Ciencia y Educación
(L-ISSN: 2790-8402 E-ISSN: 2707-3378)
Edición Especial
2025

BIBLIOMETRIC STUDY OF ORGANIZATIONAL MANAGEMENT IN PORT TERMINALS

ESTUDIO BIBLIOMÉTRICO DE LA GESTIÓN ORGANIZACIONAL EN TERMINALES PORTUARIAS

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Articulo recibido: 4 de Abril del 2025
Articulo revisado: 9 de Abril del 2025
Articulo aprobado: 12 de Mayo del 2025
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Resumen

Este estudio presenta un análisis bibliométrico de la investigación científica sobre gestión organizacional en terminales portuarias, con el objetivo de identificar las principales tendencias, autores prolíficos, países líderes, revistas clave y temas de investigación en evolución en este campo. Utilizando Scopus como base de datos principal y VOSviewer para la visualización de datos, el estudio analiza 60 documentos relevantes publicados entre 2015 y 2023. Los resultados revelan un creciente interés en temas como la eficiencia logística, el rendimiento portuario, la transformación digital y la sostenibilidad en las operaciones de terminales portuarias. El análisis también destaca el predominio de ciertas regiones en la producción científica y el surgimiento de colaboraciones interdisciplinarias. Esta revisión bibliométrica proporciona información valiosa para investigadores, responsables políticos y profesionales interesados en el desarrollo de una gestión eficiente y competitiva de terminales portuarias.

Palabras clave: Terminales portuarias, Gestión organizacional, Análisis bibliométrico, Logística, Investigación marítima.

Abstract

This study presents a bibliometric analysis of scientific research on organizational management in port terminals, aiming to identify the main trends, prolific authors, leading countries, key journals, and evolving research topics in this field. Using Scopus as the primary database and VOSviewer for data visualization, the study analyzes 60 relevant documents published between 2015 and 2023. The results reveal a growing interest in topics such as logistics efficiency, port performance, digital transformation, and sustainability in port terminal operations. The analysis also highlights the dominance of certain regions in scientific production and the emergence of interdisciplinary collaborations. This bibliometric overview provides valuable insights for researchers, policymakers, and practitioners interested in the development of efficient and competitive port terminal management.

Keywords: Port terminals, Organizational management, Bibliometric analysis, Logistics, Maritime research.

Sumário

Este estudo apresenta uma análise bibliométrica da pesquisa científica sobre gestão organizacional em terminais portuários, com o objetivo de identificar as principais tendências, autores prolíficos, países líderes, periódicos-chave e tópicos de pesquisa em evolução nessa área. Utilizando o Scopus como base de dados principal e o VOSviewer para visualização de dados, o estudo analisa 60 documentos relevantes publicados entre 2015 e 2023. Os resultados revelam um interesse crescente em tópicos como eficiência logística, desempenho portuário, transformação digital e sustentabilidade nas operações de terminais portuários. A análise também destaca a predominância de determinadas regiões na produção científica e o surgimento de colaborações interdisciplinares. Esta visão geral bibliométrica fornece insights valiosos para pesquisadores, formuladores de políticas e profissionais interessados no desenvolvimento de uma gestão de terminais portuários eficiente e competitiva.

Palavras-chave: Terminais portuários, Gestão organizacional, Análise bibliométrica, Logística, Pesquisa marítima.

Introduction

Ports have historically been recognized as fundamental strategic nodes in the global supply chain, acting not only as connection points between continents and countries, but also as key hubs for economic, cultural and social activity in nearby communities (Apolinario & Guevara 2021). According to Molina (2018), the shipping industry is the backbone on which most of the world's trade is based, a statement that underscores the central importance of ports in global trade. In recent decades, ports have undergone several significant transformations, especially around automation and digitalization of services provided by both small and medium-sized enterprises (SMEs) and large corporations within the port logistics environment (Gerlitz & Meyer, 2021). This process of change has not only affected operational efficiency but has also redefined competitiveness in a sector that now faces new dynamics and challenges (Munim & Saeed 2019). As ports enter their fifth phase of evolution, it becomes clear that the era of ports dependent on physical documentation and manual processes is behind us (Esmer et al., 2016). This transition marks a crucial step forward in the modernization of the sector, which has evolved from local integration of terminals and ports, through regional collaboration between cities and ports, to global integration in which ports and terminals operate in a coordinated manner within an interconnected global supply chain (Notteboom, 2020). This process not only reflects progress in terms of physical infrastructure, but also the transformative

impact of technology, which enables ports to offer faster, more efficient and accessible services on a global scale (Bonamigo et al., 2023).

