PORT CHOICE AND SUSTAINABLE DECISION MAKING IN CONTAINER LINER SHIPPING: A BIBLIOMETRIC REVIEW AND CONTENT ANALYSIS

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Keywords

Container Liner Shipping; Port Choice; Network Design; Sustainable Decision Making; Environmental Considerations

Abstract

Trade globalization, the increase in container ship size, and the competitive nature of the maritime industry have rendered port selection a complex decision – making process that involves many criteria. Port selection by container shipping lines is a strategic decision integral to their route and network planning, significantly influencing the operational and business performance of the organization. Contemporary scholarly literature, although addressing diverse facets of port selection by container shipping lines, lacks in offering a detailed and comprehensive analysis that encompasses a range of research methodologies, maritime and hinterland port elements, carbon reduction strategies, and available sustainability alternatives in container shipping networks. This paper presents a retrospective review of port choice from the perspective of container shipping lines by the combination of bibliometric and content analysis approaches. The bibliometric approach utilized by the bibliometrix package in the R software revealed the most relevant articles related to port choice. The bibliographic coupling approach in VOSviewer revealed five research clusters: (1) Port performance evaluation; (2) Environmental considerations in liner networks; (3) Port choice dynamics; (4) Port competitiveness; and (5) Strategic decision – making in global shipping networks. Content analysis of the most impactful articles in each research cluster provides findings forming a solid foundation of insights for the sustainable development of port choice from the perspective of container shipping lines.

1 INTRODUCTION

Container liner shipping represents a vital mode of transportation in global trade. The industry is network – based, so network decisions contribute much to the success of liner shipping companies. Routes in container transportation are organized as sequences of port calls, which together form the container transport network Tsantis et al. (2023). A maritime connection is an integral part of the container transport network. It arises from the dynamics of the trade route on which it manifests and can be influenced by the characteristics of a country's connectivity. However, it is realized only if the criteria for port selection are met.

Approximately 70% of the value of international trade is transported by maritime routes, with two – thirds of that amount shipped in containers, primarily because most high – value commercial goods are containerized Notteboom, Pallis and Rodrigue (2022). This substantial market reliance on maritime transport influences ocean carrier container port selection, which is increasingly moderated by cutting – edge industry trends such as economies of scale in shipping, port governance changes, co – opetition among ports in proximity, inter – firm networks, and green and sustainability challenges Parola et al. (2017). Additionally, the complexity of shipping networks is also expanding due to ocean carrier horizontal integration, characterized by increased operator size and interactions among diverse shipping elements; and vertical integration that connects maritime operations with hinterland networks, integrating these ocean carrier activities deeper into the global supply chain Tran and Haasis (2015). This leads to the formation of the following question: What makes decision – making in container liner shipping sustainable regarding ocean carrier port selection? The aforementioned question is crucial for understanding ocean carrier container port choice regarding the effective integration of container shipping lines into supply chains and the sustainable development of regional economies.

Contemporary academic literature on port choice often exhibits a singular focus, leading to a fragmented understanding of the overall results. Port choice research predominantly falls into three principal categories: (1) Research of factors influencing the decisions of port choice where Analytic Hierarchy Process (AHP) and Multinomial Logit Model (MNL) are main utilized models Elabbasy, Abdelkader and Elsayeh (2018); Veldman, Bückmann and Saitua (2005); (2) Identification and selection of hub ports by employing diverse cost – modeling techniques for analysis Cazzaniga Francesetti and Foschi (2003); and (3) Analysis of route design by considering various problems such as port calls, port sequences, service patterns, and fleet deployment, utilizing linear and non-linear programming models for optimization Kramberger et al. (2015). Moreover, recent academic research on port choice often adopts a generalized approach to port selection, noticeably lacking in – depth consideration of specific port types, particularly container ports Kramberger et al. (2015). Furthermore, while numerous studies offer extensive literature reviews on port choice, this research paper identifies several key shortcomings as follows. Tran and Haasis (2015) research on container liner shipping as a network – based system wherein they address port selection only as a (crucial) subcomponent within the broader context of network optimization decision – making processes. Tsantis et al. (2023) focus their research efforts on systematic identification and comprehensive analysis of factors promoting or inhibiting the establishment of direct country – to – country links in container shipping; highlighting container port selection criteria as a notable subtheme in influencing these direct link establishments. Martinez Moya and Feo Valero (2017) center their systematic literature review on port choice; however, from the perspective of port authorities as focal agents in enhancing port competitiveness.

The brief and detailed review of contemporary studies on port choice reveals three critical gaps: (1) Predominant singular focus in research methodology; (2) Generalized approach in port selection analysis; and (3) Comprehensive literature reviews address marginally port choice or from the perspective of other maritime supply chain stakeholders. This leads to the formulation of the problem statement indicating that the aspect of container port selection by ocean carriers is neither adequately addressed as a focal research point nor methodologically sufficiently integrated into contemporary scholarly maritime literature. Thus, the central motivation for this study is to thoroughly analyze and map the existing research on port choice with a specific focus on the perspective of ocean carriers in container shipping networks. In contrast to the mentioned studies, this research employs a bibliometric analysis approach to literature selection and explores a broad range of relevant contemporary maritime industry elements and trends concerning port choice and sustainable decision making in container liner shipping. Consequently, this study establishes the following research objectives: (1) Employ citation metrics to identify the key articles regarding port choice and sustainable decision making in

container liner shipping; (2) Categorize the existing literature on port choice and sustainable decision making in container liner shipping into distinct research clusters and to examine these clusters through detailed content analysis; and (3) Identify and propose pathways for future research based on the limitations of the current study and emerging trends in the field. This study establishes a robust foundation for understanding the complexities and multidimensional aspects of sustainable port selection from the perspective of ocean carriers in container liner shipping; with findings bearing significant implications for both industry stakeholders and scholars.

The subsequent sections of this paper are structured as follows: Section 2 presents the bibliometric analysis research methodology and seminal articles; Section 3 outlines content analysis of the five identified research clusters. Section 4 provides the discussion and suggests future research pathways; and Section 5 is the critical conclusion of the entire study.

2 BIBLIOMETRIC ANALYSIS RESEARCH METHOD

Bibliometric analysis represents a methodological approach extensively utilized in the domain of library and information science. The main attribute of the methodology is the systematic employment of statistical tools to quantitatively and qualitatively examine the corpus of scholarly literature Liang and Liu (2018). This analytical approach facilitates the identification of relevant authors, articles, journals and universities on basis of network analysis of citation data. Furthermore, it supports the identification of research clusters, offers insights into prevailing scholarly interests, and aids in the detection of evolving trends within a specific academic field Munim et al. (2020). Aria and Cuccurullo (2017) highlight the distinct advantages of bibliometrics analysis noting that its quantitative aspect is instrumental in science mapping, encompassing the organization and interpretation of extensive scientific literature to create knowledge structures and reveal their dynamics. Concurrently, the qualitative aspect of bibliometric analysis, as underscored by Aria and Cuccurullo (2017), proves effective in the application of guided content analysis. This methodological approach is paramount for deriving contextual significance from diverse forms of unstructured human communication media in terms of: (1) Texts; (2) Images; and (3) Symbols. Such an approach is essential in ensuring that the deductions reached are both: (1) Replicable; and (2) Valid; thus, enhancing both the depth and reliability of the knowledge structure. Consequently, bibliometrics is crucial for conducting scientific literature revies that are: (1) Replicable; (2) Transparent; and (3) Systematic; as it offers more reliable and objective scientific analyses Ellegaard and Wallin (2015).

2.1 Bibliographic Data Collection Procedure

The fundamental aspect of bibliometric analysis constitutes the accumulation of bibliographic datasets from various scientific databases. The bibliometric dataset for this study, spanning the past 20 years, was compiled on 19 February 2024 using the ISI Web of Science, a highly esteemed scientific database in the academic community. Table 1 presents a detailed 11 – step keyword search process, employing Boolean search terms for precision.

