operations, and supply chains forms vulnerabilities that entail analysis that outspreads beyond the organized necessities of these initiatives and creates substantial management challenges. This article attracted citations by suggesting the necessity of investigation/research of crisis management capabilities to

effectively control the threat of loss of competitiveness and maritime terrorism. Another review paper by Mansouri *et al.* (2015) implied that the next generation of DSS (decision support systems) for maritime transport perhaps exploits the theoretical expansion in multi-objective optimization to enable informed decision-making in MSC (maritime supply chains) given competing objectives as well as environmental sustainability. Similarly, another review paper managed to catch the attention of scholars by discussing the progression of the maritime logistic concept (Panayides, 2006). However, Lam (2015) designed a sustainable maritime supply chain by considering customer requirements, mainly cost and price competitiveness, efficient use of fuel and resources, pollution reduction, and health, safety, and security. Subsequently, Lam and Bai (2016) designed a quality function deployment approach to increase maritime supply chain resilience. These attributes demonstrated using green design engines, machinery, and ships as a crucial design requirement. Thus, Wan *et al.* (2019) proposed an advanced risk analysis method to handle the uncertainty in the maritime supply chain. Reviewing the top ten globally cited documents shows that the research directions have been diverted to various contexts and disciplines that do not exclusively envision the maritime supply chain. Thus, these articles widen the discipline into various sectors, enabling scholars to expand the research domain.

Table 2 Top 10 global cited articles

No.	Title	Author(s)	Source	PY	TC	TC/Y
1	Interfirm IT Capability Profiles and Communications for Cocreating Relational Value: Evidence from the Logistics Industry	Rai *et al.*	MIS Quarterly	2012	435	33.46
2	Balancing the Economic and environmental performance of Maritime Transportation	Psaraftis & Kontovas	Transportation Research Part D: Transport and Environment	2010	184	12.27
3	Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use	Yang	Transportation Research Part E: Logistics and Transportation Review	2019	163	27.17
4	Greening ports and maritime logistics: A review	Davarzani *et al.*	Transportation Research Part D: Transport and Environment	2016	148	16.44
5	Multi-objective decision support to enhance environmental sustainability in maritime shipping: A review and future directions	Mansouri *et al.*	Transportation Research Part E: Logistics and Transportation Review	2015	145	14.50
6	An advanced fuzzy Bayesian-based FMEA approach for assessing maritime supply chain risks	Wan *et al.*	Transportation Research Part E: Logistics and Transportation Review	2019	144	24.00
7	Assurance of security in maritime supply chains: Conceptual issues of vulnerability and crisis management	Barnes & Oloruntoba	Journal of International Management	2005	143	7.15
8	A quality function deployment approach to improve maritime supply chain resilience	Lam & Bai	Transportation Research Part E: Logistics and Transportation Review	2016	139	15.44
9	Maritime Logistics and Global Supply Chains: Towards a Research Agenda	Panayides	Maritime Economics & Logistics	2006	125	6.58
10	Designing a sustainable maritime supply chain: A hybrid QFD–ANP approach	Lam	Transportation Research Part E: Logistics and Transportation Review	2015	121	12.10

Local Cited

Table 3 presents the locally cited articles on the particular maritime supply chain study. Panayides and Song (2013) and Nam and Song (2011) influenced maritime logistics scholars by reviewing maritime logistics literature. They are substantially impacted by defining and enhancing their understanding of maritime logistics hubs and their implications. In the second top article, Lee and Song (2010) unveiled a positive relationship between social networks, knowledge acquisitions, and maritime logistics value. It demonstrates that acquiring knowledge and improved social networks enable greater maritime logistics values. Yuen and Thai (2017) reviewed the literature to identify barriers in the maritime supply chain. They classified five barriers relating to the integration of the supply chain in maritime logistics: lack of trust and commitment, resistance to change, incompatibility of strategic and operating goals, lack of resources, and measurement failure. Another systematic review conducted by Fruth and Teuteberg (2017) showed the advantages of digitalization that are relevant to efficiency, safety, and energy saving while demonstrating data abuse and cybercrime as risk factors. Analyzing the container shipping lines (ports, routes, and shipping lines), Lam (2011) proposed a tool for analyzing the container shipping lines (ports, routes, and shipping lines). Lam (2011) proposed a tool for analyzing maritime supply chain patterns.

This study identified a significant gap from the local citation analysis—a minimal empirical study that carried forward the proposed frameworks and efficiency in maritime supply chain or logistics studies.

