Hindawi
Journal of Advanced Transportation
Volume 2018, Article ID 6471625, 20 pages
https://doi.org/10.1155/2018/6471625

*Research Article*

# Analysis on Port and Maritime Transport System Researches

**Lingshan Chen,[1] Xiang Xu,[1] Ping Zhang,[2] and Xiaotian Zhang[1,3]**

[1]*School of Management, Shanghai University, Shanghai, China*
[2]*School of Economic and Management, Tongji University, Shanghai, China*
[3]*Oulu Business School, University of Oulu, Oulu, Finland*

Correspondence should be addressed to Xiang Xu; xuxiang9623@163.com

Received 30 August 2018; Revised 17 October 2018; Accepted 24 October 2018; Published 21 November 2018

Guest Editor: Zhiyuan Liu



This paper examines the past and current research in the container port and maritime field. Using rigorous bibliometric analysis, the paper identifies the core authors/affiliations, their rankings, and collaboration patterns. The analysis of the paper will enable new researchers to quickly build an understanding of the container port and maritime field by reading core authors' papers published in specific journals.

## 1. Introduction

The maritime industry has made great contributions to the world economy in recent decades. The "Maritime Review by 2015" reported by the United Nations Conference on Trade and Development (UNCTAD) shows that nearly 80% of global commodity trade in volume terms was completed through ports and maritime transport routes. The international maritime transportation industry contributes significantly to the welfare and development of nations adding around $380 billion a year via freight rates alone to the global economy. At the same time, the total amount of marine transport has steadily increased every year, and in 2014, it reached 9.84 billion tons [1–3]. Standing at the critical interface between inland and sea transportation, the container port is a critical connection between different modes of transportation and represents a critical point in the transportation chain [4]. For a country, maritime transportation not only ensures the import of scarce resources needed for production processes but also facilitates the export of excessive resources, which accumulates more wealth for the country. Maritime transport is also a key to economic globalization [5]. In particular, container transport has become the most important mode of transport in international trade and the new window for the development of foreign economic relationship and trade. Worldwide container port throughput increased from 36 million TEU in 1980 to 614 million TEU in 2017 and forecasts point to more than 800 million TEU in 2017 [6]. The flourishing industrial growth engendered numerous intellectual problems which, in turn, attracted academic interest. Subsequently, container port and maritime transportation has grown as a unique academic field.

Therefore, it is highly important to develop an overview of this field, which will provide general and historical results that permit a retrospective evaluation. In general, a number of studies have attempted to address conceptualization, methodological issues, theoretical developments, academic taxonomy, and future research directions in areas relevant to maritime logistics literature, such as Lau et al. [7]; Lee and Song [8] survey the extant research in the field of ocean container transport. Shi and Li [5] examine maritime transport researches through a comprehensive review of papers published in 19 transportation journals over the period 2000–2014. Charles [9] provided a global evaluation of the marine academic studies. Woo et al. [10] reviewed published port literature from the 1980s to 2000s in order to investigate the methodological trends in seaport research. Talley [11] reviewed and analyzed maritime transportation academic research, summarized the research topic from maritime journals, and defined future maritime transportation research directions. Chang et al. [12] examined the top 50 authors, 50 affiliations, and 50 countries in the maritime transportation field and discussed the potential correlation between the methodological popularity and author performance.

A number of reviews have been completed on specific aspects of maritime transportation research. For example, Wang et al. [3] pointed out the necessity and importance of port management and operations and suggested more research efforts on potential hot topics. Davarzani et al. [13] examined the past and present research on 'green ports and maritime logistics' and identified established research trends and future potential research areas. Several reviews have been more problem-specific and sustainable, such as the review by Mansouri et al. [14], who focused on the use of multiobjective decision methods in sustainable maritime transportation. In addition, with the increasing competition in ports, relevant research also expands rapidly. Sharaf et al. [15] provided an understanding of the efficiency analysis of container port through a comprehensive review of existing studies. Based on empirical evidence, Notteboom [16] analyzed the paths shipping lines and terminal operating companies were walking and also provided an overview of challenges port and maritime companies faced with in an ever-changing competitive environment.