Step	Keyword Search	No of Articles
1	"Port Choice"	135
2	"Port Choice" OR "Port Attractiveness"	149
3	"Port Choice" OR "Port Attractiveness" OR "Port Selection Criteria"	156
4	"Port Choice" OR "Port Attractiveness" OR "Port Selection Criteria" OR "Port Selection*"	322
5	("Port Choice" OR "Port Attractiveness" OR "Port Selection Criteria" OR "Port Selection*") AND ("Line*")	87
6	("Port Choice" OR "Port Attractiveness" OR "Port Selection Criteria" OR "Port Selection*") AND ("Line*" OR "Shipping Line*")	87
7	("Port Choice" OR "Port Attractiveness" OR "Port Selection Criteria" OR "Port Selection*") AND ("Line*" OR "Shipping Line*" OR "Container*")	165
8	Refinement by WoS Categories	136
9	Refinement by Language: English	135

10	Refinement by Document Type: Article	120
11	Refinement by Manual Screening of Articles for Relevance	62

Table 1 ISI Web of Science 11 – step keyword search procedure

The initial section of Table 1, containing steps one to seven, specifically focuses on scientific literature pertaining to port choice, port attractiveness, port selection, and the perspective of container shipping lines and ocean carriers. Section two involves the refinement of the scientific literature to the following WoS categories: (1) Transportation; (2) Operations Research Management; and (3) Green Sustainable Science Technology. The third section excludes literature not written in English. Section four further strengthens the filtration process by narrowing the focus to scientific articles, thereby aiming to elevate the level of scientific rigor. Section five represents the concluding section, involving a manual screening process to exclude articles: (1) Marginally addressing port choice, and (2) Addressing port choice from the perspective of other stakeholders within the maritime supply chain, such as freight forwarders and shippers. The refinement procedure yielded a bibliometric sample of 62 scientific articles for the study.

2.2 Determining the Most Influential Scientific Articles

Determining the number of citations is a crucial factor in assessing the overall impact of a specific study, that is, an article. Utilizing the Total Citations (TC) indicator within the bibliometrix package in the R software facilitates the determination of the most influential scientific articles. Total Citations (TC) denotes the number of citations each article has received from all articles in the ISI Web of Science database up to the date of extraction. TC per year represents the average number of citations an article receives annually since its publication. Table 2 contains the top 10 most influential scientific articles regarding port choice and sustainable decision making in container liner shipping on basis of the TC bibliometric indicator.

Ordinal Number	**Article**	**DOI**	**TC**	**TC per Year**
1	Yeo, Roe and Dinwoodie (2008)	10.1016/j.tra.2008.01.014	160	9.41
2	Chang, Lee and Tongzon (2008)	10.1016/j.marpol.2008.01.003	159	9.35
3	Tongzon and Sawant (2007)	10.1080/00036840500438871	107	5.94
4	Parola et al. (2017)	10.1080/01441647.2016.1231232	106	13.25
5	Notteboom et al. (2017)	10.1016/j.jtrangeo.2017.09.002	80	10
6	Talley and Ng (2013)	10.1016/j.ijpe.2012.11.013	73	6.08
7	Tran and Haasis (2015)	10.1007/s10696-013-9179-2	66	6.60
8	Yeo et al. (2014)	10.1080/03088839.2013.839515	64	5.82
9	Tang, Low and Lam (2011)	10.1007/s11067-008-9081-8	62	4.43
10	Martinez Moya and Feo Valero (2017)	10.1080/01441647.2016.1231233	55	6.88

Table 2 Top 10 most influential scientific articles

These articles are strongly recommended for the academic community focusing on port choice and sustainable decision making in container liner shipping within the maritime industry.

3 RESEARCH CLUSTERS IDENTIFICATION AND CONTENT ANALYSIS

The extracted bibliometric sample of 62 articles is subject to analysis using the VOSviewer software via the bibliographic coupling analysis. The bibliographic coupling analysis is a bibliometrics technique that connects documents citing the same reference, thereby facilitating the creation of document clusters Boyack and Klavans

(2010). This indicates a likelihood that the linked documents address a related subject matter, that is, research cluster. Applying a threshold of at least five citations per document in VOSviewer refined the bibliometric sample from 62 to 42 articles, with only 42 articles in the sample meeting this specified citation criterion. Figure 1 represents the five emergent and interconnected research clusters on basis of document clustering: (1) Port performance evaluation (Red cluster); (2) Environmental considerations in liner networks (Green cluster); (3) Port choice dynamics (Blue cluster); (4) Port competitiveness (Yellow cluster); and (5) Strategic decision – making in global shipping networks (Purple cluster).

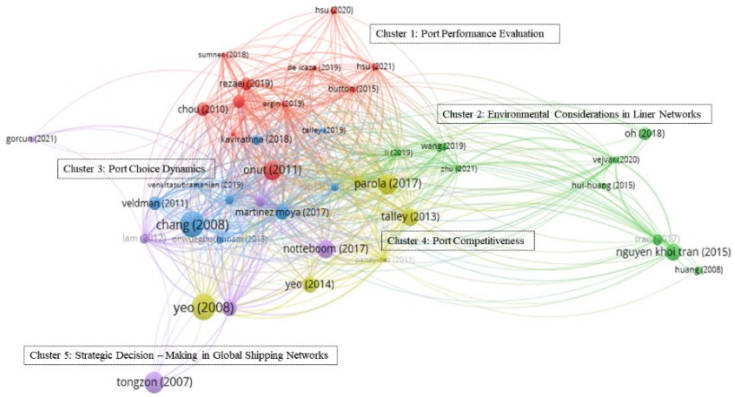

Fig. 1 The five emergent and interconnected research clusters

VOSviewer is an interactive tool specifically designed for creating and visualizing bibliometric maps van Eck and Waltman (2010). The map construction process in VOSviewer functions on two main measurement properties: (1) Total citation; and (2) Total link strength. The application of the equal weighted average on the two primary measurement properties in VOSviewer enabled the identification and selection of 25 articles seminal for port choice and sustainable decision making in container liner shipping; with five articles allocated to respective cluster as detailed in Table 3.

Cluster 1: Port Performance Evaluation	**Cluster 2: Environmental Considerations in Liner Networks**	**Cluster 3: Port Choice Dynamics**	**Cluster 4: Port Competition**	**Cluster 5: Strategic Decision – Making in Global Shipping Networks**
Ergin and Eker (2019)	Tran, Haasis and Buer (2017)	Martinez Moya and Feo Valero (2017)	Parola et al. (2017)	Lagoudis, Theotokas and Broumas (2017)
Rezaei et al. (2019)	Li, Kuang and Hu (2019)	Chang, Lee and Tongzon (2008)	Bastug et al. (2022)	Notteboom et al. (2017)
Nazemzadeh and Vanelslander (2015)	Wang y Yeo (2019)	Sanchez, Ng and Garcia-Alonso (2011)	Yeo et al. (2014)	Tang, Low and Lam (2011)
Munim, Duru and Ng (2022)	Tran and Haasis (2015)	Veldman, Garcia-Alonso and Angel Vallejo-Pinto (2011)	Talley and Ng (2013)	Lam and Dai (2012)
Chou (2010)	Vejvar, Lai and Lo (2020)	Caballe Valls et al. (2020)	Panayides and Polyviou (2011)	Tongzon and Sawant (2007)

Table 3 Identified and selected articles allocated to respective research cluster

The identified and selected 25 articles pivotal for port choice and sustainable decision making in container liner shipping were subjected to a thorough content analysis, enabling the comprehensive assessment and discussion of the five distinct research clusters.

3.1 Port Performance Evaluation

The "Port Performance Evaluation" research cluster primarily concentrates on developing multi – criteria decision making (MCDM) methodologies for assessing and improving port performance. The aforementioned methodologies encompass elements such as: (1) Environmental impacts; (2) Stakeholder perspectives; and (3) Competitive factors; across multiple and distinct port regions. The cluster is comprised of five scientific articles: (1) Ergin and Eker (2019); (2) Rezaei et al. (2019); (3) Nazemzadeh and Vanelslander (2015); (4) Munim, Duru and Ng (2022); and (5) Chou (2010).