Table 3 Top local cited documents

No.	Title	Author(s)	Source	PY	LC	GC	LC/GC
1	Maritime logistics as an emerging discipline	Panayides & Song	Maritime Policy & Management	2013	17	44	38.64
2	Knowledge management for maritime logistics value: discussing conceptual issues	Lee & Song	Maritime Policy & Management	2010	12	41	29.27
3	Defining maritime logistics hub and its implication for container port	Nam & Song	Maritime Policy & Management	2011	9	39	23.08
4	Barriers to supply chain integration in the maritime logistics industry	Yuen & Thai	Maritime Economics & Logistics	2017	9	35	25.71
5	Digitization in maritime logistics—What is there and what is missing?	Fruth & Teuteberg	Cogent Business & Management	2017	7	71	9.86
6	Patterns of maritime supply chains: slot capacity analysis	Lam	Journal of Transport Geography	2011	6	55	10.91
7	Impact of the container security initiative on Taiwan's shipping industry	Yang	Maritime Policy & Management	2010	5	31	16.13
8	Risk assessment in multimodal supply chains	Vilko & Hallikas	International Journal of Production Economics	2012	5	105	7.76
9	Measures of supply chain collaboration in container logistics	Seo *et al.*	Maritime Economics & Logistics	2014	5	19	26.32
10	Understanding the development of port and regional relationships: a new cooperation/competition matrix	Mclaughlin & Fearon	Maritime Policy & Management	2013	4	45	8.89

3.3 Science Mapping

Bibliographic Coupling

The bibliographic coupling of maritime supply chain research unveiled a nomological map of 6 major themes (clusters), compressing 243 articles or 63.61% of the entire corpus. This map is visualized in **Figure 3**, and a summary of key themes (local citation is used as an impact measure) is presented in **Table 4**.

Theme 1 focuses on logistics and shipping and is the largest and most influential theme, including 73 articles, with an average publication year of 2018.41. Panayides and Song (2013), the most cited article in this group with 44 citations, advocated the understanding and implementing maritime logistics as an emerging discipline. In contrast, Yuen and Thai (2017) and Song (2010) are the second and third most cited articles, enlightening the barriers to integrating the supply chain in maritime logistics and the relationship between social networks, knowledge acquisition, and maritime logistics values, respectively. Lack of commitment and trust due to opportunistic behaviour and scepticism, resistance to change because of individualism and complacency, incompatibility of strategic and operating goals because of inadequate leadership of supply chain and poor partner selection, lack of resources, and measurement failure are the barriers in relating to supply chain integration in maritime logistics (Yuen & Thai, 2017). Lin *et al.* (2021) evidenced structural holes in the maritime logistics network, which mainly affect the relationships with ports. These findings illustrate that this theme mainly focuses on creating maritime supply chain value by unveiling barriers and suggesting mechanisms and models to improve the relationships between logistics and shipping.

Theme 2 emphasizes the maritime supply chain and maritime logistics and is the second-largest group, comprising 56 articles with an average publication year of 2018.25. Fruth and Teuteberg (2017) is the most cited article in this cluster, with 71 citations, shedding light on the effect of digitalization in the maritime supply chain. This study emphasized the conversion of maritime logistics from analogue systems to digital formats to gain advantages regarding safety, energy savings, and efficiency. Therefore, digitization could contribute to reducing carbon emissions from maritime supply chains. Henceforth, Cariou *et al.* (2019) revealed that CO_2 emissions have been reduced in the recent decade in international shipping due to a decrease in speed and alteration in technology, as well as changes in network design that have led to less distance traveled. Kong *et al.* (2023) showed the potential of shore power to reduce CO_2 emissions. Efimova and Saini (2023) unveiled the effect of automated monitoring systems in the reduction of CO2 that ensures a greener maritime logistics system. Moreover, Qiao (2023) proposed a decision support system to optimize speed that considers the effect of weather conditions and fuel consumption that enables the reduction of greenhouse gas emissions. Similarly, Mohiuddin *et al.* (2024) studied the correlation between a fishing vessel's speed, fuel consumption, and emissions, which is consistent with findings from previous research on other types of commercial vessels. Zis *et al.* (2023) considered a new waterborne transport system for Europe that is flexible, green, robust, more autonomous and automated, and can link with rural and urban terminals. Thus, this theme prominently emphasizes converting analogue systems to automated maritime logistics systems that can reduce greenhouse carbon emissions. Theme 3 concentrates on risk management in the maritime supply chain and is the third most influential group, including 45 articles with an average publication year 2019.23. The most cited article in this group with 74 citations, Carlan *et al.* (2016) review the effects of collaborative innovation in the maritime supply chain on the cost and benefits of the port community system, whereas Vilko and Hallikas (2012), and Min (2022) are the second and third cited articles, shedding light on the identification of risks in the multimodal maritime supply chain and design of