In this context, the technological implementation of port logistics as an essential component of supply chain management (SCM) is an indispensable development. However, a relevant obstacle remains investment capacity, particularly for SMEs, which often face limitations in their operating capital, restricting their ability to adopt technological innovations in emerging logistics models (De la Peña 2020). This challenge is reflected in studies such as those by De la Peña et al. (2020) and Kapkaeva et al. (2021) who highlight the competitive disadvantage of small firms compared to their larger competitors, who have the resources to invest in new technologies. The transition to more sophisticated logistics models can generate a significant gap between companies that manage to adapt quickly to automation and digitization, and those that cannot, putting at risk their competitiveness in an industry that demands adaptability and efficiency (Guerrero et al., 2024). Another critical aspect that affects the efficiency of logistics within the port sector is the lack of effective communication between the different participants in the supply chain-suppliers, distributors, retailers and consumers-a factor that, as other studies point out, can generate inefficiencies in the flow of logistics activities and affect the quality of services offered to customers (Notteboom, 2020). In a globalized and highly interdependent context, where delivery times and accuracy are crucial for customer satisfaction, any failure in communication can result in delays, additional costs and loss of competitiveness (Merkel & Sløk, 2019). Thus, improved inter-agency communication systems and the integration of technological platforms for information exchange are essential solutions to optimize port performance and improve the coordinate on of operations along the supply chain (Ringsberg & Lumsden 2016).

Following Esmer at al. (2006) competitive strategy model, the competitive position of a port is largely defined by two key variables: the net value perceived by customers and the control that the port exerts over its area of influence. According to Silva-Domingo (2010) and Roos & Klieman (2017) these factors are determining factors when it comes to attracting traffic and securing a stable share of the global market. Port authorities must evaluate both tangible and intangible resources, such as organizational capabilities, to make strategic decisions that ensure a long-term supply of capacity (Thai, 2015). This reflection is crucial in the strategic planning process of port authorities, as making the right decisions can mean the difference between competitiveness and obsolescence (Esmer at al., 2016).

To gain an in-depth understanding of the current state of organizational management in the port sector, bibliometric studies have established themselves as an invaluable tool for identifying research trends and emerging areas of interest over time (Pallis et al., 2024). Using methods such as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), it is possible to conduct systematic reviews and meta-analyses that provide a clear view of existing research and allow the identification of gaps in knowledge (Page et al., 2021). These studies not only help to improve decision making in port authorities and logistics companies, but also facilitate the identification of areas that require further attention, such as the integration of new technologies, sustainability in port operations, and human resource management (Munim & Saeed 2019).

In addition, the PRISMA methodology provides a robust structure for assessing the quality of the studies included in the reviews, ensuring the reliability of the results and the validity of the conclusions drawn (Leyton et al., 2023). This methodological approach not only fosters collaboration between researchers from different institutions but also promotes the creation of cooperative networks between the public and private sectors, which is essential for strengthening research in port organizational management (Martin et al., 2020). Inter-institutional cooperation contributes significantly to the development of innovative and sustainable solutions that can have a profound impact on port efficiency and competitiveness (Saragiotis 2019).

The potential Impact of this bibliometric study and literature review Is significant for the future of port organizational management research. By identifying existing knowledge gaps and providing a clearer picture of emerging trends, this type of research can generate new lines of inquiry and provide innovative solutions that improve the sustainability and efficiency of port operations (Linnenluecke et al., 2019). Strengthening cooperation between academic institutions, government agencies and the private sector can facilitate the development of public policies and business strategies that are more aligned with the sector's global challenges, such as climate change, digitization and automation of port operations, which will enhance the role of ports as key players in global trade (Seguï et al., 2016).

Materials and Methods

To provide a useful guide for academics, professionals and those responsible for strategic and organizational management in the port sector, an exploratory qualitative approach study was carried out under the design of a bibliometric analysis (Leyton et al., 2023). This approach is considered a comprehensive tool that allows the evaluation of scientific activity, identifying key indicators that mainly measure the quality, production and impact of existing research (García & García, 2021). In addition, it facilitates the analysis of current trends in research to define emerging and fundamental thematic priorities for the near future (Diniz et al., 2024). The bibliometric analysis was performed following the guidelines of the PRISMA 2020 international statement for literature review (Linnenluecke et al., 2019). The admissibility criteria are a central piece in the systematic review, as they ensure the quality and robustness of the findings, contributing to the transparency and reproducibility of scientific research (Puspitawati, 2014). These criteria specify how the limits of inclusion and exclusion of studies are established, ensuring that the selected articles are relevant to the port sector subject matter (Page et al., 2021). The rigorous application of these criteria is essential to avoid bias and ensure that the results obtained are representative and valid (Snyder 2019).

All studies that met the initial conditions of the literature review were included, covering variables such as type of study, topic, research objectives, management, quality and organizational strategies in the port sector (Sousa et al., 2020). The review also considered key aspects for the training of future engineers in the sector, particularly those essential skills such as critical thinking, teamwork and communication (Landaburu et al., 2023). These skills are fundamental to lead and carry out innovations within the port field, being determining factors for the sustainable and competitive development of port infrastructures (Samanés et al., 2019). By establishing these criteria, a comprehensive review is sought that integrates both theoretical and applied studies,

providing a solid basis for future research and improvements in port management (O'Connor et al., 2023). The exclusion criteria allow clear limits to be established as to which studies should not be considered for the review. In this case, articles were excluded in three phases: (1) duplicate author records within each database were eliminated; (2) papers whose publication date was prior to 2013 were excluded, thus ensuring that only relevant and up-to-date studies in the contemporary context were included; and (3) those articles for which the full text was not available were discarded, a crucial aspect to ensure the quality and accessibility of information in the analysis. This meticulous process ensures that the results of the review are unbiased and representative of the current state of research in the port sector (Linnenluecke et al., 2019).

