

Review

Exploring Port–City Relationships: A Bibliometric and Content Analysis

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Abstract: Planning for port development presents a complex challenge. Along with fostering cooperation and economic synergies, port development also necessitates careful balancing with existing city functions. Previous research on port–city relationships (PCRs) has yielded valuable insights, but a comprehensive systematic and bibliometric review to identify future research directions is lacking. Moreover, existing research in this field has not addressed the need for a comprehensive classification of content, methods, and driving forces. This study addresses these gaps by analyzing 113 academic articles published on PCRs between 2000 and 2023. Using a bibliometric approach, this study leverages the JavaScript programming language, VOSviewer 1.6.20 software, and the Scopus database. This paper aims to identify key research areas and influential studies within the field of PCRs. This analysis reveals emerging research topics and themes within PCRs. Additionally, it depicts which research countries, journals, and keywords are the most prominent with regard to this field, outlining the relationships between them. This study’s findings provide valuable insights into the current state of PCR research, including geographical distribution, publication trends, methodological approaches, and key research variables.

Keywords: port; city; port–city relationships; bibliometric analysis; content analysis



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1. Introduction

Throughout history, port cities have emerged as prime locations for the establishment and flourishing of commercial and trade centers. This phenomenon is directly attributable to the prosperity generated by maritime trade [1–3]. Port cities’ dominance in commerce stems from their strategic location at the crossroads of regional and global trade routes. They act as gateways for goods, facilitating exchange and development, and have been instrumental in the evolution of global supply chains [4]. The establishment of a powerful port city can foster the development of polycentric urban regions, which are characterized by multiple urban centers within a larger metropolitan area. These regions can then evolve into cooperative metropolitan networks. Such cooperation facilitates economies of scale and fosters synergy between the port city and its surrounding hinterland cities [5].

The concept of cooperative metropolitan networks emanating from powerful port cities is exemplified worldwide. For instance, the development of the Guangzhou–Shenzhen metropolitan region in China can be traced back to the growth of Hong Kong as a major port [6]. Similarly, a prime example of such synergy within Europe is the Randstad region in The Netherlands. This polycentric urban region, anchored by the major ports of Rotterdam and Amsterdam, exemplifies the cooperative network fostered by a powerful port city [5,7,8].

Port cities have long been recognized as vital components for economic and cultural prosperity. The relationship between the port and the city fosters a mutually beneficial cycle, where the success of one is intrinsically tied to the other [9,10]. Traditionally, port

cities were viewed as inseparable entities, with their growth and development being intertwined [11]. However, recent research suggests a shift in this paradigm [12]. Hoyle [13] introduced a functional perspective on port–city relationships (PCRs), highlighting the intermediate space between port operations and urban centers. This space can foster cooperation and harmony, but it can also lead to conflict. As the interface between a city and a port evolves, several factors can contribute to the decline of a port while the city itself continues to develop (or vice versa). These factors include limitations on land availability for port infrastructure expansion, restricted access to deep water for accommodating larger vessels, increasing traffic congestion, rising costs due to infrastructure strain, and growing environmental concerns [14]. Paradoxically, port decline can sometimes act as a catalyst for urban prosperity. This decline can trigger the revitalization of derelict waterfront areas, unlocking their potential to create new urban value. These transformations often involve the development of mixed-use zones along the waterfront, catering to commercial, cultural, tourist, or even upscale residential needs [4,10,15,16].

While the spatial and functional separation of ports and cities may be an inevitable trend, this does not necessarily equate to decreased port efficiency. Modernized infrastructure and advanced technologies within expanding cities, often overlapping with core port areas, can play a constructive role in enhancing port performance [9]. Ideally, balanced development allows ports and cities to thrive together. Yet, globalization and the expansion of port activities have introduced greater complexity into these relationships [17]. The intricate relationship between ports and cities presents a unique challenge for researchers. The multifaceted nature of port–city issues, coupled with the historical separation between urban and port studies, has hindered the development of a unified research field [17–21]. This lack of cohesion is reflected in the absence of a universally accepted definition for a port city, with studies often referring to it simply as a point of convergence where land and maritime functions meet [22].

Despite numerous studies on various aspects of port–city relationships (PCRs), three key research gaps persist:

First, a comprehensive classification system for PCR research is lacking. This includes categorizing cited journals, top research locations, geographical scopes, research themes, methodologies, and driving forces.

Second, existing reviews (for example, refs. [23,24]) with a bibliometric and systematic approach focus primarily on environmental and sustainability aspects. Broader reviews encompassing all PCR dimensions are needed.

Third, most research relies on case studies or comparisons between a few port cities. While valuable, these approaches limit the generalizability of theories and spatial models to diverse PCR contexts.

This study aims to bridge these gaps by employing a combined bibliometric and content analysis approach to existing PCR research. These methods help identify current research trends and potential future directions in the field. Bibliometric analysis, through techniques like scientific mapping and research cluster identification, unveils the intellectual structure of the field and pinpoints burgeoning areas of inquiry. Content analysis, on the other hand, delves into the thematic evolution of PCR research, enabling a topical classification of published works. Furthermore, co-citation analysis, a key bibliometric performance indicator, enables researchers to identify the most influential journals, nations, and keywords within the field. Content analysis complements these bibliometric techniques by facilitating a literature review based on the co-occurrence of words in published texts. This allows for a deeper understanding of the field's knowledge structure and mitigates the risk of researcher bias. By applying both bibliometric and content analysis methods to PCR research and its content, this paper aims to gain a more precise understanding of current research trends and identify promising future directions for this critical field of study. The following research questions (RQs) guide this study:

RQ1: What are the most influential journals on port–city relationships?

RQ2: Which countries and geographic regions play a substantial role in the research on port–city relationships?

RQ3: What research themes are addressed in the existing articles on port–city relationships?

RQ4: How do various analytical approaches and methodologies contribute to assessing the relationship between a port and a city?

RQ5: What themes and indicators significantly influence the relations between a port and a city?