intelligent port architecture and its monitoring on the development project. Across different risk scenarios, resilience strategy selection varies, whereas port congestion, labour shortage, and abnormal freight rate fluctuation are the three typical scenarios (Gu *et al.*, 2023). Nsikan *et al.* (2023) suggested six strategies that are deemed effective in handling supply chain risks associated with seaports: creating a mechanism for risk feedback, regularly assessing risks, documenting risks, maintaining records of disruption incidents, updating cargo status regularly, and improving stakeholder relations. Thus, long-term shipping contracts, human resource backup, and accelerated container turnover are proportionate strategies for effectively enhancing resilience (Gu *et al.*, 2023).

Theme 4 facilitates digitalization in ports, such as Artificial Intelligence (AI), Big Data Analytics, the Internet of Things (IoT), and Blockchain. It is the fourth most significant and most recent group, comprising 24 articles with an average publication year of 2021.25. According to Del Giudice *et al.* (2021), who have received a substantial 143 citations, their research delves into the possibility of leveraging digitalization and new technologies to establish sustainable business models in line with the United Nations (UN) 2030 Agenda for Sustainable Development Goals (SDGs). Their study provides theoretical and practical insights, highlighting the key topics discussed in the existing literature on digitalization and new technologies in the shipping and seaport sector. Liu *et al.* (2023), cited with 60 citations, reviewed the current status of modern technologies in maritime supply chains and identified the problems and challenges. The second and third influential articles in this cluster, Yang and Lin (2023), suggested three vertical edifices of the shipping supply chain and incorporations of digitalization in maritime logistics to enhance organizational performance. Nevertheless, digitalization, data analytics, and Blockchain have been integrated into supply chain management, including the maritime supply chain, which minimizes the cost as well as creates maritime logistics value (Batwa & Norrman, 2020; Darbanian *et al.*, 2024; Kang *et al.*, 2024; Sivula *et al.*, 2020; Zhao *et al.*, 2024).