In spite of Chang et al. [12], to the best of the authors' knowledge, no other studies have analyzed the authors, affiliations, and countries in maritime research. Our paper differs from Chang et al. [12] in four aspects. First, Chang et al. [12] prespecified a set of journals which are the most closely related to maritime research and they confined the literature search within these journals. In contrast, we search the literature in the whole Web of Science database. Second, different from Chang et al. [12], we conduct a more refined literature search; for example, papers that are related to "maritime" and "fish" are excluded. Third, Chang et al. [12] investigated the whole field of maritime papers and we focus on shipping and container port research. Fourth, Chang et al. [12] judged whether a paper is relevant based on its correlation with seven authors' papers, which may not be accurate. We judge the relevance of all papers manually. Despite the differences, our research is based on Chang et al. [12]'s seminal work which provided a number of insightful ideas. Using rigorous bibliometric analysis methods, this paper reviews the literature of container port and maritime logistics research to accomplish the following goals. First, we provide some initial statistics of the key journals, authors, and institutions that have contributed to the field. Second, we identify the most active researchers, affiliations, and countries in the container port and maritime field and rank them by different scoring methods. Thus, we provide a better understanding of how maritime transportation research has been undertaken in a quantitative manner. And the ranking also helps to identify active authors. Research of active authors tends to be more advanced. Following their articles can help new comers to obtain new research hotspot more quickly.

The remainder of this paper is organized as follows. Section 2 explains the methodology and details the scope of articles, database searching, scoring methods, and measures of collaborative network. Section 3 reports the ranking of authors and affiliations by all periods of study (1996-2016) and changes over five-year periods (1996-2000, 2001-2005, 2006-2010, and 2011-2017). Section 4 discusses countries/regions' ranking performance. Section 5 analyzes and identifies research topics and seminal research areas. Finally, we present the study's conclusions and discuss the study's limitations and potential future research directions in Section 6.

## 2. Methodology

The purpose of the literature review is to map and evaluate the body of the literature and identify potential research gaps. Structured literature reviews are completed by Saunders et al. [17] by iterative using search keywords defined appropriately, searching in the databases, and accomplishing the analysis. Rowley and Slack [18] recommend a structured methodology for scanning resources, designing the mapped structure of the literature review, writing the study, and building the bibliography. Inspired by Rowley and Slack [18] and Seuring and Gold [19], we design a four-step method to collect data and conduct a methodical, comprehensive analysis of the field. We aim to identify the remarkable research, make sure about the classical areas of current research interest, and provide insights for present research and directions for the future.

*2.1. Choice of Search Word and Database.* Through several trials and errors, we identify suitable search terms and keyword structures. We design the following method to establish the keywords search structure effectively inspired by Rowley and Slack [18] and Soring and Gold [19].

(i) Build original unit of keywords.

(ii) Review the search results and make sure whether typical papers and considerable journals are contained in obtained results, and make corresponding modifications to keyword set.

(iii) Identify the keywords needed to exclude, and make corresponding modifications to keyword set.

(iv) Search for 'exclusion research areas' to confine the search scope, and make corresponding modifications to keyword set.

Initially, we relied on the prior work of Chang et al. [12] in the maritime logistics review papers to define the initial set of keywords. Thirteen search words were suggested based on these previous works. They were "port OR shipping OR maritime OR marine OR terminal OR ship OR liner OR vessel OR seaport OR water transport* OR ocean freight OR container" and "waterway transport*." First, search words were typed in the Web of Science database. This paper only retrieves academic articles (or journal papers) and rules out conference proceedings, book chapters, dissertations, and theses. The space of journals selected in this paper narrows down to Science Citation Index (SCI), Social Science Citation Index (SSCI), SCI (E), and SSCI-registered ones. Afterwards, we check the resulting articles and journals. A mass of words have a polysemic effect. For example, "vessel" means either a ship or a duct or canal holding or conveying blood or other fluid. The polysemy effect of "vessel" causes the initial search results to include a mass of papers about biological research. We also ruled out the articles that include the following irrelevant words, including "highway OR intersection OR

Table 1: Process of the material collection.

| | | Search results |
|---|---|---|
| **Step1** | Search keywords<br>port OR shipping OR maritime OR marine OR terminal OR ship OR liner OR seaport OR<br>(water transport*) OR (ocean freight) OR container OR (waterway transport*) | 81,126 |
| **Step2** | Exclusion keywords<br>AND NOT<br>highway OR intersection OR helmet OR pedestrian OR fish OR guardrail OR aviation<br>OR airport OR airline OR fishery | 78,482 |
| **Step3** | Remove the irrelevant subject areas | 12,279 |
| **Step4** | Manual refinement of the search results | 5,534 |

helmet OR pedestrian OR fish OR guardrail OR aviation OR airport OR airline" and "fishery."