2. Methodology

This paper analyzes the current literature using bibliometrics to identify prevalent study themes and developing trends in PCRs. This analysis provides a comprehensive overview of the current research interests, potential avenues for future researchers, and a methodical map of the latest advancements in research assessing PCRs. To achieve this, a thorough assessment and methodical review of a selection of articles on PCRs published between 2000 and 2023 is conducted in this study. This timeframe encompasses a period of significant development in the field.

This research employs a systematic review methodology to collect, interpret, and integrate existing research on PCRs [25–27]. A systematic review offers a rigorous and comprehensive approach for identifying, evaluating, and synthesizing relevant research, allowing us to address a broader range of questions compared to individual studies [27,28]. The systematic review process in this study followed four key phases: data collection, data assessment, data extraction, and data analysis [29]. During data collection, we searched the Scopus database for published papers on PCRs within the timeframe of January 2000 to December 2023. We utilized the following search query: TITLE-ABS-KEY-AUTH (“Port City”) OR (“City Port”) OR (“Port-City”) OR (“Port-Cities”) OR (“Port Cities”) OR (“Sea Port City”) OR (“Seaport City”) OR (“Port Town”) OR (“Port And City Interactions”) OR (“Port And City Interface”) OR (“Port And City Relationship”) OR (“Port And City Development”) OR (“Port and City Relation”)) AND PUBYEAR > 1999 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (DOCTYPE, “ar”)). The search was conducted on 2 May 2024 and resulted in a total of 3005 items. Following data collection, the assessment phase comprised a four-step process to ensure homogeneity and consistency within the search result. In the first step, items beyond the scope of the analysis were excluded. This included publication types other than journal articles, i.e., books, conference proceedings, and doctoral dissertations ($n = 1165$), as well as publications in non-English languages ($n = 247$). After a title and abstract screening process, only 142 of the initial 1570 articles were deemed appropriate for further examination. In cases where the abstract lacked sufficient information to determine relevance, the introduction and conclusions of the paper were scanned for additional details. A final exclusion of 29 articles due to access restrictions resulted in a final sample of 113 articles being subjected to analysis in this systematic review. A flowchart outlining the article selection process is presented in Figure 1.

Open-source coding, a deductive content analysis approach, was employed to extract relevant data from the reviewed articles. This involved developing a structured spreadsheet in Microsoft Excel to capture specific information from each paper. The extracted data included details on the methodologies employed, variables investigated, geographic focuses and timeframes, and publication timelines. Following established open-source coding procedures, a two-step coding process was implemented [30]. First-order coding involved extracting codes directly from the text of the studies. These initial codes were then subjected to a process of axial coding (recoding), leading to the formation of higher-order themes (second-order coding). Finally, a third-order coding process was utilized to identify overarching categories that encompassed the identified themes [29]. For descriptive statistical visualization, content analysis software, JetBrains WebStorm 2023.3, was employed. The software utilized the JavaScript language and the d3 library to generate visualizations such as ridgelines, edge bundling, and Sankey diagrams. To ensure consistency in the

coding process, the first author conducted the content analysis. The extracted data were then synthesized, and the findings are presented in the following section. Bibliometric analysis was conducted to explore publication trends and co-authorship patterns. This involved exporting the complete bibliographic data of the analyzed documents as text files. The exported data included titles, publication dates, author names and affiliations, citation counts, keywords, abstracts, and references. VOSviewer 1.6.20 software was utilized for this analysis.

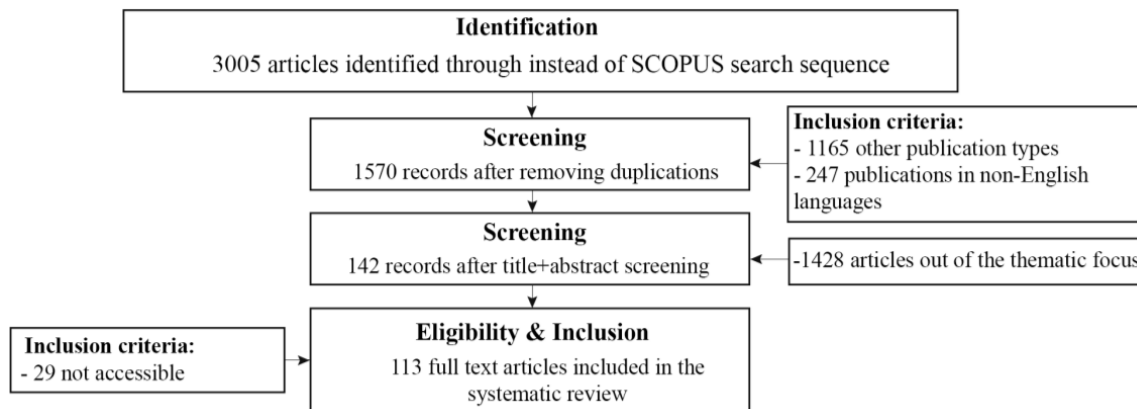


Figure 1. Summary of the systematic literature review process.

3. Results and Discussions

3.1. Descriptive Analysis

To address *RQ1* (What are the most influential journals on port–city relationships?), we conducted a citation analysis of sources as the units of analysis. The 113 articles included in this study were published in 63 different journals. The results of top-ranked journals indicate that the *Journal of Transport Geography*, *Cities*, and *Sustainability* are among the top three journals with the highest publication records on PCRs (Figure 2). The *Journal of Transport Geography* serves as a prominent venue for scholars engaged in spatial geography research pertaining to ports, as evidenced by the inclusion of 10 selected articles within its publication scope. This journal exhibits a dual emphasis, addressing various modalities of transportation while concurrently accommodating research on globally renowned ports, which are intricately linked to multiple modes of transportation, including maritime, land, rail, and air. Given this multidimensional focus, the inclination of researchers from diverse disciplinary backgrounds towards this journal is substantiated. The journal *Cities* undertakes the analysis and evaluation of contemporary and historical urban development and management, which are influenced by urban planning policies. In addition to documenting urban phenomena, it proposes strategies aimed at enhancing the efficacy of urban policy implementation processes. Similarly, the journal *Sustainability* dedicates its focus to the examination of the environmental, cultural, economic, and social sustainability concerns affecting human communities. By addressing such multidimensional sustainability challenges, it contributes to the discourse surrounding PCRs. Moreover, it is noteworthy that various other journals have also published pertinent articles within the domain of PCRs, contingent upon their specialized thematic coverage.