The literature review process in this study was conducted comprehensively using multiple secondary sources of information. Mainly scientific databases were selected, such as Scopus, which offers peer-reviewed literature and has tools for monitoring the analysis and visualization of research, with emphasis on areas such as business management, human resources, logistics and transportation (FECYT, n. d.). In addition, a multidisciplinary database created by Digital Science was incorporated, which is free and covers a wide range of knowledge fields (University of Navarra, 2018). This combination of sources ensures that the analysis has a comprehensive view of port management research, considering both academic and professional approaches. The search strategy was designed to cover all relevant databases and ensure an exhaustive compilation of the scientific production. The search criteria in the Scopus database were as follows: Scopus search criteria: (TITLE-ABS-KEY ((("port sector" AND "organizational capacity") OR ("port sector" AND "organizational strategies") OR ("port sector" AND "management")) OR TITLE-ABS-KEY (((("port sector" AND "management") OR ("port sector" AND "organizational capacity") OR ("port sector" AND "organizational strategies")))). Similarly, the same search formula was used in the Dimensions database to ensure the collection of relevant articles from diverse sources of academic information. This highly structured search strategy ensures that the selected studies cover a wide range of topics related to organizational management in the port sector.

By applying the two search equations, a total of 110 records were obtained, which were extracted and stored in Microsoft Excel® and Jamovi® spreadsheet files. Subsequently, the previously defined exclusion criteria were applied to refine the results. As a next step, the VOS Viewer tool was used to build and visualize bibliometric networks, considering journals, authors or individual publications to create citation networks, bibliographic coupling, co-citation or co-authorship, as well as co-occurrence networks of important terms in the sector (Arévalo, 2020). This methodology not only allows visualizing the evolution of research in the field but also facilitates the identification of emerging areas and key researchers, which is crucial to guide future research in the port field. For the article selection process, following the elements established in the PRISMA 2020 statement, the research authors worked autonomously applying the search strategy and exclusion criteria. Subsequently, the differences found were established in consensus, to agree on which papers should be selected (Riera, 2023). A total of 40 records were used to analyze the information in this scientific article. Indicators were found that show the behavior of the

publications of scientific productions by: years, authors, languages, areas and countries. A comprehensive quantitative and descriptive analysis was conducted through the use of Excel, Jamovi, and VOSviewer software, focusing on 40 records of scientific publications in the field of port management. This review includes an examination of document types, publication frequency, and the networks of authors and keywords.

Results y Discussion

Publications by Type of Document and Year

The analysis revealed that the documents studied are primarily categorized as articles, conference papers, and reviews, as shown in Table 1. The publication frequency for each document type from 2013 to 2024 is as follows:

Table 1. *Publications by Type of Document and Year*

Type of Documents	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total Publications
Article	2	2	1	4	3	3	4	5	4	2	2	3	35
Conference Paper	0	0	0	0	0	0	1	2	0	0	0	0	3
Review	0	0	0	0	0	0	1	0	0	1	0	0	2
Total	2	2	1	4	3	3	5	5	4	3	4	4	40

Source: own elaboration.

The analysis reveals a notable increase in publications during 2019 and 2020, particularly within the realm of port sector research. This pattern signifies heightened academic interest and relevance during these years, possibly linked to emerging trends or crises, such as global economic shifts or environmental concerns in port operations.

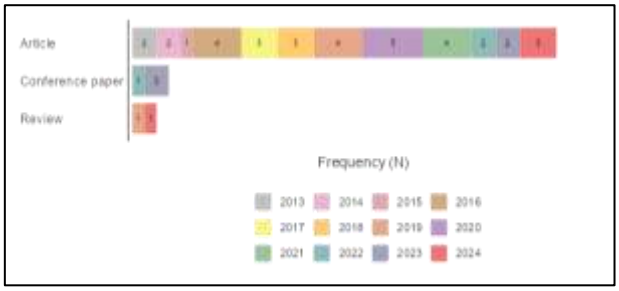

Figure 1: *Illustrates the annual distribution of document types, confirming the peak years of publication.*

The analysis also identified the primary language of publication. The distribution across languages shows that English is the predominant language, followed by Spanish and Portuguese.