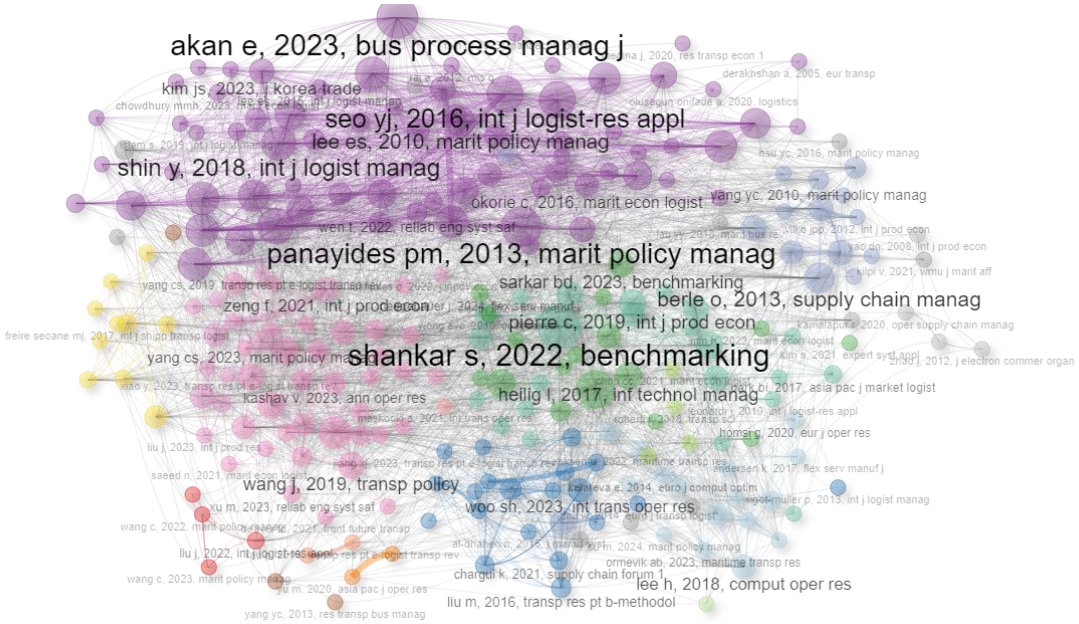

Figure 3 Bibliographic coupling

Theme 5 presents the disruptions to maritime supply chains concerning COVID-19, the Blockade of the Suez Canal, the Red Sea crisis, and other issues. In this cluster, Notteboom *et al.* (2021) compared the supply and demand shocks of COVID-19 on container ports and the shipping industry to those observed during the 2008-2009 financial crisis regarding their temporal and spatial sequences. Findings indicate that supply chain disruption orientation was significant for adopting digital technology during the pandemic; moreover, digital technology facilitated improved supply chain resilience and market performance. Besides, Fan *et al.* (2022) analyzed the Suez Canal blockage case study to provide insights for accident investigation and prevention. Utilizing a new data-driven risk model enables the systematic analysis of the risk factors of maritime accidents in restricted waters. Notteboom *et al.* (2024) delved into the various factors contributing to the crisis, including geopolitical tensions, piracy threats, and environmental concerns. Due to the ongoing attacks by Houthi rebels in Yemen, shipping lines have been compelled to redirect their vessels away from the Red Sea and Suez Canal. As a result, numerous ships kilometres opting out for the longer route around the Cape of Good Hope in South Africa, adding thousands of kilometers and resulting in significant delays to voyages between Asia and Europe. They analysed the impacts of these challenges on shipping routes, port operations, and trade flows in the Red Sea and adjacent waterways.

Theme 6 is the trending and concerning issue among global players, and it focuses on slow steaming, capacity sharing, and CO_2 emissions. In this cluster, Tran and Lam (2022) investigated the effects of ship speed from a supply chain perspective on the environment, linear operators, and customers, while Fernando *et al.* (2019) examined the effects

of maritime green supply chain management on sustainable business performance. Mansouri *et al*. (2015) discussed environmental sustainability in maritime shipping. They stated that maritime sustainability significantly influenced the design of organizational business models, which are theoretically discussed and proven but less practically implemented in the maritime sector. Consequently, maritime sustainability scholars emphasize implementing sustainable business models to achieve sustainable goals in the maritime sector. Undeniably, this theme allows future researchers to investigate the procedure for implementing sustainable business models in the practical domain.

Table 4 Summary of major themes on maritime supply chain

Author(s)	Article	Journal	Citations
Theme 1. Logistics and shipping (Cluster color: ash; Publications: 73; Average publication year: 2018.41)			
(Panayides & Song, 2013)	Maritime logistics as an emerging discipline	Maritime Policy & Management	44
(Yuen & Thai, 2017)	Barriers to supply chain integration in the maritime logistics industry	Maritime Economics & Logistics	35
(Lee & Song, 2010)	Knowledge management for maritime logistics value: discussing conceptual issues	Maritime Policy & Management	41
Theme 2. Maritime supply chain and maritime logistics (Publications: 56; Average publication year: 2018.25)			
(Fruth & Teuteberg, 2017)	Digitization in maritime logistics—What is there and what is missing?	Cogent Business & Management	71
(Cariou *et al*., 2019)	Towards low carbon global supply chains: A multi-trade analysis of CO2 emission reductions in container shipping	International Journal of Production Economics	71
(Kong *et al*., 2023)	Exploring the carbon abatement measures in the maritime supply chain: a scenario-based system dynamics approach	International Journal of Production Research	8
Theme 3. Risk management in the maritime supply chain (Publications: 45; Average publication year: 2019.53)			
(Carlan *et al*., 2016)	How port community systems can contribute to port competitiveness: Developing a cost-benefit framework	Research in Transportation Business & Management	74
(Vilko & Hallikas, 2012)	Risk assessment in multimodal supply chains	International Journal of Production Economics	105
(Min, 2022)	Developing a smart port architecture and essential elements in the era of Industry 4.0	Maritime Economics & Logistics	19
Theme 4. Digitalization and intelligent technology in port and shipping supply chain (Publications: 24; Average publication year: 2021.25)			
Del Giudice *et al*., (2021)	Digitalization and new technologies for sustainable business models at the ship–port interface: a bibliometric analysis	Maritime Policy & Management	143
(Liu *et al*., 2023)	Blockchain technology in maritime supply chains: applications, architecture and challenges	International Journal of Production Research	60
(Yang & Lin, 2023)	The impact of digitalization and digital logistics platform adoption on organizational performance in maritime logistics of Taiwan	Maritime Policy & Management	2
Theme 5. Disruptions to maritime supply chains (Publications: 5; Average publication year: 2022)			
Notteboom *et al*., (2021)	Disruptions and resilience in global container shipping and ports: the COVID-19 pandemic versus the 2008–2009 financial crisis	Maritime Economics & Logistics	202
(Fan *et al*., 2022)	Shipping accident analysis in restricted waters: Lesson from the Suez Canal blockage in 2021	Ocean Engineering	32
(Notteboom *et al*., 2024)	The Red Sea Crisis: ramifications for vessel operations, shipping networks, and maritime supply chains	Maritime Economics & Logistics	2
Theme 6. Slow steaming, capacity sharing, and CO2 emissions (Publications: 4; Average publication year: 2017.75)			
(Tran & Lam, 2022)	Effects of container ship speed on CO2 emission, cargo lead time, and supply chain costs	Research in Transportation Business & Management	20
(Fernando *et al*., 2019)	Maritime green supply chain management: it's light and shadow on the bottom line dimensions of sustainable business performance	International Journal of Shipping and Transport Logistics	42