The initial search results left about 12279 articles after several trial and error attempts. The search results have expanded to a wide range of thematic areas beyond the scope of this paper. Hence, papers from irrelevant thematic areas need to rule out. Irrelevant subject areas are those that do not belong to the space of container and marine transport system. The unrelated areas were identified through discussions with other senior researchers in the field. The unrelated areas included (1) astronomy, planet sciences, and related areas, (2) agricultural sciences and related areas, (3) medicine, biology, and related areas, (4) physics and related areas, and (5) psychology. Finally, the authors went through 12,279 references and reduced the number of relevant articles to 5,534 as a refinement. Table 1 shows the whole process of the material collection.

*2.2. Scoring Method.* In this paper, we used two criteria to rank researchers, affiliations, and countries, the number of their publications, and their impact score. The following text describes the composition of each indicator and the rationale for how to use them in detail. The number of publications is an important indicator of academic performance. Numerous studies have used this indicator to approximate author performance [13, 20]. However, only calculating the number of publications has the limitation of measuring the impact of authors on the whole field. In this case, the more crucial part the authors played in an article, the more important evaluation they should be given.

Authors who publish their work in more prestigious journals deserve more respect and higher scores. In this case, it seems appropriate to use the impact factor of a journal to adjust the authors' impact score. There is, in general, a widespread consensus among the authors that the impact factor measures the quality of journals approximately and reasonably. And usage of impact factor is prevalent [21, 22]. The Journal Citation Reports published by Thomson Reuters provided statistical data over the years. A number of journals had no statistical results for certain years, since they recently entered SCI (E) or SSCI, including *Maritime Policy and Management*. In such a case, the impact factor in the entry year was applied to the nonentrance periods. For example, the 2011 impact factor for *Maritime Policy and Management* was applied to 2000-2010. Afterwards, the impact score was denoted by

$$Score_j = \sum_{y=2000}^{2017} \sum_{i}^{N} \frac{1}{I_j^i} \times IM_y^i \quad (1)$$

where $Score_j$ is the impact score of author j, N is the number of papers published by author j, $I_j^i$ represents the number of corresponding authors in paper i with author j, and $IM_y^i$ is the impact factor of journals that paper i was published in in year y.

Apart from impact score assessment, the number of citations of each paper is also included in the database we have obtained, which is more basic and fundamental and also a good indicator of the author's performance. We measured the total number of citations of an author i by

$$c_i = \sum_{n \in N} ct_n \quad (2)$$

where $c_i$ is the citation score of authors i, N is the total number of publications of author i, and $ct_n$ is the citations of paper n.

## 3. Analysis of Author and Affiliation

Section 3.1 illustrates the overall trend of publications. Sections 3.2-3.3 report rankings of author and affiliation for 1996-2017, respectively.

*3.1. Overall Trend.* Figure 1 shows the number of papers published each year. Between 1996 and 2012, the published paper counts in maritime transport system field increased every year. The number peaked in 2012 and decreased thereafter. In 2015, this number began to rise again. The rising paper numbers may be due to the Chinese government vigorously promoting the economic strategy of the Silk Road Economic Belt and the 21st Century Maritime Silk Road. The paper number of Chinese scholars has improved, thereby causing the total number of papers to increase in 2015. Section 3.3 reports the country rankings from 1996 to 2016 and supports this conclusion.

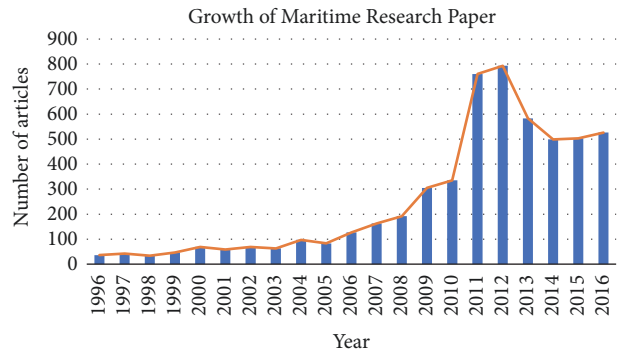


Figure 1: Growth of maritime research paper.