Table 2. *Publications by Language*

Type of Documents	English	Portuguese	Spanish	Total Publications
Article	29	2	4	35
Conference Paper	1		2	3
Review	2			2
Total	32	2	6	40

Source: own elaboration

The fact that most of the research is published in English aligns with the global nature of the port and logistics industries, which primarily operate in English-dominated academic and professional spheres. Citation analysis is crucial for understanding the intellectual structure and evolution of the field. In this review, three citation patterns were explored: (1) Co-citation: Examines how frequently two articles are cited together, reflecting thematic connections; (2) Bibliographic Coupling identifies articles that reference a common set of documents, showing shared scholarly influence; and, Direct Citations tracks how often an article or author is cited directly, providing insight into their impact. The citation network by author allows the identification of the most influential contributors within the field of port organizational management and helps visualize the connections between different authors through mutual citations. To this end, four authors per article were considered, with a minimum of one document per author. With these two criteria, VOSViewer identified 70 authors. As seen in Figure 2, the most cited authors in the scientific production of this field include Acciaro et al. (2014) and Sdoukopoulos et al. (2019).

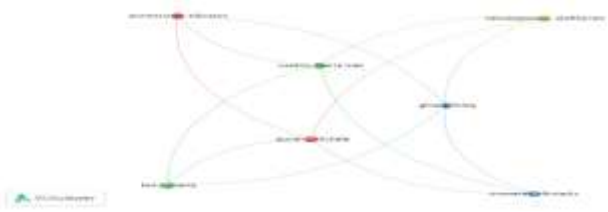

Figure 2: *Appointment Network by Country*

One of the critical strategies port authorities must consider ensuring the sustainability and efficiency of port operations is energy management (Acciaro et al., 2014). This strategy requires not only detailed planning and coordination but also aligns economic activities within the port ecosystem. Prioritizing energy efficiency allows ports to optimize their operations, increase profits, and strengthen their competitive position in a highly dynamic global market. European port authorities have identified energy consumption as the second most critical environmental priority, prompting the adoption of innovative policy frameworks. These include implementing operational practices and investing in cutting-edge technologies to achieve energy savings and enhance energy performance (Sdoukopoulos et al., 2019). Recent empirical studies reinforce the economic and operational benefits of energy efficiency in ports. For example, ports implementing renewable energy sources, such as wind or solar energy, have reported cost savings of up to 20% annually, while simultaneously reducing their carbon footprint (Merino et al., 2022). The integration of Internet of Things (IoT) technologies further transforms asset management, allowing ports to operate more sustainably and efficiently. IoT-based systems, supported by robust communication infrastructures and data analytics, enable real-time decision-making that enhances customer satisfaction and reduces downtime, thereby fostering a more competitive and resilient port sector (Merino et al., 2022).

Port tariffs play a pivotal role in determining the economic competitiveness of a country, particularly in regions reliant on international trade. Efficient tariff structures ensure that port services remain attractive to global shipping lines while fostering national economic growth. There is an urgent need to review and adapt port tariffs to address inefficiencies, particularly in regions like Brazil, where outdated or inconsistent tariffs hinder competitiveness (Andriotti et al., 2021). Empirical evidence underscores the importance of balancing tariffs to attract higher cargo volumes while

maintaining profitability. Studies in Latin America reveal that ports with adaptive tariff frameworks have achieved increased cargo throughput, enabling them to capture a larger share of global trade (Sousa et al., 2020). Competitive tariff systems also incentivize investments in modern infrastructure and technology, which enhance port efficiency and reduce operational costs. The linkage between port tariffs and the broader logistics chain is significant. High tariffs can cascade into increased transportation costs, reducing the cost-effectiveness of exported goods and diminishing competitiveness in international markets (González et al., 2020). Conversely, ports that optimize tariffs create ripple effects throughout the economy, enhancing the competitiveness of local industries and increasing their appeal as logistics hubs.

Case studies in Asia and Europe demonstrate that ports implementing dynamic tariff models—adjusted based on cargo type, volume, and market conditions—have experienced measurable benefits. For example, ports that offer discounts for bulk shipments or prioritize eco-friendly vessels have attracted sustainable business practices and reduced environmental impact (Merkel & Sløk, 2019). Additionally, the introduction of digital tools to manage tariff structures has streamlined administrative processes and improved transparency, fostering trust among stakeholders. Proactive management approaches, which transition ports from passive infrastructure owners to active facilitators of activities and services, are crucial for long-term sustainability. This involves fostering collaboration with stakeholders, digitizing operations, and adopting systematic management practices to enhance overall performance and service quality (Bautista et al., 2021). For example, ports that integrate risk management frameworks and implement advanced monitoring technologies have demonstrated reduced reaction times to potential threats, thereby ensuring the protection of critical infrastructure (González-Gutiérrez et al., 2022).

A comparative study of Indonesian ports underscores the Importance of public-private partnerships and robust legal frameworks in achieving efficient and competitive operations (Puspitawati, 2014). Similarly, studies in Europe reveal that strategic planning and reduced dependence on government policies are vital to operational efficiency and cost reduction, which are key determinants of a port's long-term sustainability (Caldeirinha et al., 2017). Gender diversity in port management remains an underexplored yet critical aspect of achieving equitable and efficient organizational structures. Despite the increasing global emphasis on gender inclusion, the maritime industry, including port management, continues to exhibit significant gender imbalances, particularly in leadership roles (Halimah et al., 2019). Cultural preferences, entrenched gender stereotypes, and limited access to mentorship programs often create barriers for women aspiring to management positions.