A review of PCR articles reveals limitations in journals and thematic scopes. Despite the vital role of port cities in economic development, global trade, and supply chains, no dedicated journals focus solely on their challenges, successes, and interactions. While research covers diverse themes, the main focus remains on transportation, logistics, physical aspects, land use, management, and environmental issues. Although socio-cultural conflicts are gaining attention, neglected areas persist, including coastal and historical-cultural tourism, analysis of port-city towns and landscapes, morphological changes and functional design, architectural adaptation to climate change, and port-city sustainability and resilience.

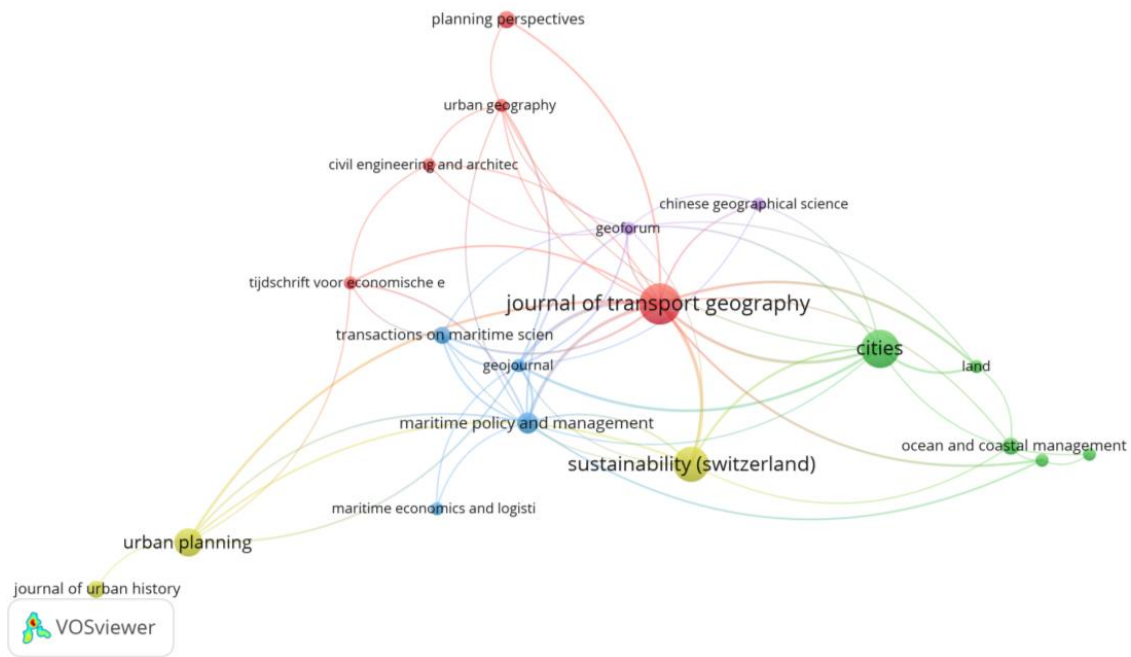


Figure 2. Map of cited sources. The minimum number of citations per source was set to 2.

To answer RQ2 (Which countries and geographic regions play a substantial role in the research on port–city relationships?), we conducted a citation analysis using countries as the unit of analysis. To investigate the geography of knowledge production, Table 1 shows that the most influential research (in terms of total link strength and the number of citations) on PCRs originated in The Netherlands. Altogether, Europe and China were the most significant contributors to the development of this research area.

Table 1. Top ten countries researching PCRs—sorted by the number of citations.

Rank	Country	Documents	Citations	Total Link Strength
1	The Netherlands	17	853	135
2	China	29	457	121
3	United Kingdom	7	428	45
4	South Korea	5	399	62
5	Singapore	7	285	65
6	Hong Kong	5	281	11
7	France	6	145	44
8	Italy	5	92	31
9	Germany	3	76	21
10	United States	5	71	25

The selection of articles reflects a geographical bias towards East and South Asia, which aligns with the distribution of the world’s largest and most active ports (e.g., Singapore, Shanghai, and Shenzhen). This is evidenced by the significant contribution (49 articles) from Chinese scholars focusing on the spatial structure of port cities in this region. Northwestern Europe, with its major ports (e.g., Rotterdam, Antwerp, Hamburg, and Klaipėda) and well-developed industrial and service sectors, also features prominently in the reviewed literature (48 articles). This focus reflects the importance of this region’s port cities. Nine articles within the reviewed literature examined the spatial structure of port cities in North and South America. The unique spatial organization of these regions, characterized by

the dispersion of dense port–city complexes (e.g., Philadelphia, Savannah, San Francisco) alongside powerful production, distribution, and consumption nodes on both the eastern and western coasts of the United States, has garnered significant scholarly interest.

To bolster the generalizability and validity of their theoretical frameworks, several scholars have employed case studies from ports across the globe. This focus on diverse geographical contexts is evident in eight of the reviewed articles, which adopted a global perspective. Five additional articles specifically examined port cities like Cape Town and Algeria, along with their associated production, distribution, and consumption networks within the broader African continent (as illustrated using ArcGIS in Figure 3). This regional focus allows for a more nuanced understanding of the spatial relationships within this specific context.