Table 4 Summary of major themes on maritime supply chain (Con't)

Author(s)	Article	Journal	Citations
Theme 6. Slow steaming, capacity sharing, and CO2 emissions (Publications: 4; Average publication year: 2017.75)			
(Mansouri *et al.*, 2015)	Multi-objective decision support to enhance environmental sustainability in maritime shipping: A review and future directions	Transportation Research Part E: Logistics and Transportation Review	145

Co-Authorship Mapping

Figure 4 presents the network mapping of co-authorship in producing maritime supply chain-related research articles. According to the mapping, Vanelslander led the central cluster of co-authorship that collaborated with 6 more authors. However, this cluster of authors continuously focused on port innovation, designing maritime supply chains based on customer requirements to enhance maritime supply chain resilience (Lam, 2015; Lam & Bai, 2016; Lam & Zhang, 2014; Vanelslander *et al.*, 2019). Another cluster of co-authorship was formed by Parola, who collaborated with five more authors. These authors emphasized the maritime logistics corporate strategy effect on financial performance, adoption of digitalization in logistics to create business opportunities, demand, and integration of maritime in the global supply chain (Panayides, 2006; Panayides & Song, 2013; Parola *et al.*, 2015, 2021). Another noteworthy network developed by Liu with another five authors in their cluster mainly focused on the area including blockchain technology in maritime supply chain and port operation effectiveness, constructing maritime supply model concerning environmental benefits, and financial advantage of the maritime supply chain (Liu *et al.*, 2022, 2023; J. Wang *et al.*, 2020). These clusters of co-authorship discovered several themes in the maritime supply chain scholarly articles such as maritime supply chain, port operations and configuring ways to improve effectiveness, technology adoption in smooth and effective operations, and environmental and financial benefits of the maritime supply chain.

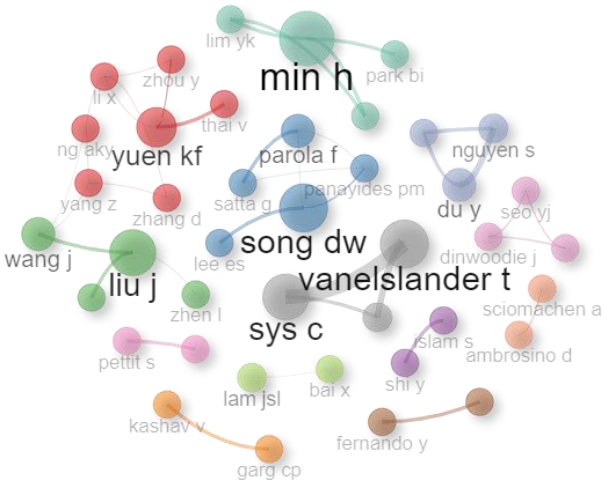

Figure 4 Co-authorship network
Source: Biblioshiny

Collaboration of Affiliated Countries

The network collaboration represents the corresponding authors' affiliated nations (**Figure 5**). China is leading the scholarly exploration and investigation of the maritime supply chain. Even authors demonstrated the strategies linked to maritime driving international trade in China (Summers, 2016; Y. *et al.*, 2020). However, China has formed the most extensive network with other countries, among others, the United Kingdom, the USA, Australia, Germany, India, and Singapore, to explore and investigate the opportunities, issues, and development of a framework to improve current operations of the port as well as integration of maritime in the global supply chain. Another cluster only represents the collaboration among EU countries such as Belgium, Greece, Cyprus, Ireland, Spain, Sweden, Italy, and the Netherlands. Meanwhile, Norway, France, Canada, Brazil, and Asian economies such as Iran, Bangladesh, Malaysia, and UAE formed another significant cluster representing the blended collaboration cluster. It is observed that China is leading the maritime relevant scientific investigation worldwide.