The benefits of greater gender diversity in port management are well-documented. Studies have shown that organizations with more gender-diverse leadership teams tend to exhibit stronger financial performance, enhanced innovation, and improved decision-making processes (Ahmad et al., 2020). Diverse teams bring varied perspectives, which are essential for tackling complex challenges and fostering creativity. Strategies to promote gender diversity include implementing policies that actively encourage the recruitment and retention of women in maritime professions, offering flexible work arrangements, and

creating mentorship and leadership development programs specifically tailored for women. Establishing gender quotas in leadership positions and fostering a culture of inclusivity through training and awareness programs can further help dismantle structural barriers (Jiang et al., 2021).

Case studies from countries like Norway and New Zealand, where gender inclusion policies have been effectively implemented, provide valuable insights. For example, the Port of Auckland's initiatives to promote gender diversity include equal pay policies, gender-balanced recruitment practices, and career development workshops targeting women in the maritime sector. Similarly, Norwegian ports have introduced mentorship programs and leadership training aimed at increasing female representation in decision-making roles. Collaborative efforts between industry stakeholders, government bodies, and educational institutions are crucial for driving sustainable change. Encouraging young women to pursue careers in maritime through targeted outreach programs and scholarships can build a pipeline of talent, ensuring a more gender-balanced future for port management. By addressing these challenges, the industry can unlock untapped potential, foster innovation, and achieve a more inclusive and sustainable operational framework.

Environmental priorities for ports, as highlighted in Ecoports environmental reports, include air quality, noise reduction, and energy efficiency (Boljat et al., 2020). Ports adopting circular economy principles can become innovation hubs, attracting new industries and optimizing resource use (Jugovic et al., 2022). For example, the implementation of wastewater treatment systems and stricter ballast water controls has proven effective in mitigating environmental impacts (García et al., 2021). Furthermore, the integration of Key Performance Indicators (KPIs) enables a comprehensive analysis of operational performance and environmental sustainability (Samanés et al., 2019). Environmental Performance Indicators (EPIs) are increasingly used to assess inland port performance. These include management indicators (policies and practices), operational indicators (carbon footprint, water consumption), and condition indicators (air and water quality) (Seguí et al., 2016). Ports that incorporate climate adaptation strategies, such as infrastructure rehabilitation and improved drainage systems, demonstrate greater resilience to climate-related risks (Sharaan et al., 2024).

The integration of smart and green port concepts has emerged as a transformative approach to modernizing port operations while addressing environmental and economic challenges. Smart ports leverage advanced technologies, such as the Internet of Things (IoT), artificial intelligence (AI), blockchain, and big data analytics, to streamline operations, improve efficiency, and enhance decision-making processes. These technologies enable real-time tracking of cargo, predictive maintenance of port equipment, and optimized resource allocation, significantly reducing operational costs and minimizing delays (Wang et al., 2024). Green ports, on the other hand, focus on implementing sustainable practices to reduce environmental impacts and promote eco-friendly operations. This includes the adoption of renewable energy sources, electrification of port machinery, implementation of shore-to-ship power systems, and development of carbon-neutral logistics chains. By prioritizing environmental sustainability, green ports not only reduce their carbon footprint but also align with global sustainability goals, attracting

environmentally conscious stakeholders (Jugovic et al., 2022).

The convergence of smart and green port strategies has resulted in innovative solutions such as smart grids, automated cargo handling systems, and integrated environmental monitoring platforms. For instance, the Port of Rotterdam has become a leading example of this integration by deploying digital twin technology to simulate port operations, optimize logistics, and minimize environmental impacts. Similarly, the Port of Los Angeles has implemented clean energy initiatives and AI-driven tools to manage emissions, showcasing the potential of these dual strategies to achieve operational excellence and sustainability. By fostering collaboration among stakeholders, investing in research and development, and creating supportive regulatory frameworks, ports can successfully integrate smart and green concepts. This not only enhances their competitive edge but also positions them as leaders in the global transition toward sustainable and intelligent port ecosystems.

The adoption of Business Process Management (BPM) systems has significantly enhanced port efficiency by optimizing processes, facilitating decision-making, and fostering continuous improvement (Saragiotis, 2019). For instance, the use of Data Envelopment Analysis (DEA) has emerged as an effective tool for performance evaluation, enabling ports to benchmark their operations and identify areas for improvement (Pedersini et al., 2022). The network of citations by country allows us to visualize and understand how the different scientific productions contribute to the scientific literature in the context of port organizational management, with an international collaboration analyzing the metrics and their impacts. Acciaro et al. (2013) that has the greatest citation force in the scientific field, in addition to identifying opportunities for collaboration and understanding the geographical distribution of knowledge in the academic community. Where 26 countries are involved in scientific productions on the subject of the port sector such as: Germany, Australia, Belgium, Brazil, China, Colombia, Croatia, Croatia, Denmark, Ecuador, Egypt, Slovenia, Spain, the United States, Greece, Indonesia, Ireland, Italy, Malaysia, Norway, the Netherlands, Portugal, Singapore, the United Kingdom and Sri Lanka, Sweden and Turkey; only 3 of them have a higher total binding strength, these are: Belgium, Ireland and the Netherlands (Page et al., 2021).