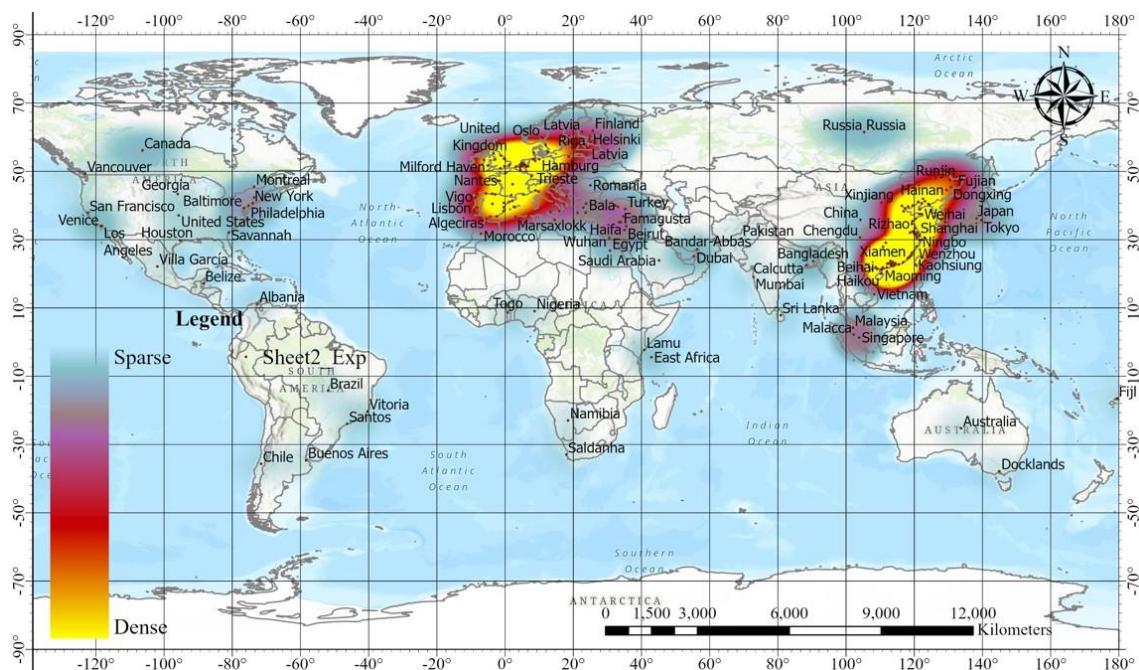


Figure 3. Geographical distribution of PCR articles.

A critical look at the spatial distribution of PCR research reveals a focus by East and Southeast Asia, the EU, and North America on analyzing port–city relations, promoting spatial development and cooperation, solving related problems, and exploring the future of port cities. However, recent years have seen prosperity in South Asian, Middle Eastern, North African, and Latin American port cities due to coastal attractions, free trade zones, industry investments, transit hubs, and tourism. This growth attracts populations and fosters physical, land-use, and spatial changes in these areas. The resulting challenges—like conflicts between container ports and tourist spaces—highlight a gap in research for these regions.

Answering RQ3 (*What research themes are addressed in the existing articles on port–city relationships?*) serves a twofold purpose. First, it establishes the existing knowledge base, preventing redundant inquiry and ensuring strategic positioning within the field. Second, by mapping themes, it facilitates the identification of potential research gaps, paving the way for novel research questions. We used keyword and co-occurrence analyses to answer this question. This involved extracting and analyzing relevant words and concepts to visualize the content of the reviewed articles on PCRs. Each article was assigned a keyword descriptor ('term') based on the terms identified within the titles and abstracts of the analyzed papers. Subsequently, science maps were generated, utilizing these keywords to explore the thematic landscape and identify prominent topics addressed within the included articles. To mitigate the potential bias of relying solely on author-assigned keywords, automatic term extraction was additionally conducted on article titles

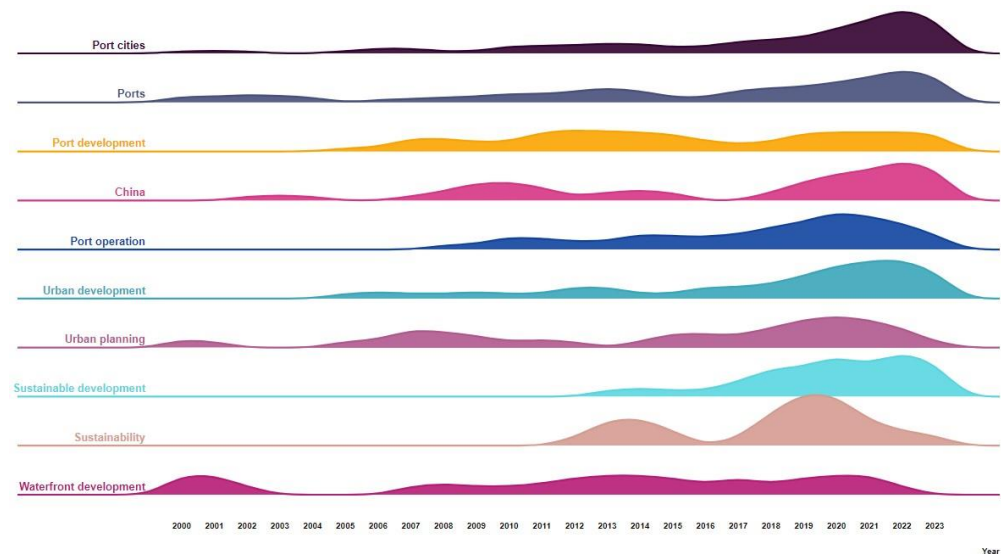


Figure 5. The most frequent keywords concerning PCR studies.

3.2. Methodological Approach

Addressing RQ4 (*How do various analytical approaches and methodologies contribute to assessing the relationship between a port and a city?*), a methodological analysis was conducted to categorize the research approaches employed within the reviewed articles. This analysis focused on three subcategories: type of methods, analytical techniques, and analytical tools. The first subcategory, type of methods, investigated the prevalence of quantitative, qualitative, or mixed-methods approaches. The findings revealed a distribution of research methods, with 44 articles (38.9%) utilizing quantitative methods, 59 articles (52.2%) employing qualitative methods, and with the remaining 10 articles (8.8%) being classified as mixed methods.