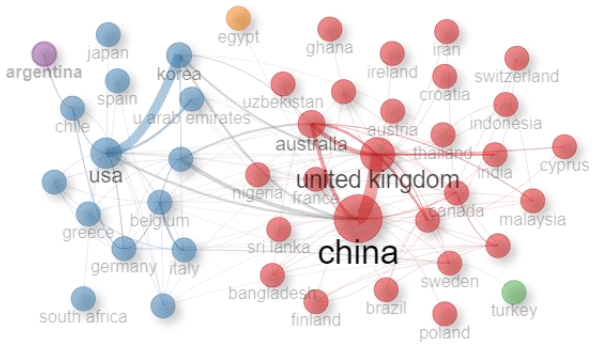

Figure 5 Collaboration network of affiliated countries
Source: Biblioshiny

Co-occurrence Mapping

Figure 6 presents the co-occurrence mapping of keywords in the maritime supply chain/logistics domain. In the figure, nodes (rectangles) present each keyword, and the size of the nodes represents the frequency of appearances in the articles; edges (links) connect the keywords that imply the concurrent appearances of keywords simultaneously in the document. The largest node represents *maritime logistics*, indicating the 'hotspots' in maritime supply chain/logistics articles (van Eck & Waltman, 2010). Maritime logistics is associated with integer programming, container terminals, port operations, berth allocation problems, decision-making, and numerical models as clusters. Future researchers can acknowledge these keywords as current trends in maritime logistics research and signposts for further studies since this cluster has not adopted many keywords. Similarly, 'port operation' with the transportation system, supply chain integration, freight transport, and container shipping integrated as a cluster whereby researchers predominantly emphasized in the USA and Asia. Hence, supply chain management signified as the 'hotspot' with blockchain, digitalization, freight transportation, maritime trade, international trade, drop-

shipping, innovation, competition, ports and harbours, transportation policy, and vulnerability in the largest cluster of keywords co-occurrences. This cluster designates the inclusion of digitization and blockchain technology in supply chain management to gain an advantage from competitive maritime and international trade in the scholarly investigation applying game theory, particularly in the context of China. Another vertex clustering (green) represents transportation with supply chain collaboration, economic and social effects, fuel consumption, shipping logistics, waterway transportation, carbon emission, and sailing vessels as clusters. Henceforth, the significant vertex clustering exhibits the association of maritime transportation with green maritime logistics, transportation planning, digitalization, vessels, and sustainable development. The researchers in this cluster dominantly developed conceptual frameworks by reviewing the literature, uncertainty analysis, and optimization. These keywords appearances highlight the current themes and trends in the maritime supply chain and maritime logistics studies that create opportunities for further studies.