Co-authorship networks are a fundamental tool for the bibliometric analysis of port organizational management, as they offer a comprehensive view of collaborative dynamics within the field. By mapping these networks, researchers can identify influential research groups, assess the intensity of cooperation, and uncover patterns that shape the development of academic, scientific, or literary contributions. Co-authorship reflects shared intellectual contributions, mutual recognition, and the pooling of diverse expertise, making it a valuable indicator of collaboration and innovation in the field of port organizational management (Hilário et al., 2022). The co-authorship network by authors represents a critical bibliometric tool for understanding collaborative dynamics in the field of port organizational management. This network highlights the interconnections among researchers based on shared academic outputs, enabling the identification of key contributors, collaborative clusters, and thematic trends within the discipline. Co-authorship is not only a measure of intellectual synergy but also an

indicator of the interdisciplinary and cross-institutional approaches shaping the field (Hilário et al., 2022). Empirical evidence reveals that collaborative efforts among authors often lead to higher citation impacts, as they foster the integration of diverse perspectives and methodologies (Apolinario & Guevara, 2021). For instance, a prominent group of authors—Andriotti R.F., Vieira G.B.B., Sander N.E., Campagnolo R.R., and Kliemann Neto F.J.—has made significant contributions to research on port administration. Their co-cited works emphasize the economic implications of port tariffs, lease contracts, and infrastructure utilization, particularly in the context of the Brazilian port system, such as the Port of Rio de Janeiro. This research underscores how lease agreements play a pivotal role in the financial sustainability of port authorities, offering insights into optimizing revenue streams and operational efficiency (Apolinario & Guevara, 2021).

Figure 3: *Co-authorship Network by Authors*

Similarly, the collaboration of Acciaro, Ghiara, and Cusano demonstrates a strong research focus on sustainability and innovation within the port sector. Their works, which have garnered a substantial number of citations, delve into the integration of renewable energy sources, digital transformation, and green logistics as critical factors driving the modernization of port operations. These findings highlight the strategic importance of aligning port activities with global sustainability goals, reinforcing the competitive advantage of environmentally conscious ports (Acciaro et al., 2014). The visualization of co-authorship networks, as illustrated in Figure 3, provides a valuable framework for detecting influential research clusters and emerging themes. This knowledge can inform future research priorities, facilitate targeted funding allocation, and foster collaborative initiatives among academia, industry, and policymakers. The co-authorship network by country serves as an essential tool for mapping international collaboration in port research, revealing patterns of knowledge exchange and regional specialization. This analysis allows for the evaluation of each country's influence based on metrics such as degree centrality, betweenness centrality, and proximity. By examining these metrics, it is possible to identify countries that act as hubs of innovation and collaboration in the global port sector (Leyton et al., 2023).

Figure 4: Co-authorship Network by Country

Empirical data, as presented in Figure 4, highlights Spain as the leading country in collaborative port research, with ten publications reflecting a strong tradition of academic and industrial partnerships. Spain's prominence is attributed to its robust maritime infrastructure and its role as a gateway for trade between Europe, Africa, and Latin America. Brazil follows closely with nine documents,

reflecting its strategic position as a key player in South American trade routes and its growing investment in port modernization initiatives. Other countries, such as the United Kingdom, Belgium, China, Croatia, Ecuador, Egypt, Ireland, and Malaysia, contribute significantly to the global research landscape, albeit with a smaller volume of publications. For example, collaborative studies between European and Asian researchers have explored the application of smart port technologies and digital transformation strategies, emphasizing the importance of global knowledge sharing in addressing complex challenges such as climate change, supply chain disruptions, and geopolitical tensions (Jugovic et al., 2022).

Notably, Ecuador's inclusion in the network indicates a growing interest in port research within the context of Latin American trade dynamics. Collaborative efforts with countries like Spain and Brazil are paving the way for studies on regional competitiveness, regulatory frameworks, and sustainable development in the Ecuadorian port sector. This underscores the potential for leveraging international partnerships to drive innovation and capacity-building in emerging economies. By fostering transnational collaborations, co-authorship networks contribute to the advancement of scientific knowledge, the dissemination of best practices, and the formulation of evidence-based policies. This not only enhances the academic impact of research but also ensures its relevance to real-world challenges in the port and logistics sectors.

The keyword co-occurrence network is a valuable analytical tool used to examine relationships between key concepts in port organizational management. This visualization helps identify thematic clusters and emerging research trends, enhancing the understanding of interrelated topics. In this study, prominent keywords include "management," "port management," "strategies," "organizational capacity," "logistics," "sustainability," "technology," and "port sector." Additionally, secondary keywords such as "port performance," "port strategy," "efficiency," "environmental management," and "maritime industry" emerged as significant themes, reinforcing the multidisciplinary nature of port studies (Figure 5).