Ergin and Eker (2019) adhere to the fact that container ships represent a primary source of emissions in maritime transport, impacting the environment both during navigation and at container ports. The proximity of container ports to city centers has significant detrimental environmental effects on local populations due to container ship induced port emissions. The authors employ the fuzzy TOPSIS method for container port selection from the perspective of ocean carriers; focusing on criteria beyond cost and efficiency to include environmental impacts. In evaluating Turkish container ports, the study highlights: (1) Port cost; (2) Port efficiency; and (3) Green port projects; as key criteria for port selection. Rezaei et al. (2019) identify that traditional research treats port performance and port choice as separate areas, limiting proactive responses to changes in stakeholder preferences. The scholars introduce a new multi – criteria decision analysis (MCDA) methodology, specifically the Best – Worst Method for measuring port performance by evaluating factors affecting container port choice. The methodological innovation manifests in inclusion of hinterlands services during the process of: (1) Identification; (2) Quantification; and (3) Weighting of criteria; along with performance calculation of alternatives. The empirical analysis results conducted on European ports highlight that: (1) Transport costs and times; account for over half of the weight in port competitiveness criteria. The remaining weight is attributed to qualitative factors such as: (1) Satisfaction; (2) Reputation and (3) Flexibility in handling and shipping options. Nazemzadeh and Vanelslander (2015) focus on understanding factors influencing port users' choices, examining: (1) Antwerp; (2) Rotterdam; and (3) Hamburg ports, and analyzing preferences of: (1) Shippers; (2) Carriers; and (3) Freight forwarders. The Analytical Hierarchy Process (AHP) method is used for determining the relative importance of port selection criteria, with data collected via questionnaire surveys. Key port selection criteria identified in the order of importance are: (1) Port costs; (2) Geographical location; (3) Quality of hinterland connections; (4) Productivity; and (5) Capacity. Different respondent groups prioritize criteria differently, with carriers valuing hinterland connections and freight forwarders focusing on ports with substantial outbound cargo. The scholars' findings suggest Public – Private Partnerships (PPPs) as strategies for improving port competitiveness and efficiency, with the Deurganck dock lock in Antwerp serving as a successful example. Munim, Duru and Ng (2022) introduce a novel method via employing the Analytic Network Process (ANP) MCDM for predicting transshipment port competitiveness in the Bangladesh container market based on market share. The scholars evaluate seven major components for container port competitiveness assessment: (1) Connectivity; (2) Port facility; (3) Efficiency; (4) Cost factor; (5) Policy and management; (6) Information systems; and (7) Green port management. The study investigates four regional hub ports connected to Bangladesh; (1) Singapore; (2) Colombo; (3) Port Klang; and (4) Tanjung Pelepas; with Singapore identified as the most competitive and Tanjung Pelepas as the least competitive. The research highlights that all assessed ports perform below expectations in green port management practices, suggesting a significant area of improvement. The study's methodology and findings can help port operators in understanding the dynamic nature of regional port competitiveness, and guide them in strategic planning and enhancing hub – and – spoke networks. Chou (2010) develops an Analytic Hierarchy Process (AHP) model for simulating carrier behaviors in making port choices in regions with multiple ports with focus on reducing total transportation costs. The model's utility is demonstrated through a case study involving five shipping companies divided into two main groups; (1) Oceangoing carriers; and (2) Coastal carriers, highlighting its applicability in real – world scenarios. Oceangoing carriers' critical concerns in order of importance are: (1) Containership berth depth; (2) Port charges; (3) Taxes; (4) Rents; (5) Costs; and (6) Loading/ discharging efficiency. Coastal carriers' critical concerns in order of importance encompass: (1) Hinterland economy; (2) Port charges; (3) Taxes; (4) Rents; (5) Costs; and (5) Loading/ discharging efficiency. The importance of enhancing port infrastructure, specifically constructing new deepwater berths, emerges as a key factor for attracting more oceangoing carriers. The growth of the hinterland economy is highlighted as vital for attracting coastal carriers who prioritize local economic strength. The authors' findings prove helpful in providing insights into a balanced approach in port management by addressing both; (1) Operational efficiencies; and (2) Broader economic factors, being crucial for long – term container port competitiveness and sustainability.

3.2 Environmental Considerations in Liner Networks

The "Environmental Considerations in Liner Networks" research cluster primarily focuses on the adoption and integration of eco – efficient practices in container liner shipping operations. The methodologies within this research cluster consist of incorporation of carbon footprint: (1) Assessment strategies; and (2) Reduction strategies; along with reaching sustainable logistics practices in terms of optimizing: (1) Maritime network; and (2) Hinterland network; efficiencies alignment with global sustainability goals. The cluster is comprised of five scientific articles: (1) Tran and Haasis (2015); (2) Li, Kuang and Hu (2019); (3) Wang and Yeo (2019); (4) Tran, Haasis and Buer (2017); and (5) Vejvar, Lai and Lo (2020).

Tran and Haasis (2015) conduct a comprehensive literature survey of network optimization in container liner shipping. The scholars indicate that contemporary research trends in container liner shipping network optimization consist of the following main elements: (1) Route and schedule design; (2) Fleet size and mix, (3) Container movement; and (4) Port selection. Port selection represents a critical component in the context of network design realization, as it influences the efficiency and effectiveness of the entire shipping operations, including; (1) Routes; (2) Schedules; and (3) Fleet management. Crucial insights encompass facts that the contemporary container industry exhibits both: (1) Vertical integration; and (2) Horizontal integration; with container shipping networks expanding in complexity and increasingly connecting with hinterland operations; reflecting a more integrated approach to maritime logistics and supply chain management. The scholars conclude the recognition that contemporary optimization models do not entirely capture the complexities of modern liner networks. This suggests that ocean carriers search for ports that are evaluated through holistic approaches, considering not just maritime factors, but the entire door – to – door supply chain. Li, Kuang and Hu (2019) indicate three pivotal gaps in eco – efficient and sustainable port selection practices: (1) Scholarly interest ignores port selection as an important part of the carbon reduction strategy; (2) The existing literature lacks the scenario of container re – routing and road price reduction; and (3) The necessity to expand the study of quantitative models and algorithms for multimodal transport networks at a strategic level. The scholars fill this gap by conducting a study where the main objective is the exploration of how changes in port selection can lead to the formation of environmentally friendly shipping routes and encourage the adoption of multimodal transport systems, with a direct focus on reducing CO_2 emissions in the container shipping industry. The study employs the entropy weight Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method to calculate a freight demand index, providing a quantitative measure of container demand in various destination cities, crucial for assessing freight needs. The research analyzes five scenarios under China's container development strategy, assessing the cost and carbon emissions associated with rerouting containers to comprehend the environmental effects of establishing new shipping routes and implementing multimodal transport systems. The results indicate that carbon taxes have a negligible effect on multimodal transport networks, suggesting that other factors, such as loading and unloading costs, play a more significant role in the total cost and environmental impact of container transport. Wang and Yeo (2019) explore factors influencing the selection of a transshipment (T/S) hub port by a feeder port in a dual hub – port system, aiding container ocean carriers in making informed port selection decisions. The case study examines the choice between: (1) Shanghai; and (2) Ningbo; as T/S hub port options for the Nanjing feeder port in the Yangtze River Delta. The combined AHP and Consistent Fuzzy Preference Relations (CFPR) method reduce the complexity of pairwise comparisons and incorporation of expert knowledge into the decision-making process. The study identifies: (1) Cost; (2) Availability of hub port space allocation; and (3) Connectivity between the feeder and hub port; as critical factors in the T/S hub port selection for container ocean carriers. Although Shanghai being selected in the case study, the research suggests that Ningbo port, due to its cost advantages and potential for improved feeder port relationships, might be favored over Shanghai in a dual hub – port system. The potential shift in preference to Ningbo port, based on improved connectivity relationships and cost advantages, indicates a strategic approach to sustainability, where eco-efficiency is balanced with operational effectiveness. Tran, Haasis and Buer (2017) propose a model for optimizing container flows between continents, focusing both on: (1) Maritime routes; and (2) Inland connections; aiming to minimize total costs in terms of: (1) Ship; (2) Port; (3) Inland; (4) Transport; (5) Inventory; and (6) CO_2 costs. Computational results from applying the model to the Europe – US trade routes reveal that inland transport costs, heavily influenced by port selection, contribute most significantly to total costs; emphasizing the importance of strategic port choice in maritime supply chain optimization. Main research contributions are the integration of both: (1) Maritime aspects; and (2) Inland aspects; of the supply chain with societal costs like CO_2 emissions in the model. Thus, the model offers a holistic view and effective optimization strategy, with the optimal solution involving multiple port calls to reduce

overall costs. Vejvar, Lai and Lo (2020) conduct a citation network analysis in order to reveal and discuss current trends and focal issues in shipping performance, emphasizing their impact on policy development and importance for the future of container liner shipping management, particularly in sustainable port selection. The study identifies issues with unclear terminology and a lack of comprehensive frameworks in sustainability research regarding port selection, noting a dominance of economic considerations. Research in port management and selection primarily focuses on economic issues with emphasis on operational performance and cost aspects. However, results indicate that a newly emerging body of literature on port selection is showing focus on: (1) Green policies; (2) Green performance indicators; and (3) Port sustainability rankings, indicating a shift towards environmentally responsible port operations by inclusion of environmental performance in port evaluations, alongside considerations of ecological and social impacts.

3.3 Port Choice Dynamics

The "Port Choice Dynamics" research cluster concentrates on the analysis of key factors determining port competitiveness by encompassing; (1) Operational strategies; (2) Regional influences; and the (3) Dynamic role of Port Authorities; in shaping and advancing port attractiveness and efficiency. The cluster is comprised of five scientific articles: (1) Martínez Moya and Feo Valero (2017); (2) Chang, Lee and Tongzon (2008); (3) Sanchez, Ng and Garcia-Alonso (2011); (4) Veldman, Garcia-Alonso and Angel Vallejo-Pinto (2011); and (5) Caballe Valls et al. (2020).