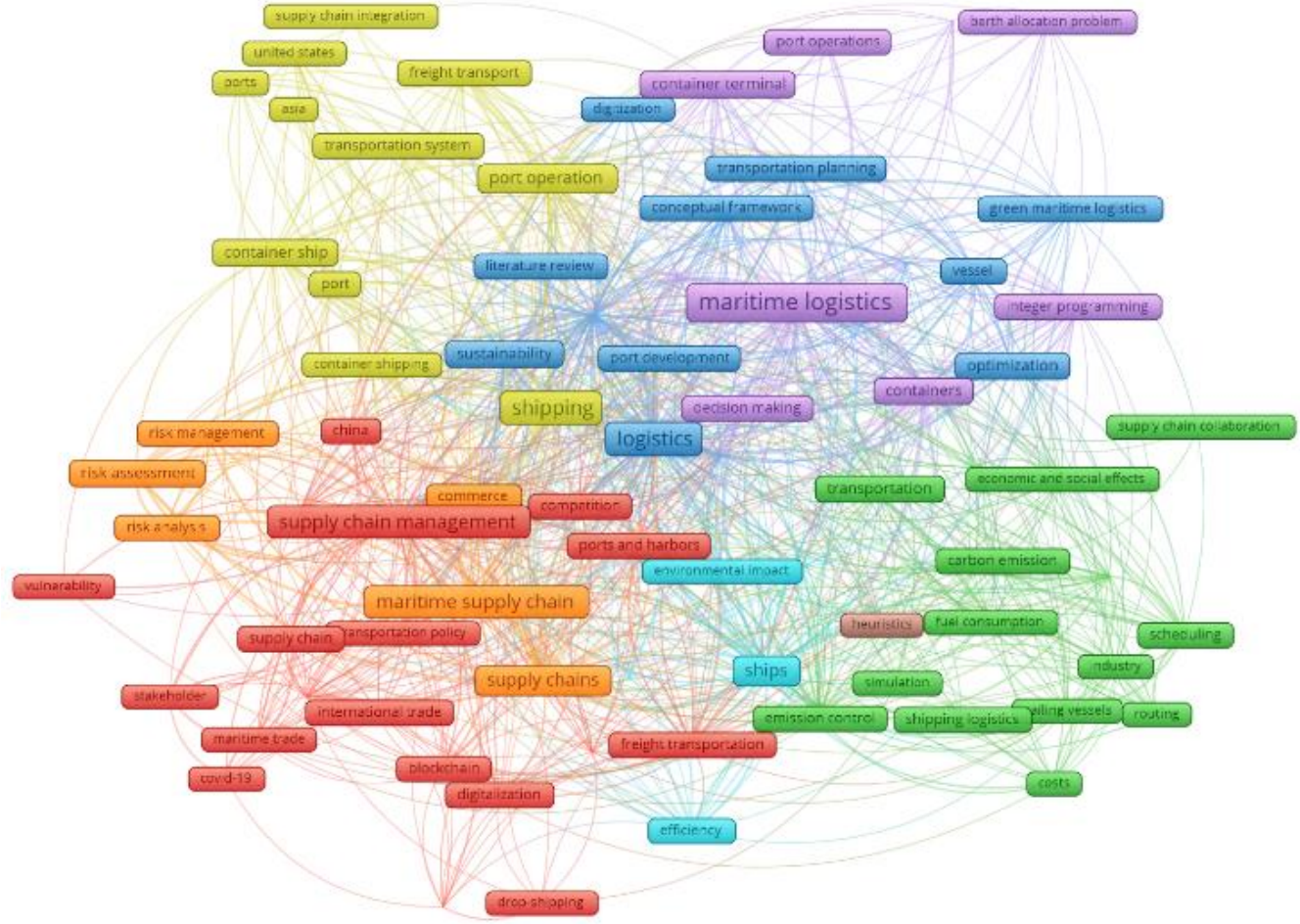

Figure 6 Co-occurrence mapping of keywords
Source: VOSViewer

4. DISCUSSION AND FUTURE STUDIES

Bibliometric findings demonstrated several crucial findings in the maritime research articles. Performance analysis is emerging and receiving significant attention from academic researchers. The findings have unveiled several scopes for further studies that can fill the gaps and broadly aid the maritime horizon, especially the supply chain sector. Maritime is a complex concept comprising several attributes, multiple players and layers, networks, and systems mutually interconnected. Therefore, any disruptions or innovations to any player or attribute would impact others tremendously, and overall performance would be impacted eventually (Nguyen *et al.*, 2023). Earlier studies predominantly emphasized the measures and framework designed according to mathematical models, blockchain or digitally, and other technical support systems to configure and assess issues, risks, challenges, and their effects on maritime players and port authorities of organization level, transport system, and geographical location (Fratila *et al.*, 2021; Kashav *et al.*, 2023; Lam, 2015; Lam & Zhang, 2014; Narasimha *et al.*, 2021). However, a minimal study empirically investigates how these frameworks or measures would aid in improving the resilience performance of maritime as well as their organizations. Henceforth, several studies focused on port operations, its smooth operations, and maritime logistics and its vulnerability have been a

hotspot in the earlier studies (El Mekkaoui *et al.*, 2023; Gülmez *et al.*, 2023; Min *et al.*, 2017; Wen *et al.*, 2022).

Nevertheless, the maritime supply chain is still at its emerging level, while the maritime sector contributes to a significant portion of global trade. Thus, a lack of attention is noticed in the research, particularly on the maritime supply chain. Although some studies have been taken to assess the integration of maritime supply chain, blockchain integration in the supply chain, its effect, and enhancing effectiveness (Jiang *et al.*, 2023; Liu *et al.*, 2023; Panayides, 2006; Tran & Lam, 2022), but not to an extended amount, which leaves ample scope for future researchers. Future studies may investigate the effect, the measure of the maritime supply chain and its effect on national and international economic activities. Besides, how stakeholders perceive the maritime supply chain and their benefits in the global context can be included in future studies. Nonetheless, COVID-19 affected almost 90% of the maritime international trade (Narasimha *et al.*, 2021)Hence, the maritime supply chain requires resilient and sustainable measures and an empirically verified framework to recover from and prepare for future uncertainty. As a result, future studies can be carried out to empirically measure and verify sustainable and resilient maritime supply chain practices in relation to pandemics or other uncertain events. Another potential measure of how the maritime supply chain became an integral part of the blue economy globally, especially in regions with seaports, could be included in further studies.