The prevalence of qualitative research methods (52.2%) within the reviewed articles highlights their growing importance in the studies on port cities over the recent two decades. This shift represents a move away from the dominance of quantitative methods and data analyses that characterized regional studies and port geography in the latter half of the 20th century. Since the start of the 21st century, researchers have increasingly embraced qualitative and mixed-methods approaches, incorporating observational and situational analyses to gain deeper insights into PCRs. This trend reflects a commitment to exploring a wider range of research questions and developing new theoretical frameworks. Table 2 and Figure 6 show that the reviewed articles demonstrate the utilization of diverse quantitative and qualitative methods and analytical techniques and approached. Notably, the exponential growth of qualitative methods since the early 21st century suggests the potential for a burgeoning methodological landscape within PCR research.

Table 2. Research methods and their applications in PCR studies.

Type of Methodology		Research Methods	References
Quantitative	Multi-Criteria Decision Analysis	DEMATEL	[31]
		Fuzzy Analytic Hierarchy Process (FAHP)	[32]
		Analytic Hierarchy Process (AHP)	[33]
		Entropy Weight Method	[34]
		Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)	[32]
		Best-Worst Method (BWM)	[32]

Table 2. Cont.

Type of Methodology	Research Methods	References	
Multi-Criteria Decision Analysis	Simple Additive Weighting (SAW)	[35,36]	
	Complex Proportional Assessment (COPRAS)	[35,36]	
	Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)	[35]	
Descriptive Statistics	Tables and Charts	[37–43]	
	Mathematical Models	[44]	
Descriptive Models	Network Analysis	[17]	
	Economic Models	[45]	
Estimation Models	Spatial Econometric Methods	[46]	
	Allometric Growth Model	[47]	
	Economic Geography Modelling	[48]	
	Quadratic Assignment Procedure	[49]	
	Super-Efficiency EBM-DEA Model	[50]	
Forecast Models	Logistic Model	[46]	
	Auto Regressive Moving Average (ARIMA)	[51]	
	Regression Analysis	[45,49,52–57]	
Assessment Methods	Cellular Automata Model	[58]	
	Dynamic Centralization Index Model	[59]	
	Coupling Coordination Degree Model	[60]	
	Synergy Degree Model	[55,61]	
	Triple Bottom Line	[31]	
	H-DEA Improved Aggregation Model	[31]	
	Panel Measurement Model	[62]	
	Data Envelopment Analysis	[63,64]	
	Super-Efficiency EBM-DEA Model	[50]	
	Evaluation Methods	In-VEST Model	[65]
Modelling and Simulations	System Dynamics	[66–70]	
Comparative Methods	Double Difference Analysis Method	[71]	
	Difference-in-Differences Regression Model	[72,73]	
	Difference-in-Differences Regression Model	[71–73]	
Situational Analysis	Case Study	[11,74–76]	
	Comparative Geographic Analysis	[77–87]	
Observational Analysis	Mapping Analysis	[88–106]	
Content Analysis	Grounded Theory	[107,108]	
	Semi-Structured Interviews	[12,109–114]	
	Deep Interviews	[110,115–117]	
	Structured Face to Face Interviews	[109,113,118]	
	Questionnaire survey and Interview	[119–121]	
	Transcribed and Coded	[23,24,122–127]	
Mixed Method	Mixed Method	Mixed Quantitative and Qualitative Methods	[9,128–136]

PCR studies leverage a wide range of methodologies to capture the multifaceted nature of PCRs. From economics and social research to transportation and environmental studies, PCRs encompass diverse fields within these key gateways for goods and people. Therefore, all three research methodologies (quantitative, qualitative, and mixed) are valuable. Reviews show that quantitative data dominate the studies focused on port efficiency, logistics, infrastructure, and economic analysis. Conversely, qualitative methods are prevalent in the research studies on historical evolution, physical changes, governance, and socio-cultural patterns. Finally, combined methods are often used for urban planning, land use, environmental concerns, and modeling port cities' resilience and sustainability.

3.3. The Study Themes: Driving Themes of PCRs

To answer RQ5 (*What themes and indicators significantly influence the relations between a port and a city?*), we performed a content analysis using 127 themes, 20 sub-themes, and 5 main themes, i.e., physical-spatial, infrastructure-support, economic, management-social, and environmental. Figure 6 shows the core result of the content analysis, including the themes driving PCRs, which are categorized into themes, sub-themes, and main themes, with the repeating codes being outlined within the papers investigated.

3.3.1. Physical-Spatial

- Strategic and Geopolitical Position of Port Cities

The geographical location of a port city [9,17,88,91,97,124,137], concerning its surrounding areas and the general topography of the region, is critical in increasing the flow of commodities through the port [122] and improving the port's function at the regional level [9]. Beyond their own development, port cities can significantly influence the formation and structure of extensive cooperative urban networks. These networks, often initiated by a central port, are evident across the globe. For instance, the expansive Guangzhou-Shenzhen-Hong Kong urban network in China finds its starting point in the massive port of Hong Kong. Similarly, in North American contexts, a clear correlation exists between the size of a metropolitan area and the scale of its associated port [33,34,47,52,57,61], as exemplified by major cities like New York and Los Angeles. It is important to note, however, that exceptions to this observed pattern exist. Some metropolitan areas, such as Rio de Janeiro and Buenos Aires, boast significant populations despite having comparatively smaller ports. These outliers highlight the need to consider additional factors beyond port size that influence the formation and development of cooperative urban networks.

- Quality of Life and Desirable Urban Planning

The confluence of several factors can trigger a period of rapid growth within a port city, which is often referred to as a "port boom" [33]. These factors include intensified ship traffic and maritime transportation activities; expansion of commercial and industrial sectors within the port and surrounding areas; a surge in import and export volumes; and an overall increase in international trade. Such a boom can significantly influence the urban morphology of a port city [122]. This impact manifests in various aspects, including the design of optimal street networks, the development of high-quality public spaces, the creation of desirable tourist destinations, and the implementation of strategic urban zoning regulations [76,133].

Furthermore, port prosperity fuels growth in civil construction [31,34,52]. This development manifests in the construction of hotels, restaurants, shopping centers, and other commercial and mixed-use buildings, along with the establishment of tourism facilities that capitalize on a port city's historical identity [17,75,81,83,96,98,111,122] and urban design heritage [23,89]. However, these environmental changes and land-use transformations within port cities [84,99,121] necessitate careful consideration when selecting an appropriate range for urban growth and development [33,59,122,126]. Striking a balance between economic opportunity and sustainable urban planning is crucial.