Martínez Moya and Feo Valero (2017) highlight that the central research topic in port competitiveness is the influence and definition of competitiveness by port authorities, particularly through: (1) Investments in infrastructure; (2) Efficiency improvements; and (3) Enhanced hinterland accessibility. This results in the development of new models for assessing port competitiveness and the active role of Port Authorities (PAs) in enhancing port attractiveness by adherence to the importance of Functional Characteristics (FC) of port choice. The majority of scholarly interest focuses on the FC of ports, indicating a trend towards emphasizing operational aspects in port management, and the crucial role of PAs in improving these characteristics. Ocean carriers are recognized by PAs as key decision makers in port choice, resulting in PAs traditional focus on attracting more shipping lines rather than directly improving services for landside users, acknowledging that the level of service perceived by landside users is mainly determined by the availability of maritime services. PAs can take under consideration the enhancement of port attractiveness via two types of factors: (1) Beyond control of PAs: (1.1) Geographical location; divided into: (1.1.1.) Transport cost; and (1.1.2.) Maritime distance; and (2) Under control of PAs, divided into: (2.1) Port performance; (2.2) Port connectivity; (2.3) Port charges; and (2.4) Port quality systems. The authors conclude that contemporary port choice criteria vary significantly by geographical area, with the North American region displaying emphasis on: (1) Business characteristics, while the Asian and European regions display emphasis on (2) Functional characteristics; suggesting a need for research on regional factors influencing port choice for ocean carriers. Chang, Lee and Tongzon (2008) conduct Exploratory and confirmatory factor analyses and reveal five categories of port choice: (1) Advancement/ convenience of port; (2) Physical/ operational ability of port; (3) Operational condition of shipping lines; (4) Marketability; and (5) Port charge. Consequently, the survey among two types of shipping companies: (1) Main haul shipping lines; and (2) Feeder shipping lines; identified the following six factors affecting port choice: (1) Local cargo volume; (2) Terminal handling charge; (3) Berth availability; (4) Port location; (5) Transshipment volume; and (6) Feeder network. Results indicate that main haul shipping lines show a preference for factors like: (1) Terminal handling charge; (2) Berth availability; and (3) Port location; emphasizing cost – efficiency and reliability in their port choice. Feeder shipping lines prioritize factors such as: (1) Local cargo volume; (2) Transshipment volume; and (3) Feeder network; focusing on connectivity and accessibility regarding their port choice. Port authorities should focus on advancing their cargo base and offering comprehensive value – added services with differing strategies for trunk and feeder service lines. Sanchez, Ng and Garcia-Alonso (2011) conduct an exploratory survey study on the crucial attributes that define port attractiveness with a focus on the perspectives of: (1) PAs as service providers; contrasting it with the perspectives of: (2) Shipping lines as service users. The main rationale for the research is that the evolution of liner shipping, characterized by: (1) Larger ship sizes; and (2) Extensive geographical coverage; has resulted in intensification of competition among ports, necessitating a focus on sustaining and enhancing port service quality. Results suggest that while both groups value service quality, their focus differs; PAs place emphasis on: (1) Overall operational excellence; and (2) Efficiency; whereas shipping lines prioritize specific aspects such as: (1) Berth availability; and (2) Turnaround times. The study concludes that contemporary PAs often consider long – term infrastructure and superstructure

investments as crucial elements of competitiveness; whereas shipping lines prioritize more immediate operational benefits. Veldman, Garcia-Alonso and Angel Vallejo-Pinto (2011) develop a demand choice function for Spanish container port services, crucial for: (1) Economic; and (2) Financial evaluations of port investment projects. The scholars utilize the multinomial logit model along with coefficients estimated through regression analysis in order to obtain an understanding how various factors, including; (1) Inland transport costs; and (2) Ocean transport costs; influence port choice. The analysis reveals that inland transport costs represent a highly greater impact on port choice than maritime transportation costs, indicating the significance of their role in the distribution of inter – port container traffic in Spain. Scholarly contribution of this study consists of two facts: (1) The emphasis on the demand choice function for container ports highlights the importance of economic and financial considerations in port selection; and (2) The greater impact of inland transport costs compared to maritime transport costs suggests that ports need to focus on improving their hinterland connections and logistics efficiency. Caballe Valls et al. (2020) focus on analyzing the factors pivotal for determining port choice for container cargoes from specific hinterlands in Spain by utilizing a nested logit model to incorporate two variables: (1) Maritime connectivity; and (2) Intermodal connectivity. The research places emphasis on the significant influence of maritime connectivity to overseas regions and intermodal connectivity to hinterland locations on a port's market share in specific hinterland areas. The empirical analysis of data is obtained from the Spanish customs, providing a robust foundation for understanding port choice dynamics. The analysis indicates that a strong transshipment orientation potentially represents a threat in a port's ability to reach hinterland markets. This indicates that further analysis must be conducted in order to reach an equilibrium or trade – off between container port: (1) Transshipment orientations; and (2) Hinterland orientations. The findings suggest that increasing maritime connectivity and improving intermodal connectivity are sensible strategies for port authorities and terminal operators, with implications for: (1) Port concession policies; and (2) Hinterland service standards.

3.4 Port Competitiveness

The "Port Competitiveness" research cluster centers on the exploration of the following factors crucial for influencing port competitiveness: (1) Governance; (2) Economies of scale; and (3) Sustainability. The diversity of the aforementioned factors is pivotal for elaborating the evolving trends in the maritime industry and the differing priorities of: (1) Port operators; and (2) Liner shipping companies. The cluster is comprised of five scientific articles: (1) Parola et al. (2017); (2) Bastug et al. (2022); (3) Yeo et al. (2014); (4) Talley and Ng (2013); and (5) Panayides and Polyviou (2011).

Parola et al. (2017) aim to further deepen the understanding of the complex concept of port competitiveness by categorization of its main drivers by conducting a comprehensive literature review of international scientific journals over a time span of 20 years. The ten traditional drivers of port competitiveness, namely: (1) Port costs; (2) Hinterland proximity; (3) Hinterland connectivity; (4) Port geographical location; (5) Port infrastructures; (6) Operational efficiency; (7) Port service quality; (8) Maritime connectivity; (9) Nautical accessibility; and (10) Port site; are reinterpreted in the context of current cutting - edge industry trends: (1) Economies of scale in shipping; (2) Port governance changes; (3) Co – opetition among ports in proximity; (4) Inter – firm networks; and (5) Green and sustainability challenges. The paper posits a nuanced and updated understanding of the factors impactful for driving port competitiveness, providing a solid knowledge base of the evolving nature of the global maritime industry. Bastug et al. (2022) conduct a research study employing a 20 – year literature review, surveys, and the Fuzzy Analytic Network Process (FAHP) to assess competitiveness criteria from both; (1) Ocean carriers (OCs); and (2) Terminal Operators (TOs); viewpoints. Contrary to previous studies, the scholars' research places emphasis on the understanding of different priorities of OCs and TOs (ports), suggesting that improved mutual comprehension might lead to more efficient maritime economic systems. Results indicate the top three factors prioritized by OCs being: (1) Operational efficiency; (2) Quality of port service; and (3) Geographical location and accessibility; while TOs three main preference factors are: (1) Port location; (2) Service level; and (3) Port tariffs. The study reveals a significant divergence in factor priorities between OCs and TOs. The results explain and reaffirm how the rapid changes in the container shipping industry, such as: (1) Growth in ship sizes; and (2) Alliance dynamics, place new demands on port competitiveness. Yeo et al. (2014) address the challenges in making decision under uncertainty for selecting container ports of South East Asia. The scholars introduce a new method combining: (1) Fuzzy logic; and (2) Evidential reasoning; for port choice, allowing for the synthesis of raw data into fuzzy grades to produce a port choice preference score. The new method fills the gap in current port choice evaluation models by providing an