Several prior studies also emphasized environmental performance, especially climate change, as well as final performance linked to maritime (Mansouri *et al.*, 2015; C. *et al.*, 2023). Maritime green supply chain management practices indirectly accelerate maritime supply chain businesses' sustainable environmental, economic, social, and operational performance (Fernando *et al.*, 2019). Besides, Jasmi *et al.* (2020) found a positive relationship between maritime green supply chain and maritime supply chain financial efficiency. Hence, green imitative and securities and regulation are significant dimensions of the maritime green supply chain (Jasmi & Fernando, 2018). However, social performance, especially stakeholders, needs to be discussed in further studies since they are indirectly affected by its innovation and expansion. Henceforth, Chou *et al.* (2022) demonstrated five key indicators, namely, lessening of waste expulsion and pollution treatment; construction of eco-friendly fleets, fleet replacement, and desulfurization retrofit to comply with the regulations of international maritime organization and improve energy efficiency; regular assessment, audit, and review of environmental laws and regulations compliance; priority access to ports and enhanced profitability by engaging in the green ship incentive event; and dedicated departments and management units responsible for policies linked to green capabilities for critical success of maritime green supply chain. However, further studies can be undertaken to empirically investigate these factors in maritime supply chain operations using these green factors. Only a few studies have emphasized maritime green supply chain management practices in the seaport; therefore, future researchers should focus more on its advantages, disadvantages, challenges and issues, sustainable performance, and green logistics in further studies. Henceforth, maritime pollution and carbon emission in maritime logistics and port operations can be integrated into maritime supply chain and logistic studies.

Meanwhile, prior studies considerably applied mathematical or technology-based measurements and qualitative approaches in developing a framework, while quantitative or statistical measures were scarce. Future studies can measure the framework and model by employing a quantitative approach with statistical analyses. Besides, prior studies mainly focused on China and some emerging countries. In contrast, several other economies that largely rely on port economies, such as Sri Lanka, Hong Kong, and some African countries, could be included in future studies.

5. CONCLUSION

This study aimed to explore the research publication trends, themes, and scopes for further studies in relation to the maritime supply chain domain. A bibliometric analysis was adopted to analyze and review influential research articles. The findings demonstrated an emerging publication trend in the maritime supply chain, although they mostly emphasized maritime logistics. The science mapping analyses demonstrated several existing themes, such as maritime supply chain management, integration of blockchain in maritime logistics, the efficiency of port transportation and operations, maritime supply chain risk management, green maritime logistics, green maritime supply chain, and methodologically proposing framework by reviewing the literature. Although these themes are pretty significant and cover a substantial part of the maritime supply chain. Thus, several other areas, such as the green maritime supply chain, maritime pollution, and carbon emission, need to be integrated, and the existing conceptual exploration should be extended into empirical investigation in future studies.

Implications

This study aids the dominant body of literature on maritime supply chain and maritime logistics by providing compound information related to the maritime supply chain and logistics publications, trending themes, and countries that focus on it. Further, it recognized the keywords (maritime supply chain, maritime logistics, shipping supply chain, freight logistics, port operations) that create the main area of the maritime domain. These contribute to the maritime literature as well as provide new ideas and potential guidance for future researchers. Undoubtedly, this study also contributes to the port authority and stakeholders by offering information linked to the maritime supply chain and logistics, maritime green supply chain, and the potential innovations and expansions to enable them to effectively make decisions in view of the designing framework. Finally, policymakers or authorities can use these findings and information to emphasize this sector more by providing funds for better and more effective maritime supply chain design in order to attain a competitive advantage from the blue economy, especially the shipping industry.

Limitations

This study is not dissimilar to other studies that do not posit any limitations. Although this study was conducted comprehensively, it was not entirely as it only drew research articles from two popular databases. Further study can

include other databases like DOAJ, Google Scholar, and other databases for comparative analysis. Apart from this, this study only included articles published in journal and conference proceedings, excluding books and book chapters.

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