- **Contradiction Physical–Spatial and Integration of a Port and a City**

Beyond facilitating port growth and competitive advantage, enhanced hinterland connectivity improves accessibility for both people and cargo moving between inland cities and port regions [83]. However, port cities often face challenges such as limited land availability for urban expansion and port-induced congestion [12,118]. To strike a balance between port and urban functions, optimize land use efficiency, and establish clear demarcations between port and city areas, many port cities like Xiamen, Naples, Trieste, Rijeka, and Koper have adopted a strategic policy of “separating a port and a city” [101]. This approach is a significant strategy for managing the spatial relationship between the port and the urban center [69].

3.3.2. Infrastructure Support and Development

- **Development of Existing Facilities and Construction of New Facilities**

The development and construction of new ports and docks [37,41,45,48,52,61,66,73,75,76,83,88,90,94,95,97,99,100,102,105–107,123,124,134–137] has always been associated with customs clearance [95,133] and has played a significant role in strengthening the relationship between cities and ports. With the development of port activities [107,136], port performance (cargo loading and unloading volume) rises as well [17,46,50,65,77,84,85,91,99,107,121,122]. When a port is adequately developed, the variety of port services develops according to the port’s cargo handling capacity [33,34,47,52,57,61], container port operating capacity [31,33,34,38,46,53,61,63], and the quality of port and logistics equipment [55,59,121,122,133]. Over the recent few decades, ports have strategically positioned themselves as central transportation and trade hubs [64,118] to attract more vessels and cargo. This strategy aims to enhance the port’s overall sustainability, inventiveness, and flexibility.

- **Development of Advanced Multimodal Transportation Infrastructure in Ports**

According to Tan [84], Guo et al. [59], and Kammoun and Abdennadher [64], the interactions between ports and their surrounding areas, encompassing both hinterlands (land-based) and forelands (sea-based), can manifest in two distinct ways. One potential outcome is port-driven spatial polarization, where development and economic benefits concentrate around the port, potentially exacerbating the existing inequalities in the surrounding regions. Alternatively, these interactions can foster positive spatial synergies, leading to the establishment of a multi-centered logistics system that integrates the port with diverse hinterland and foreland centers. This integrated system leverages the advantageous location of the port city, which often serves as an economic and political hub for port development and expansion.

These advantages encompass the volume and diversity of traffic flows within the port city, including both freight (e.g., containerized goods, bulk cargo) and passenger movement [38,39,54,58]. Notably, this includes the volume of urban transportation within the city itself [34,59]. In contrast, well-managed industrial densities under port authority control can facilitate the development of transportation infrastructure that streamlines port-city interactions [64,118,122]. This includes the organization of efficient transit systems and encompasses the potential for an increase in international container shipping routes [33]. Furthermore, the interplay between port operations and access to domestic distribution centers shapes the land-use structures and spatial patterns of port cities, differentiating them from non-port cities [95,133].

- **Quantity and Quality of Transit Corridors (Rail, Road, and Air) for Interactions with Hinterlands**

Ports are acknowledged and introduced as commercial infrastructure between port and hinterland areas, and they play a vital role in global supply chains. From a national economic perspective, the growth of maritime transport activities [33] plays a significant role in facilitating international trade by generating value through advanced transportation

services. Containerization, a key contributor to this growth, encompasses two aspects: multimodal transportation and simplified goods transit. These elements not only enhance the quality of airfreight accessibility [84,88] but also improve the access to maritime transport itself [23,49,62,84,124,130]. Unlike traditional single-mode transportation, containerization allows for the strategic coordination of various goods movement options. Multimodal transportation [83,88], in particular, emerges as a crucial system where the overall efficiency surpasses the efficiency of individual components. Its core goals include integrating maritime, land, and rail transportation methods, ultimately strengthening the connections with hinterland regions. A typical example of multimodal transportation involves combining truck delivery with airfreight movement. However, initial access to airports often relies on road or rail infrastructure, depending on the specific regional context. Notably, advancements in the quality of road and rail access [34,39,58,59,70,81,83,96,98,99,102,133] have led to a wider adoption of these methods, particularly in regions like the US, Europe, and Asia.

- Development of Terminal and Warehousing Facilities and Infrastructure

The relocation of port facilities [34,39,58,59,70,81,83,96,98,99,102,133] must be carefully planned to minimize disruptions and ensure efficient performance of transportation networks and terminal productivity and efficiency. Ports are essential for facilitating commerce. To guarantee the smooth transition of contemporary container terminals and the continuous effectiveness of transportation networks, the relocation of port facilities necessitates meticulous planning that takes into account several themes, such as proximity to shipping routes, water depth, land availability, and access to transportation networks, including roads, railways, and airports. [24,63].

3.3.3. Economic

- Development of Various Types of Industrial and Production Activities in Ports and their Local Ports

The economic prosperity of a port city is often reflected in its Gross Domestic Product (GDP) [31,33,34,45,51,61,63,75] and Gross Domestic Product per Capita (GDP per Capita) [64,118,122]. This prosperity extends beyond the city limits, benefiting surrounding communities as well. The growth of a port city attracts skilled labor and investors, fueling the development of logistics, industrial activities (e.g., manufacturing, construction) [39,67,72,108,110,119,137], and the port industry itself. This leads to an increase in the share of industrial value-added [31,59] and a rise in the prominence of primary, secondary, and tertiary industries (services) within the city's economic landscape. Examples include the growth of petrochemical industries and oil companies [39,59,81,104]. To accommodate this expansion, the development of industrial areas outside the city center is often encouraged [76,136,137]. Consequently, the national and transportation sectors experience significant growth, contributing to an increase in the overall output value of the tertiary sector [59] and the added value per capita within this sector [123]. Additionally, financial incentives [133] may be implemented to improve the quality of life for the local population.