adequate and valid framework for combining both: (1) Quantitative; and (2) Qualitative factors. The dual approach for port competitiveness evaluation is utilized on the following factors: (1) Port service; (2) Hinterland condition; (3) Availability; (4) Convenience; (5) Logistics cost; (6) Regional center; and (7) Connectivity on two types of respondents: (1) Customer group (OC); and (2) Provider group (TO). The main contribution of the study manifests in proposing a decision – support tool in both: (1) External assessment (Customer group); and (2) Internal assessment (Provider group); of port performance. This approach helps in identifying and improving aspects that could weaken a port's attractiveness and competitiveness, with case studies of South East Asia ports confirming the feasibility of the ranking procedure. Talley and Ng (2013) integrate the literature on port choice into the broader context of maritime transport chain choices, highlighting the crucial role of port selection in the entire maritime transport system. The authors develop a formal mathematical model of the maritime transport chain on basis of monetary costs in order to capture the complex interdependencies among: (1) Carriers; (2) Ports; and (3) Shippers. This model conceptualizes the maritime transport chain as an equilibrium model (Nash equilibria), aiding in understanding the: (1) Dynamics, and (2) Balance; within the system. The research places emphasis on the importance of the choices made by ports in selecting shipping lines and shippers, and vice versa. It provides a demonstration that the cost factors determining shipping line and shipper port choice are also pivotal in their decision within the maritime transport chain. The main contributions of the paper are twofold: (1) The provision of the theoretical understanding of how maritime transport chains function and are chosen on basis of variational cost inequalities; and (2) The incorporation of port choice literature into the maritime transport chain context results in a new perspective on how the determinants of port choice by relevant stakeholders are integral to the broader maritime transport chain decisions. Panayides and Polyviou (2011) introduce a pioneering approach by investigating how the logistics – relate attributes and services provided by ports enhance: (1) The business; and (2) Supply chain; performance of shipping companies. A Structural Equation Model (SEM) is proposed to understand the interplay between port services and shipping company performance. The study highlights that shipping companies find satisfaction with the efficiency of ports': (1) Multimodal operations; (2) Service time; and (3) Loading/ discharging rates. However, there is notable dissatisfaction with information system availability, suggesting a need for improvement in communication and information provision. The results of this study indicate that the relationship between the satisfaction of shipping lines with port services and their performance is crucial. If a shipping line finds a port's service lacking, it may opt for another port, resulting in intensification of competition among ports. The competition drives the need for continuous improvement in port services, thereby enhancing overall port competitiveness.

3.5 Strategic Decision – Making in Global Shipping Networks

The "Strategic Decision – Making in Global Shipping Networks" research cluster pivots on the analysis and understanding of the multifaceted factors influencing port selection, including the: (1) Decision – making process of shipping lines and alliances; (2) Economic impacts; and (3) Strategic position of ports; within global shipping networks. The cluster is comprised of five scientific articles: (1) Lagoudis, Theotokas and Broumas (2017); (2) Notteboom et al. (2017); (3) Tang, Low and Lam (2011); (4) Lam and Dai (2012); (5) Tongzon and Sawant (2007).

Lagoudis, Theotokas and Broumas (2017) categorize port selection studies into two main groups: (1) First focusing on the factors considered by users in strategic, operational and tactical decision – making; and (2) Second focusing on the impact of port container terminals on regional economies. The scholars reveal that the increasing bargaining power of shipping lines due to alliances formation results in ports being faced with the strategic choice whether to operate as: (1) Regional hubs; or (2) Feeder ports. This is a decision that profoundly influences the services, operations, and competitive stance of container ports. The results conclude that ports must implement multifaceted strategies considering factors like (1) Port efficiency; (2) Port performance; and (3) Port competitiveness; to know the actual from the stated preferences of shipping lines regarding port selection, in order to maintain their competitive edge in the maritime industry. Notteboom et al. (2017) focus on the Europe – Far East trade from 2006 to 2017 and employ both binary and non – binary data methodologies in order to understand the extent of terminal involvement by alliance members on port inclusion in liner services. The research provides a conceptual analysis of the interplay between: (1) Shipping line routines; (2) Terminal operations; and (3) Alterations in port calling patterns; complemented by the empirical data on the relationship between these factors in North – West European ports. The study's findings challenge the initial hypothesis regarding terminal involvement and port selection, revealing a more complex relationship,

particularly in the key UK ports and Hamburg, where significant alliance ports showed no terminal involvement by alliance members. Tang, Low and Lam (2011) improve the traditional multinomial logit preference (MNL) model by developing the Network – based Integrated Choice Evaluation (NICE) model. The new model integrates port service networks with observable port attributes to better understand factors influencing port choice decisions. It provides a more holistic analysis of port choice; combining various elements: (1) Port efficiency; (2) Scale economies; and (3) Network characteristics; to determine their impact on liner shipping companies' decisions. The study highlights that (1) Port efficiency; and (2) Scale economies; are crucial factors for liner shipping companies. The study concludes that factors such as: (1) Mix of containers; (2) Hinterland trade structure; and (3) Reliability of services; significantly impact a port's productivity and strategic positioning in transport networks. Lam and Dai (2012) utilize the AHP methodology to develop a novel web – based Decision Support System (DSS) to streamline the port selection process by shipping lines. The system facilitates easier access for decision – makers and expedites data collection, offering a structured approach to complex decision problems. It allows shipping lines to select and prioritize port criteria based on real – life scenarios and company policies. This adaptability ensures that shipping company decision – makers can tailor their choices to specific cases, enhancing: (1) Port service quality; and (2) Port competitiveness. The study acknowledges the need for future improvements in the DSS, particularly in updating the system by incorporating: (1) New criteria for more precise port selection; and (2) Shipper perspectives; in order to obtain and consider the diverse perceptions of other stakeholders relevant for port selection. Tongzon and Sawant (2007) acknowledge that there is a growing emphasis on understanding port selection from the perspective of shipping lines, moving from relying on their stated preferences to examining their revealed preferences, which focus on their actual choices and actions. The scholars conduct a 7 - point Likert scale survey with Boxplot analysis to identify the stated preferences of shipping lines, and successively apply the Binary Logistic Regression (BLR) and Model selection to identify the revealed preference of shipping lines, based on their behavior and actual choices made by them. The primary identified factors crucial in influencing the choices of shipping lines in their decision – making process are: (1) Port charges; and (2) The range of offered services. The results of the study reveal two important findings: (1) Ports must place emphasis on a holistic approach in port services by integrating lower charges, value – added services and adequate infrastructure; and (2) In the competitive landscape of the maritime industry, ports must align their strategies with the revealed actual preferences of shipping lines by making investments on basis of factors influencing their actual behavior and choices.

4 RESULTS AND DISCUSSION

The concept of port selection has been examined from various perspectives to clarify and unravel its complex multidimensional nature. The brief literature review in the Introduction section demonstrates that scholars have endeavored to understand the multifaceted nature of ports and the diverse factors that influence their selection. The analysis of five research clusters comprehensively provides a detailed examination of sustainable port selection by container ocean carriers, considering key factors such as environmental impacts, operational efficiencies, and strategic considerations. This approach clearly demonstrates a comprehensive understanding of the diverse factors that influence sustainable decision-making in port selection within the container liner shipping industry.

The research cluster "Port Performance Evaluation" demonstrates how ocean carrier sustainable decision-making regarding port selection is increasingly influenced by multi-criteria decision-making (MCDM) methodologies, which integrate environmental, operational, and regional competitiveness factors. Ergin and Eker (2019) emphasize that ocean carriers are prioritizing ports involved in green port projects as part of their selection criteria, focusing on those that actively mitigate environmental degradation from port operations and urban impacts, reflecting an expanded consideration of environmental impacts beyond traditional cost and efficiency metrics. Ergin and Eker (2019) and Munim, Duru, and Ng (2022) demonstrate that employing MCDM methodologies like fuzzy TOPSIS and Analytic Network Process (ANP) enables ocean carriers to assess ports using a comprehensive framework that includes sustainability, efficiency, and connectivity, thereby supporting more holistic and sustainable decision-making in port selection by incorporating diverse criteria such as environmental management. Furthermore, Nazemzadeh and Vanelslander (2015) and Munim, Duru, and Ng (2022) point out the importance of geographical location, quality of hinterland connections, and port efficiency as critical factors influencing sustainable port choice. Their findings suggest that strategic improvements in container port governance methods, such as Public - Private Partnerships (PPPs) and green

management practices, emerge as pivotal in enhancing port infrastructure and operations via the incorporation of sustainable technologies that align with the environmental goals of ocean carriers. The diversity in carrier preferences and performance metrics, as explored by Chou (2010) and Rezaei et al. (2019), underscores the need for ports to adapt to varying carrier needs which include operational efficiency, hinterland connectivity, and cost-effectiveness. These factors are balanced against sustainability criteria, influencing carrier decisions on port selection which aim for both economic and environmental sustainability. Container carriers are categorized into oceangoing and coastal, with findings indicating that both groups prioritize different criteria based on their operational focus. This suggests that enhancing port infrastructure, especially deepwater berths, is critical for attracting oceangoing carriers, while the growth of the hinterland economy attracts coastal carriers.

Future research should focus on: (1) Developing and refining quantitative models that specifically measure the environmental impacts of port operations; (2) Investigation of the long – term effects of regulatory compliance on port operations through longitudinal studies to provide insights into the evolution of container port's environmental strategies and effectiveness over time; and (3) Conduct comparative studies of port management across different regulatory environments and regions to identify effective green port practices.