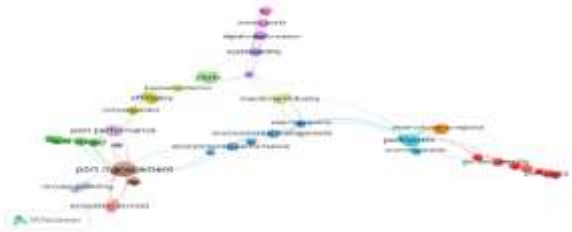

Figure 5: Keyword co-occurrence network

This bibliometric study shows that port organizational management faces multiple challenges today, including increasing global competition, sustainability, technological innovation, staff motivation and corporate social responsibility. In this context, port efficiency depends not only on infrastructure and technology, but also on the ability of ports to adapt to market demands and international regulatory changes. As international trade expands and cargo volumes increase, the ability of ports to operate efficiently and sustainably becomes a determining factor in the competitiveness of national economies. In this regard, the literature reviewed highlights the need for advanced management strategies to balance economic growth with environmental and social responsibility. Roos & Kliemann (2017) and Acciaro et al. (2013) evidence that the exclusion of economic factors in the measurement of environmental performance limits the ability of ports to efficiently manage

sustainability. Furthermore, they highlight how energy management in European ports such as Hamburg and Genoa have advanced through the use of innovative technologies such as shore power and alternative fuels, which significantly reduce carbon emissions and the environmental impact of port operations.

In this regard, the need to adapt port operations to more stringent environmental standards is imminent, considering the growing number of international regulations on emissions and energy efficiency, such as the provisions of the International Maritime Organization (IMO). Failure to integrate these criteria into port management can negatively affect the long-term competitiveness and sustainability of ports. From a strategic perspective, Esmer et al. (2016) and O'Connor et al. (2023) argue that port competitiveness should not be analyzed solely from an economic or methodological perspective, but should consider intangible factors such as the perception of service quality, operational efficiency and the ability of ports to innovate in their business models. In this sense, long-term strategic planning is essential to ensure efficient and resilient operations in the face of global trade fluctuations. The findings of these studies suggest that ports must develop critical capabilities to remain competitive, which involves modernizing infrastructure, optimizing logistics processes, and adopting advanced technologies. On this point, Gerrero et al. (2024) and Bonamigo et al. (2023) highlight the fundamental role of digitization, Big Data and artificial intelligence in the transformation of ports towards the **smart ports** model, within the framework of Industry 4.0.

The concept of **Lean 4.0**, linked to the circular economy, is presented as a key strategy to optimize port sustainability. The application of these principles allows the reduction of resource waste, improvement in energy efficiency and optimization of logistics processes, fundamental elements for the competitiveness of the sector in an environment of increasing environmental and regulatory pressure. The management of climate impacts in port operations is another of the fundamental issues addressed in the literature. Azarkamand et al. (2020), O'Keeffe et al. (2020) and Beškovnik & Bajec (2015) warn about the vulnerability of ports to extreme climate events and the need to implement mitigation and adaptation strategies. Key measures include the reduction of carbon footprint, the implementation of resilient infrastructure and the adoption of low-emission technologies. Corporate Social Responsibility (CSR) has also taken on a central role in port sustainability. Ports must not only minimize their environmental impact, but also contribute to the social development of the communities in which they operate. This involves creating labor inclusion programs, improving working conditions and promoting ethical and sustainable business practices.

From an organizational perspective, Andrade et al. (2023) and Flores et al. (2023) agree that human capital is a determining factor in the operational efficiency of ports. Staff motivation and talent management directly influence productivity and service quality. In this sense, worker empowerment and continuous training are essential strategies to strengthen the commitment of human talent and improve organizational performance. Somensi et al. (2017) and Diniz et al. (2024) complement this view by noting that the lack of alignment between management practices and strategic objectives can negatively affect port performance. They further discuss how the maritime sector is aligning its operations with

the **Sustainable Development Goals (SDGs)**, highlighting the importance of adopting coordinated strategies to improve the efficiency and sustainability of the port sector. This bibliometric study has been strengthened by data triangulation, which has allowed validation of the findings through different sources and methodological approaches. The combination of case studies, statistical analyses and systematic reviews has allowed for a more robust assessment of trends and challenges in port management. The use of empirical sources that address different dimensions of the sector-from sustainability and digitalization to competitiveness and talent management-allows for a holistic view that contributes significantly to knowledge in this field. This approach ensures that the findings are not only relevant in the present but also serve as a basis for future research.

The analysis conducted highlights that port management today is facing a profound transformation driven by digitization, sustainability and the need for innovative management strategies. The literature reviewed indicates that harbor needs to adopt a holistic approach combining operational efficiency, environmental management, technological innovation and human talent development. It is critical to continue to explore how digitization and automation can optimize port processes without compromising employment and sustainability. Also, the impact of environmental regulations on port competitiveness and the effectiveness of climate change mitigation strategies in the maritime sector should be further explored. Therefore, this bibliometric study provides an updated view of the challenges and opportunities in port management, as well as a solid basis for the development of new lines of research that contribute to the advancement of knowledge in this critical area for global trade.