- Amount of Income, Expenditure, and Investment in Port Cities

In addition to regulating the port city's spatial layout and development strategies, economic development in the city [11,45,46,55,62,65,67,135] also directs the port to improve its service quality to continuously meet its changing needs. For instance, oil revenues [76,129] drove Dubai's early development, in contrast to Singapore's story of rapid development. Global conditions and cutting-edge global technologies align with the city port's economic growth [52,68] and the development of ports that is influenced by capital flows [17,122]. They have increased port production results and improved port performance, which resulted from the implementation of integrated territorial investments [23], investments in fixed assets throughout society [34,51,59,61,118], and by assessing the amount of domestic and foreign investments [33,34,49,81,118]. These themes eventually lead to a rise in the general budget of local financial resources [51]. In order to maintain the sustainability and efficiency of these investments, strategic planning, technological adaptability, shifting

business patterns, and environmental themes must be adequately utilized as they all impact the longevity of investments in port infrastructure [77]. These variables affect the resilience of port cities.

- Quantity and Quality of Financial Interactions and Commercial Policies of Ports

International trade [84,88,124] and commodity exchange are growing daily. Increased port activity increases urban activity, strengthening the link between ports and cities [126]. However, the bond between cities and ports has deteriorated in the recent few decades. The expansion and development of ports and transportation infrastructure, particularly the cruise ship industry [82,121], cause this weakness. The industry seeks to continuously adapt to shifting market structures and trade strategies [133], economic needs and commercial incentives [84], and the variety of commercial positions [122]. Commercial and industrial growth [33,45,51,67,93,95,96,118,119,122,137] can be based on trade policy measures (such as low taxes and tariffs) [75,76,122], increasing the competitiveness of port cities. Trade barriers can be reduced, economic efficiency can be increased [59,88,121,133], interaction among stakeholders in port cities [23,86,119] can be fostered, and exports and imports of goods can be increased [31,33,34,51,61,77], increasing the income and profitability within a port city (agriculture, port, tourism, etc.) [34,51,75,122].

- Growth and Diversity of Employment and Enhancement of Workers' Welfare in Port Cities

The local labor market situation and residents on welfare [32,34,63,118,122] in port cities are reflected through the ratio of the employed population [31,33,122] versus the unemployed population. A robust job market and dynamic industrial growth are indicated by the amount of employment generated in ports [107] in port operations, maritime transportation, logistics, and trade industries. It has varying effects on the income levels of the inhabitants as a result of investment opportunities, competitive advantages, and the attraction of skilled labor [34,51].

3.3.4. Managerial-Social

- Improving the Management and Application of Information Technology in Loading, Unloading, and Storing Goods

Globalization and the progress made in information technology changes [17,74,108] have been combined to create the "communication age." Technology development and application have ushered in the "communication age," which offers users new prospects and socioeconomic advantages. The value of a technology depends on how it is used; it cannot be said to be intrinsically good or bad. Being the points of contact between land and sea transportation, ports have developed to keep up with technological changes [17,38,39,45,53,60,68,77,85,90,105–109,122,123,137]. As a result of improved safety and security of goods [133], ports have shifted away from conventional modes of transportation and cargo handling toward container shipping.

- Reforming the Method of Management and Regional Planning of Ports

The role of governance in land usage management [76,121,124,127]: The jurisdiction oversees policy development and land-use operations in port cities. These policies consider ports' and cities' unique needs and characteristics while being influenced by local, regional, and global forces [9,76,99,137]. The city and the port are separated by the lack of appropriate rules and regulations [107] and distinct planning approaches [8,76]. However, each region and set of local conditions determines the governance model of port areas [84,99,121,137] in port cities. However, in order to ensure transparent and efficient governance [122] as well as control of administrative corruption and rent at local levels of ports and industries [107] in port cities, flexibility, adaptability, and stakeholder participation are essential principles.

- Promotion of Local Governance in PCRs

Misalignment between national trade policies (export–import restrictions) and local port management [107,108] deters traders and investors, favoring rival ports. Implementing efficient customs procedures and foreign trade zones [133] can mitigate these issues. Effective urban planning in port cities hinges on clear regulations (land-use, zoning, environmental standards) addressing both port and urban needs [46,80,83,102,107,110,115,119,123]. This minimizes conflicts and optimizes port performance and land use. Conversely, fragmented planning institutions [9,89,107] exacerbate divisions between a port and a city development, hindering overall progress [33]. Additionally, well-defined property rights [108,112] and educational programs focused on maritime industries (universities, colleges, training centers) [33,83] are crucial for the successful integration of a port city.

- Promotion of National Management and International Interaction of Ports

Ports in port cities are essential for supply chain management [133] because they optimize the movement of commodities and raw materials, cut costs, and improve service quality and speed. Ports also serve as an economic resource. Because of these themes, port cities are superior to international distribution and transit hubs. In a port city, political stability [76,122] is essential for drawing in foreign and domestic investors and international transportation companies. International relations [9,89,107] thus increase due to the promotion of the use of ports for shipping and due to guaranteeing the security of commercial relations. How do decision-making institutions and government actors [11,12,42,70,75,77–79,111,116,126,127,133,136] adjust to political changes, economic challenges, technological transformations (including increased containerization), and social needs following governmental strategies [61,76,133], national and local level strategies [9,99], strategic planning [118], governmental structures [12,108], and government revenues and expenditures [31]? The natural environment, ports, and urban structures must be adjusted according to transportation demands. Therefore, macro policies, sectoral planning, and integrated government management must be implemented [9,58,107,137].

- Social Dissonance or Convergence between a City and a Port

Urban policies [137] and port policies [137] are essential in urban planning, zoning laws, and land use. These regulations may designate spaces for port-related operations or limit particular uses near residential areas. Therefore, by striking a balance between the interests of the public and private sectors, the convergence of a port city [108] and the integration of urban and port planning [23] can lead to the sustainable development of port cities.

- Increasing the rate of population growth and migration to the port city

Because they offer business opportunities, ports (as economic hubs) have the potential to, as economic centers, increase the rate of migration to the city [77,107]. However, due to various factors, like local planning policies, economic conditions, and urban development strategies, population growth [17,34,45,51,52,107,108,117,118,129] in port cities can be unpredictable.