The research cluster "Environmental Considerations in Liner Networks" clarifies the manner in which sustainable port selection by ocean carriers hinges on integrating environmental considerations with operational efficiencies. Tran and Haasis (2015) emphasize the necessity of ocean carrier holistic approaches in port selection that consider both maritime and hinterland operations to align shipping practices with global sustainability goals. Complementing this, Li, Kuang, and Hu (2019) elucidate the significant impact of port selection on environmentally friendly shipping routes, using the entropy weight TOPSIS method to highlight how quantitative models integrated into China's container development strategy can effectively reduce CO_2 emissions and enhance multimodal transport systems. Additionally, Wang and Yeo (2019) investigate the selection of transshipment hub ports through a case study of Shanghai and Ningbo, emphasizing that cost, hub port space allocation, and connectivity are essential for balancing economic efficiency and environmental sustainability in port operations. Tran, Haasis, and Buer (2017) propose a model that optimizes container flows between continents, highlighting the strategic significance of port selection in minimizing shipping, port, inland transport, inventory costs as segments of logistics costs; along with CO_2 costs minimization as a segment of societal and environmental costs, thereby enhancing the sustainability of maritime supply chain management. Finally, Vejvar, Lai, and Lo (2020) conduct a citation network analysis that reveals a significant shift in shipping performance trends towards incorporating green policies and sustainability metrics in port evaluations, underscoring the growing recognition of environmental and social impacts as essential for promoting sustainable practices in the container liner shipping industry.

Future research should focus on: (1) Development of more comprehensive and holistic sustainability metrics that integrate economic, environmental and operational aspects to provide a balanced view of port performance; (2) Development and refinement of advanced – decision support systems that incorporate real – time data and predictive analytics to aid ocean carriers in port selection; and (3) Integration and optimization of maritime and hinterland network efficiencies because ports are pivotal nodes within broader supply chain networks.

The research cluster "Port Choice Dynamics" reveals that sustainable port selection by ocean carriers is profoundly influenced by the strategic roles of Port Authorities and the operational preferences of shipping lines. Port authorities enhance port competitiveness through significant investments in infrastructure with the aim of improving efficiency and attaining better hinterland accessibility Martínez Moya and Feo Valero (2017). This proactive role helps in developing new models for assessing port competitiveness and emphasizes the importance of functional characteristics in port choice, which is vital for sustainable development strategies of ocean carriers. Chang, Lee, and Tongzon (2008) indicate that ocean carriers prioritize operational efficiency, quality of port services, and geographical location due to their alignment with needs for cost-effectiveness and reliability, which are critical for sustaining both environmental and economic viability in shipping operations. Importantly, Port authorities and shipping lines have differing perspectives on what constitutes service quality, with port authorities focusing on overall operational excellence and shipping lines emphasizing specific operational aspects like berth availability and turnaround times for their sustainability criteria Sanchez, Ng and Garcia-Alonso (2011). Furthermore, inland transport costs significantly influence port choice more than maritime transport costs, underscoring the importance of enhancing hinterland connections to improve logistics efficiency and reduce the environmental impact of shipping Veldman, Garcia-Alonso and Angel Vallejo-Pinto

(2011). It is important to note that the balance of maritime and intermodal connectivity is crucial for determining a port's market share and its ability to meet both global shipping needs and local market demands, which is vital for the sustainable growth of port operations Caballe Valls et al. (2020).

Future research should focus on: (1) Examination in greater depth how the strategies and policies implemented by Port Authorities affect the decision – making processes of ocean carriers regarding port selection; (2) Assess how the quality of hinterland connections, namely road, rail, and inland water transport improvements influence ocean carrier port choice and overall supply chain efficiency; and (3) Finding the optimal balance between transshipment and direct shipment orientation of container ports, potentially through case studies of ports with varying levels of transshipment activity to better understand the trade – offs and benefits regarding ocean carrier decision making in port selection.

The research cluster "Port Competitiveness" indicates that sustainable decision-making for port selection by ocean carriers relies significantly on container port operational efficiency, service quality, and geographical location and accessibility. Bastug et al. (2022) emphasized that these priorities influence ocean carriers' port selection decisions, as they seek to minimize time at port and maximize cargo movement efficiency. This aligns with sustainability when efficiency gains coincide with reduced fuel consumption and emissions during port stays. Furthermore, shipping companies highly value the efficiency of ports' multimodal operations, service time, and loading/discharging rates. These aspects directly contribute to sustainable practices by reducing idle times and optimizing resource use, crucial for sustainable decision-making in container liner shipping Panayides and Polyviou (2011). Furthermore, Parola et al. (2017) articulated that governance and economies of scale are significant drivers of port competitiveness, which also factor into sustainable practices. Effective governance can enforce environmental standards, while economies of scale can lead to more sustainable operations through enhanced capacity and reduced per-unit costs. Yeo et al. (2014) developed a decision-support tool combining fuzzy logic and evidential reasoning for port choice, which integrates both quantitative and qualitative sustainability factors. This tool aids ocean carriers in making informed choices that balance operational needs with environmental and social sustainability. Finally, Talley and Ng (2013) provide a critical insight into how port selection is integrated into the broader maritime transport chain, influencing overall system sustainability. They propose that the strategic selection of ports based on cost and service factors plays a crucial role in the equilibrium of the maritime transport system, thereby affecting the sustainability outcomes of shipping logistics.

Future research should focus on: (1) Conducting comparative case studies of ports before and after governance reforms to analyze shifts in competitive dynamics and assess the efficacy of different governance models in enhancing port competitiveness and attractiveness to ocean carriers; (2) Exploring how ports differentiate themselves in competitive markets through strategic decisions on service expansion, pricing strategies, and marketing approaches, to understand their impact on the competitive positioning of shipping lines; and (3) Investigating the system-wide effects of strategic port selection on the sustainability of the entire transport chain, including how optimizing one segment influences others.

The research cluster "Strategic Decision Making in Global Shipping Networks" reveals that ocean carrier sustainable decision-making regarding port selection is significantly influenced by multiple strategic factors of container liner shipping networks. Lagoudis, Theotokas, and Broumas (2017) suggest that ports must implement comprehensive strategies focusing on efficiency, performance, and competitiveness to align with shipping lines' preferences for operational efficiencies that promote sustainability, such as reduced time at port and minimized environmental impacts. Notteboom et al. (2017) provide insights into how terminal operations and the routines of shipping lines affect port calling patterns, especially in key ports like those in the UK and Hamburg. Their findings challenge assumptions about terminal involvement and highlight a more complex interplay, suggesting that sustainable decision-making involves understanding and managing these intricate relationships to enhance port inclusion in liner services without compromising operational sustainability. Moreover, Tang, Low, and Lam (2011) advance the traditional decision-making models by incorporating network-based integrations that account for port efficiency and scale economies. This holistic approach allows for a more accurate assessment of how ports can meet the sustainability criteria crucial for ocean carriers, influencing their decision to select ports that optimize resource use and minimize environmental footprints. Lam and Dai (2012) discuss the development of a web-based DSS using the Analytic Hierarchy Process (AHP), which aids in refining the port selection process. This system supports sustainable decision-making by allowing shipping lines to prioritize port criteria based on real-life scenarios and policies, thus facilitating choices that are environmentally and

operationally sustainable. Lastly, Tongzon and Sawant (2007) contrast the stated and revealed preferences of shipping lines, emphasizing the importance of ports responding to the actual behavior of shipping lines. Their findings suggest that for sustainable decision-making, ports must focus on providing a combination of competitive charges, value-added services, and robust infrastructure to align with the real preferences of shipping lines, thus promoting sustainability in operations and choices.

Future research should focus on: Refinement of Network – based Integrated Choice Evaluation (NICE) models by integrating environmental sustainability metrics to assess the environmental impact of port operations, including emissions data, waste management practices, and resource efficiency, to foster a more scientifically grounded approach to sustainable port selection; (2) Upgrading existing decision support systems by integrating real – time data on port conditions, such as congestion and operational status, to enhance the precision and adaptability of ocean carrier container port selection in dynamic maritime environments; and (3) Conducting comparative studies on the discrepancies between the stated and revealed preferences of shipping lines across various regions and shipping alliances to determine if these differences are consistent industry-wide.

5 CONCLUSIONS

The process of port selection constitutes high complexity due to factors like trade globalization, container ship size growth, and the competitive nature of the maritime industry. This complexity necessitates considering numerous criteria in the decision – making process. Understanding the complexities of ocean carrier container port selection is crucial, both for effectively integrating shipping lines into global supply chains and for fostering the sustainable growth of regional economies, particularly given that approximately 70% of the value of international trade is transported by maritime routes, with two – thirds of that amount shipped in containers, primarily because most high – value commercial goods are containerized.