Port organizational management must continually improve environmental performance assessment techniques. To this end, efficient port administration must integrate both technical and economic considerations in environmental management decision-making. In this context, innovation aimed at increasing energy efficiency and strengthening port competitiveness becomes strategically relevant in an environment of growing environmental awareness (Acciaro et al., 2014; Roos & Kliemann, 2017; Andrade et al., 2018). This analysis suggests that strategic management should focus on both tangible resources, such as physical capacity, as well as organizational and intangible capabilities, to ensure an adequate supply of capacity in the future (Esmer et al., 2016); O'Connor et al., 2023). The literature supports that the development of organizational competencies enables better adaptation to structural and regulatory changes, contributing to a more resilient and sustainable management.

In this sense, the introduction of new technologies emerges as a central axis for the optimization of port management. While technological progress improves operational efficiency, it also poses challenges in terms of organizational adaptation and real-time data management. The implementation of Lean strategies in ports can facilitate the identification and reduction of waste, foster innovation and develop a culture of continuous improvement, aligned with sustainability objectives (Gerrero et al., 2024; Bonamigo et al., 2023). Ports must also adapt to changing climatic conditions to protect both their infrastructure and nearby communities. This highlights the need for increased climate change awareness and preparedness among port

managers (Azarkamand et al., 2020; O'Keeffe et al., 2020; Beškovnik & Bajec, 2015). Climate mitigation and adaptation strategies should be integrated into port planning, ensuring resilience to extreme events and minimizing environmental impacts.

Likewise, the study concludes that organizational motivation is a key factor in increasing employee engagement and improving the management of productive resources, which directly contributes to the achievement of strategic objectives. Labor empowerment encourages the active participation of workers in decision making, thus optimizing organizational performance (Andrade et al., 2023; Flores et al., 2023). Finally, the gap between theory and practice in port performance evaluation underscores the need for further research and alignment in the implementation of performance indicators adapted to operational realities. This suggests that sustainability is consolidating as a central axis in port management. Despite progress, challenges persist in the effective integration of the Sustainable Development Goals (SDGs) in port operations, evidencing the need for strategic policies and interdisciplinary collaborative initiatives to move towards greater sustainability (Somnensi, 2016; Diniz et al., 2024).

Conclusiones

Ports are at the core of global trade and economic development, yet they face pressing challenges, including sustainability, competition, and technological innovation. The transition towards smart, sustainable ports requires a multidimensional approach, integrating environmental, technological, and managerial strategies. The implementation of innovative technologies—such as automation, digitalization, and artificial intelligence (AI)—is crucial for enhancing operational efficiency and global competitiveness. However, despite advancements in these areas, many ports still struggle to fully incorporate sustainability into their core operations. A key challenge is the integration of sustainable practices without compromising economic viability. Digitalization, Big Data, and AI play a transformative role in optimizing port logistics, predictive maintenance, and real-time decision-making, reducing inefficiencies and minimizing environmental footprints. Ports adopting AI-driven management systems can achieve significant reductions in fuel consumption, emissions, and operational delays. Nevertheless, the gap between technology adoption and effective implementation remains, requiring further research on scalability and cost-effectiveness in different port contexts.

Climate change exacerbates vulnerabilities in port infrastructure, making resilience planning a priority. Rising sea levels, extreme weather events, and shifting trade routes necessitate robust climate adaptation strategies. Carbon footprint reduction, through the use of alternative fuels, shore power, and green corridors, is essential for ports seeking to align with international sustainability frameworks such as the Sustainable Development Goals (SDGs) and the International Maritime Organization's (IMO) decarbonization targets. Furthermore, corporate social responsibility (CSR) is becoming a key pillar in sustainable port management, promoting stakeholder engagement, social inclusion, and environmental stewardship. Employee motivation and empowerment also play a crucial role in improving port management and ensuring the successful implementation of sustainable practices. Human capital development, through continuous training and technological literacy programs, enhances

workforce adaptability to digital transformations and sustainability initiatives. A highly engaged workforce contributes to increased operational efficiency and fosters a culture of innovation, which is vital for meeting strategic port objectives.

Future research should delve deeper into the correlation between environmental management practices and port performance indicators, particularly in refining evaluation methodologies for sustainability metrics. Moreover, further investigation is needed into the role of AI, Big Data, and blockchain in port operations, particularly in predictive analytics, supply chain transparency, and security. Climate adaptation strategies should also be explored in more detail, focusing on resilient infrastructure, risk assessment models, and socio-economic preparedness of surrounding communities. Additionally, addressing the existing gaps in SDG integration within port operations requires interdisciplinary collaboration and strategic policy design, ensuring that ports become key facilitators of global sustainability objectives. This comprehensive approach will pave the way for ports that are not only economically efficient but also environmentally responsible and technologically advanced, contributing to the long-term resilience and competitiveness of global maritime trade.

Acknowledgements

Peer review is an essential component in the production of scientific knowledge. The authors recognize the importance of this process and thank the reviewers for their commitment to academic excellence.

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