- Cultural and Historical Identity of Ports

The effects of colonial rule [96,97] can impact port management, infrastructure development, and trade policies. For instance, in order to control and carry out its trade policies, Britain invested in multiple ports, such as Hong Kong and Singapore, which are significant Asian commercial hubs. However, political and administrative shifts in ports can also be brought about by the defeat of empires [77,98] and the establishment of a new government [85,92]. Ports like Koper in Slovenia and Hamburg in Germany suffered due to the severe destruction of their port facilities due to the effects of World War II [77,102]. This had a significant impact on the performance of these ports. In order to re-establish these ports as regional trading hubs, great efforts were undertaken in their reconstruction. Remarkably, civil wars such as the American Civil War [93,95] can serve as catalysts in the growth of port cities, such as Mersin in Turkey.

3.3.5. Environment

- Using Cheaper, Less-Polluting, and Clean and Renewable Energies in Port cities

Structural changes in the economy of port cities began with the change from coal energy to oil energy [85] as their vital energy source. In the 1970s, with the beginning of the oil crisis, the development of clean energy technologies [23] increased the use of nuclear energy [77] as a sustainable and clean energy source. Alongside these developments came the construction of contemporary port terminals, refineries, trans-shipment centers, and port infrastructure outside the city center. It is noteworthy that port cities outside of North America and Europe are now suited for industrialization or tourism, while traditional port centers close to city centers are being abandoned or evacuated.

- Environmental Protection and Sustainable Development of Port Cities

Due to being in close proximity to the sea, the industry, and commerce, port cities are highly susceptible to environmental pollution production [8,12,40,43,75,83,107,118,119,121,122]. In recent decades, the creation of green ports [60] has helped, to some extent, to mitigate the environmental pollution issues that ports cause. If not mitigated, this pollution may result in adverse effects on climate changes [8,34,63,108] and environmental quality (air, water, and soil) [8,31,33,34,63,108,122]. Increased energy conservation and emission reduction regulations [60] as well as waste management [33,34,75,122] are two examples of environmental quality measures that are being maintained in port cities like Shanghai, Ningbo, Singapore, Liaoning, and Xiamen for natural resource management [34,69].

This section reveals a vast and growing range of indicators and driving forces in PCRs. Research often explores the positive or negative impacts of port–city interactions on the functionality and morphology of port cities. Reviews of port and city development drivers highlight a key focus: proving divergence or convergence in physical, economic, environmental, and social aspects. Frequent indicators include pollution, land use, limited space, port–city function balance, transportation access, employment rates, economic growth, and governance models. As port cities develop, researchers need a meta-systemic approach to analyze and solve the challenges associated with them. A critical urban planning insight, for example, is the disconnect between port development plans and adjacent city plans. Applying meta-systemic thinking in future PCR research can lead to solutions being drawn for strategic issues and a convergent development model for port–city relationships.

4. Conclusions

This paper contributes to PCR scientometrics by investigating research publication trends from 2000 to 2023. The main contributions are twofold. Firstly, it introduces an objective approach to identify influential research within the field of PCRs, departing from the subjective methods prevalent in many previous studies that relied on individual perspectives. Secondly, this paper adopts a broader scope, encompassing the entire port city field, in contrast to prior research that often focused on specific geographic regions or thematic areas, such as European port cities or their sustainability. By analyzing 113 articles, this study establishes a robust and reliable foundation for determining trends in PCR research. Furthermore, it introduces a multi-level analysis using various resolution and aggregation scales. This allows for a nuanced understanding of the field, encompassing both overall research trends and specific thematic areas.

The analysis shows that PCR research has increasingly focused on resilience and sustainability, reflecting global concerns about climate change, natural disasters, and the role of technological advancements in intelligent urban planning and management. It also unveils the growing integration of new methods and modeling approaches into PCR research. Examples include the applications of panel measurement models, ARIMA models, cellular automata models, and system dynamics. This integration suggests that the applications of these methods and models extend beyond the conceptual level, with multi-disciplinary publications being co-authored by computer scientists and PCR researchers.

A significant finding is the surge in PCR publications since 2018. The analysis reveals the China–The Netherlands collaboration to be the most prominent link between authors. Dutch researchers appear to have a strong influence in this field, partially due to the economic and historical significance of ports like Rotterdam and Amsterdam. Conversely, the analysis shows that a large portion of Chinese PCR research focuses on domestic ports. This highlights the ongoing trend towards globalization in PCR research, with a shift from country-specific studies to research with broader implications. Consequently, recent years have witnessed a distinct rise in international collaborations.

The findings are categorized into five thematic areas: (1) Physical–Spatial, exploring the spatial and physical relationship between a port and a city; (2) Infrastructural Support, focusing on corridors and communication infrastructure linking ports and urban centers; (3) Economic, addressing economic policies and investments in port cities; (4) Managerial–Social, centering on governance structures, management practices, and overall activity within the port–city system; and (5) Environmental, dedicated to examining environmental protection issues and policies within the area of a port city. The objective identification of trends presented in this paper offers valuable insights for planners, managers, and researchers in the development of port cities and related disciplines. This knowledge empowers them to strategically direct their efforts and attention towards emerging topics within the field. Without such comprehensive understanding, navigating the complexities of PCRs can be challenging.

These findings also hold significant implications for port–city associations. The evolving landscape necessitates a re-evaluation of capacity-building and training programs. By incorporating the latest advancements, these programs can enhance the skillsets of professionals that specialize in the field of port cities and equip them with appropriate tools to address the emerging paradigms. Specific domains, such as the resilience in port cities and the smart development of port cities, require multidisciplinary training. This can empower urban planners and policymakers to tackle climate change challenges and leverage emerging technologies to create sustainable, productive, and livable port cities. While this study offers valuable insights, several questions remain regarding the thematic drivers behind the observed trends in PCR research. To gain a deeper understanding, further research is necessary. Future works should delve into the internal dynamics of each identified thematic cluster, explore the interconnectivity between these clusters, and analyze the themes influencing the gradual transitions within the field.

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