However, the limitations to the existing literature, specifically the predominant singular focus in research methodology, generalized approach in port selection analysis, and comprehensive literature reviews marginally addressing port choice, lead to significant gaps. Consequently, this results in the formulation of a problem statement indicating that the aspect of container port selection by ocean carriers is neither adequately addressed as a focal research point nor methodologically sufficiently integrated into contemporary scholarly maritime literature.

This paper aims to alleviate the aforementioned complexity by providing a comprehensive review of the most relevant articles regarding ocean carrier container port selection from the ISI WoS scientific database with adherence to Boolean search terms. The search process yielded a bibliometric sample of 62 scientific articles for the bibliometric and content analysis. Top three most influential articles as identified on basis bibliometric analysis TC measure are: (1) Yeo, Roe and Dinwoodie (2008); (2) Chang, Lee and Tongzon (2008); and (3) Tongzon and Sawant (2007). The bibliographic coupling of 42 articles revealed five research clusters: (1) Port performance evaluation; (2) Environmental considerations in liner networks; (3) Port choice dynamics; (4) Port competitiveness; and (5) Strategic decision – making in global shipping networks. The clusters were thoroughly examined using a qualitative content analysis approach. The main content analysis insights of each respective cluster are addressed via the formulated question: What makes decision – making in container liner shipping sustainable regarding ocean carrier port selection?

Cluster 1 (Port Performance Evaluation) provides insights that multi-criteria decision-making methodologies significantly shape OC sustainable decision-making in port selection, with a focus on integrating environmental impacts, operational efficiencies, and competitive factors. These methodologies, such as fuzzy TOPSIS and the Analytic Network Process, are instrumental in assessing and enhancing port performance, thereby influencing the strategic choices of ocean carriers. Cluster 2 (Environmental Considerations in Liner Networks) depicts how Eco-efficient practices and the integration of carbon footprint reduction strategies are vital in OC's port selection process to align shipping practices with global sustainability goals. This cluster emphasizes sustainable logistics practices and focuses on the implementation of carbon reduction strategies to enhance the environmental sustainability of port operations. Cluster 3 (Port Choice Dynamics) provides insights how the dynamic role of Port Authorities and operational strategies are crucial in shaping port competitiveness

and efficiency, significantly influencing OC's port choice. This cluster focuses on analyzing regional influences and the strategic role of Port Authorities in enhancing port attractiveness and functionality, which are key determinants of port selection by ocean carriers. Cluster 4 (Port Competitiveness) depicts that factors such as governance, economies of scale, and sustainability initiatives are pivotal in influencing port competitiveness, which in turn affects OC's port selection. This cluster delves into the exploration of how changes in governance and economies of scale impact port operations, highlighting the significant role these elements play in determining the competitive positioning of ports in the view lens of ocean carriers. Cluster 5 (Strategic Decision Making in Global Shipping Networks) elucidates how strategic factors, including the decision-making processes of shipping lines and their economic impacts, play a critical role in OC's port selection. This cluster focuses on the consideration of strategic positioning and the economic ramifications that influence port selection, emphasizing how these elements guide the choices of ocean carriers within global shipping networks.

Furthermore, future research directions are recommended for each cluster respectively. Future research should explore and refine quantitative decision – making models to measure environmental impacts alongside economic impacts regarding ocean carrier port selection, enhance advanced decision support systems to include real – time data in order to aid ocean carriers in making informed and sustainable port selection decisions, and investigate the long-term effects of regulatory compliance on port operations through longitudinal studies to provide insights into the evolution of container port's environmental strategies and their effectiveness over time.

On a practical level, the insights gained from this study have significant implications for port authorities and ocean carriers. For port authorities, understanding the priorities and selection criteria of ocean carriers can guide infrastructure and service enhancements that align with carrier needs while promoting sustainability. For ocean carriers, the study underscores the importance of incorporating sustainability into route and port selection strategies, potentially leading to cost savings and improved environmental performance. In conclusion, this study not only enhances the understanding of the factors influencing sustainable port selection but also underscores the need for a comprehensive approach that integrates environmental, operational, and strategic considerations to support the sustainable growth of the maritime industry.

6 REFERENCES

Aria, M., Cuccurullo, C., 2017. bibliometrix : An R-tool for comprehensive science mapping analysis. *Journal of Informetrics* [online], vol. 11, no. 4, [accessed: 6 April 2023]. ISSN 17511577. DOI 10.1016/j.joi.2017.08.007. Available at: https://linkinghub.elsevier.com/retrieve/pii/S1751157717300500.

Bastug, S., Haralambides, H., Esmer, S., Eminoglu, E. Port competitiveness: Do container terminal operators and liner shipping companies see eye to eye? *Marine Policy.* [online] January 2022, Vol. 135. England: Elsevier Sci. Ltd. Available at: https://doi.org/10.1016/j.marpol.2021.104866

Boyack, K.W., Klavans, R. Co-citation analysis, bibliographic coupling, and direct citation: Which citation approach represents the research front most accurately? *Journal of the American Society for Information Science and Technology* [online], 2010, vol. 61, no. 12, [accessed: 25 February 2024]. ISSN 1532-2882, 1532-2890. DOI 10.1002/asi.21419. Available at: https://onlinelibrary.wiley.com/doi/10.1002/asi.21419.

Caballe Valls, J., De Langen, P.W., Garcia Alonso, L., Vallejo Pinto, J.A. *Understanding Port Choice Determinants and Port Hinterlands: Findings from an Empirical Analysis of Spain*. March 2020. England: Palgrave Macmillan Ltd.

Cazzaniga Francesetti, D., Foschi, A.D. The Impact of Hub and Spokes Networks in the Mediterranean Peculiarity. *SSRN Electronic Journal* [online], 2003, [accessed: 14 April 2024]. ISSN 1556-5068. DOI 10.2139/ssrn.385166. Available at: http://www.ssrn.com/abstract=385166.

Chang, Y.-T., Lee, S.-Y., Tongzon, J.L. Port selection factors by shipping lines: Different perspectives between trunk liners and feeder service providers. *Marine Policy.* [online] November 2008, Vol. 32 Iss. 6, pages 877-885. England: Elsevier Sci LTD. Available at: https://doi.org/10.1016/j.marpol.2008.01.003

Chou, C.-C. AHP model for the container port choice in the multiple-ports region. *Journal of Marine Science and Technology*. Vol 18: Iss. 2, Article 8. [online] April 2010. Taiwan: Natl Taiwan Ocean University. Available at: https://jmstt.ntou.edu.tw/journal/vol18/iss2/8

Elabbasy, M., Abdelkader, S. And Elsayeh, M. Port Selection Using Analytic Hierarchy Process with Perfect Consistency. *International Journal of Humanities and Social Sciences* [online] June 2018. Egypt: Arab Academy for Science, Technology and Maritime Transport. Available at: https://www.academia.edu/download/56908999/15._IJHSS_-_PORT_SELECTION_USING_ANALYTIC_HIERARCHY_PROCESS.pdf

Ellegaard, O., Wallin, J.A. The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics* [online], vol. 105, no. 3, [accessed: 6 April 2023]. ISSN 0138-9130, 1588-2861. DOI 10.1007/s11192-015-1645-z. Available at: http://link.springer.com/10.1007/s11192-015-1645-z.

Ergin, A., Eker, I. Application of fuzzy topsis model for container port selection considering environmental factors. *International Journal of Maritime Engineering.* September 2019, Vol. 6 No. A3. England: The Royal Institution of Naval Architects. Available at: https://doi.org/10.5750/ijme.v161iA3.1100

Kramberger, T., Rupnik, B., Štrubelj, G., Prah, K., Port Hinterland Modelling Based on Port Choice. *PROMET - Traffic&Transportation*, 2015. [online], vol. 27, no. 3, [accessed: 14 abril 2024]. ISSN 1848-4069, 0353-5320. DOI 10.7307/ptt.v27i3.1611. Available at: https://traffic.fpz.hr/index.php/PROMTT/article/view/1611.

Lagoudis, I.N., Theotokas, I., Broumas, D. A literature review of port competition research. *International Journal of Shipping and Transport Logistics*. Vol. 9, Iss. 6, [online] 2017. Switzerland: Inderscience Enterprises Ltd.

Lam, J.S.L., Dai, J., A decision support system for port selection. *Transportation Planning and Technology*, Vol. 35, Iss. 4, pages 509-524. [online] 2012. England: Taylor & Francis Ltd. Available at: https://doi.org/10.1080/03081060.2012.680822

Li, X., Kuang, H., Hu, Y. Carbon Mitigation Strategies of Port Selection and Multimodal Transport Operations-A Case Study of Northeast China. *Green Maritime Trasnport*, Sustainability 2019, 11, 4877. September 2019. Switzerland: MDPI. Available at: https://doi.org/10.3390/su11184877

Liang, T.-P., Liu, Y.-H. Research Landscape of Business Intelligence and Big Data analytics: A bibliometrics study. *Expert Systems with Applications* [online], 2018, vol. 111, [accessed: 23 February 2024]. ISSN 09574174. DOI 10.1016/j.eswa.2018.05.018. Available at: https://linkinghub.elsevier.com/retrieve/pii/S0957417418303099.

Martínez Moya, J., Feo Valero, M. Port choice in container market: a literature review. *Transport Reviews* [online], 2017, vol. 37, no. 3, [accessed: 10 November 2023]. ISSN 0144-1647, 1464-5327. DOI 10.1080/01441647.2016.1231233. Available at: https://www.tandfonline.com/doi/full/10.1080/01441647.2016.1231233.

Munim, Z.H., Duru, O., Ng, A.K.Y. Transhipment port's competitiveness forecasting using analytic network process modelling. *Transport Policy* [online], 2022, vol. 124, [accessed: 11 December 2023]. ISSN 0967070X. DOI 10.1016/j.tranpol.2021.07.015. Available at: https://linkinghub.elsevier.com/retrieve/pii/S0967070X2100216X.

Munim, Z.H., Dushenko, M., Jimenez, V.J., Shakil, M.H., Imset, M. Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions. *Maritime Policy & Management* [online], 2020, vol. 47, no. 5, [accessed: 23 February 2024]. ISSN 0308-8839, 1464-5254. DOI 10.1080/03088839.2020.1788731. Available at: https://www.tandfonline.com/doi/full/10.1080/03088839.2020.1788731.

Nazemzadeh, M., Vanelslander, T. The container transport system: Selection criteria and business attractiveness for North-European ports. *Marit Econ Logist* 17, 221–245. [online] June 2015. Available at: https://doi.org/10.1057/mel.2015.1

Notteboom, T., Pallis, A.A., Rodrigue, J.-P. *Port Economics, Management and Policy* [online], 2022. New York: Routledge. [accessed: 2 June 2023]. ISBN 9780367331559. Available at: https://porteconomicsmanagement.org/pemp/contents/part1/maritime-shipping-and-international-trade/value-containerized-trade/.

Notteboom, T.E., Parola, F., Satta, G., Pallis, A.A. The relationship between port choice and terminal involvement of alliance members in container shipping. *Journal of Transport Geography* [online], 2017, vol. 64, [accessed: 2 June 2023]. ISSN 09666923. DOI 10.1016/j.jtrangeo.2017.09.002. Available at: https://linkinghub.elsevier.com/retrieve/pii/S0966692317301497.

Panayides, P.M. And Polyviou, M. The effect of ports' logistics attributes and services on the business and supply chain performance of shipping firms. *International Journal of Shipping and Transport Logistics*, 2011, vol. 3, no 4, p. 430-453. Switzerland: Inderscience Enterprises Ltd. Available at: https://doi.org/10.1504/IJSTL.2011.041136

Parola, F., Risitano, M., Ferretti, M., Panetti, E. The drivers of port competitiveness: a critical review. *Transport Reviews*, 2017, vol. 37, no 1, p. 116-138. England: Taylor & Francis Ltd. Available at: https://doi.org/10.1080/01441647.2016.1231232

Rezaei, J., Van Wulfften Palthe, L., Tavasszy, L., Wiegmans, B., Van Der Laan, F. Port performance measurement in the context of port choice: an MCDA approach. *Management Decision* [online], 2019, vol. 57, no. 2, [accessed: 9 marzo 2023]. ISSN 0025-1747. DOI 10.1108/MD-04-2018-0482. Available at: https://www.emerald.com/insight/content/doi/10.1108/MD-04-2018-0482/full/html

Sanchez, R.J., Ng, A.K.Y., Garcia-Alonso, L. Port selection factors and attractiveness: the service providers' perspective. *Transportation journal*, 2011, vol. 50, no 2, p. 141-161. USA: Pennsylvania State University Press. Available at: https://doi.org/10.5325/transportationj.50.2.0141

Talley, W.K., Ng, M. Maritime transport chain choice by carriers, ports and shippers. *International Journal of Production Economics*, 2013, vol. 142, no 2, p. 311-316. April 2013. Netherlands: Elsevier. Available at: https://doi.org/10.1016/j.ijpe.2012.11.013

Tang, L.C., Low, J.M.W., Lam, S.W. Understanding port choice behavior—a network perspective. *Networks and Spatial Economic*s, 2011, vol. 11, p. 65-82. USA: Springer. Available at: https://doi.org/10.1007/s11067-008-9081-8

Tongzon, J.L., Sawant, L. Port choice in a competitive environment: from the shipping lines' perspective. *Applied Economics* [online], 2007, vol. 39, no. 4, [accessed: 9 December 2023]. ISSN 0003-6846, 1466-4283. DOI 10.1080/00036840500438871. Available at: http://www.tandfonline.com/doi/abs/10.1080/00036840500438871.

Tran, N.K., Haasis, H.-D. Literature survey of network optimization in container liner shipping. *Flexible Services and Manufacturing Journal*, 2015, vol. 27, p. 139-179. Netherlands: Springer. Available at: https://doi.org/10.1007/s10696-013-9179-2

Tran, N.K., Haasis, H.-D., Buer, T. Container shipping route design incorporating the costs of shipping, inland/feeder transport, inventory and CO2 emission. *Maritime Economics & Logistics* [online], 2017, vol. 19, no. 4, [accessed: 1 diciembre 2023]. ISSN 1479-2931, 1479-294X. DOI 10.1057/s41278-017-0075-7. Available at: http://link.springer.com/10.1057/s41278-017-0075-7.

Tsantis, A., Mangan, J., Calatayud, A., Palacin, R. Container shipping: a systematic literature review of themes and factors that influence the establishment of direct connections between countries. *Maritime Economics & Logistics* [online], 2023, vol. 25, no. 4, [accessed: 1 December 2023]. ISSN 1479-2931, 1479-294X. DOI 10.1057/s41278-022-00249-3. Available at: https://link.springer.com/10.1057/s41278-022-00249-3.

Van Eck, N.J., Waltman, L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* [online], 2010, vol. 84, no. 2, [available at: 7 April 2023]. ISSN 0138-9130, 1588-2861. DOI 10.1007/s11192-009-0146-3. Available at: http://link.springer.com/10.1007/s11192-009-0146-3.

Vejvar, M., Lai, K.-H., Lo, C.K.Y. A citation network analysis of sustainability development in liner shipping management: A review of the literature and policy implications. Maritime Policy & Management, 2020, vol. 47, no 1, p. 1-26. England: Routledge Journals, Taylor & Francis Ltd. Available at: https://doi.org/10.1080/03088839.2019.1657971

Veldman, S., Garcia-Alonso, L., Angel Vallejo-Pinto, J. Determinants of container port choice in Spain. Maritime Policy & Management, 2011, vol. 38, no 5, p. 509-522. England: Routledge Journals, Taylor & Francis Ltd. Available at: https://doi.org/10.1080/03088839.2011.597450

Veldman, S.J., Bückmann, E.H., Saitua, R.N. River Depth and Container Port Market Shares: The Impact of Deepening the Scheldt River on the West European Container Hub-Port Market Shares. *Maritime Economics & Logistics* [online], 2005, vol. 7, no. 4, [accessed: 14 April 2024]. ISSN 1479-2931, 1479-294X. DOI 10.1057/palgrave.mel.9100142. Available at: http://link.springer.com/10.1057/palgrave.mel.9100142.

Wang, Y., Yeo, G.-T. Transshipment hub port selection for shipping carriers in a dual hub-port system. Maritime Policy & Management, 2019, vol. 46, no 6, p. 701-714. England: Routledge Journals, Taylor & Francis Ltd. Available at: https://doi.org/10.1080/03088839.2019.1627012

Yeo, G.-T., Ng, A.K.Y., Lee, P.T.-W., Yang, Z. Modelling port choice in an uncertain environment. Maritime Policy & Management, 2014, vol. 41, no 3, p. 251-267. England: Routledge Journals, Taylor & Francis Ltd. Available at: https://doi.org/10.1080/03088839.2013.839515

Yeo, G.-T., Roe, M. And Dinwoodie, J. Evaluating the competitiveness of container ports in Korea and China. Transportation Research Part A: Policy and Practice, 2008, vol. 42, no 6, p. 910-921. England: Pergamon-Elsevier Science Ltd. Available at: https://doi.org/10.1016/j.tra.2008.01.014