### 3.2. Author Ranking Analysis

*3.2.1. Author Ranking for 1996-2016.* Table 2 displays the ranking of top 50 authors in the port and maritime transport system field according to the three metrics we mentioned above. Column 3 shows the ranking of the first metric, which is calculated based on the number of papers published. Numbers are counted when the author is one of all coauthors or the single author of a paper. For example, the top ranked Qiang Meng published 61 papers, either as an author or a coauthor. The second metric ranking is the impact score (column 6) that considers the journal impact factor. In terms of paper numbers, Qiang Meng is the top researcher and published 61 papers. Qiang Meng was followed by Shuaian Wang with 52 papers. After those two researchers, the differences between the subsequent authors are not substantial.

Considering the impact score, Meng and Wang still take the first and second places, but their ranks are reversed. The gap between the second and third is relatively large. A notable change can be seen. Among the top 10 authors, Metin Celik, Chung-Yee Lee, Dong-Ping Song, and Lu Zhen emerge. Celik's ranking increased from 16th to 7th. Lee's ranking increased from 24th to 8th. Song's ranking increased from 16th to 9th. Zhen's ranking increased from 35th to 10th.

Significant changes can be observed on the citation score: Nishimura, Etsuko, and Stahlbock, R are the first time appearing in the top 10. Compared with the rank of number of papers, Imai, Akio, Voss, Stefan, and Papadimitriou, Stratos's ranks up more than 25.

*3.2.2. Ranking Dynamics of Authors.* This section examines the changes in the author's performance over each five-year period. Table 3 shows the dynamics of the impact score ranking of authors. The columns next to the impact score indicate the change of the ranking relative to the previous period in 2001-2005, 2006-2010, and 2011-2015, respectively. Ranking changes of an author will not be shown if he/she was outside the top 100 in the previous period. Overall, the rise and decline of core authors are prominent in the port and maritime transport system field. A notable point is that K.H. Kim maintains a top 10 ranking in every period. Numerous top 50 authors from 1996 to 2000 do not make the rankings in the next period, while most of the top 50 authors in 2001-2005 are new authors. A similar pattern appeared between 2006 and 2010 and 2011 and 2015. This field also had a new strength among the top 5 from 2011 to 2015. A typical example is S.A. Wang. Since all of his articles are published after 2010, he did not appear in the ranking of first three-time periods. Nevertheless, his centrality for 2011-2015 is quite high. Other examples include J.S.L. Lam and L. Zhen. It can be expected that these authors will contribute more to the field in the coming years. Only Notteboom maintains a top 5 position over the entirety of the last decade. The changeable ranking means this field is full of competition and opportunity.

Another point worth noting is that the five-year impact scores of active authors have a significant raise. For example, the impact scores of the top 3 between period 3 and period 4 soared from 9.05, 8.73, and 7.79, respectively, to 34.45, 31.03, and 17.98, respectively. It may have been influenced by the growing number of publications and more publications being published in high-impact journals (impact score = $\sum_{y=2000}^{2017} \sum_{i}^{N} (1/I_j^i) \times IM_y^i$).

*3.2.3. Core Authors and Collaboration Patterns.* Derek Price prompted the celebrated "square root law" that states that half of the scientific papers are contributed by the top square root of the total number of scientific authors. The law was first proposed in Little Science-Big Science [23] and is heuristically based on Lotka's inverse square law. The Price's law is calculated from the following equation:

$$M = 0.749\sqrt{N_{max}} \tag{3}$$

where $N_{max}$ is the maximum number of the articles by one author. M is the minimum number of articles by a core author, which means the author whose published paper number is above M is the core author. In our data sample, $N_{max}$ equals 61, and according to Price's law M equals 5.8. Thus, there are more than 190 authors who have published more than 6 papers in the field.

For further analysis, we also tried to analyze the cooperation pattern of the core authors. The cooperation pattern means different authors appearing in multiple joint articles frequently. Table 4 shows the results. An interesting observation is that the core authors (such as S.A. Wang, Q. Meng, E.P. Chew, L.H. Lee, and K. Fagerholt) in the container port and maritime field do frequently cooperate. This result indicates that most container port and maritime researchers are willing to cooperate with their familiar partners.

The top articles were considered as the lead articles of a research area [13]. The titles of core authors' top 10 articles in the container port and maritime research area are also shown in Table 5. All of the top 3 articles are the overview in the port and maritime research area which may help new comers to understand quickly about container port and maritime field. The rest of the top 10 articles are interested in specific topics, including economics, operations research, business, and planning.

### 3.3. Affiliation Ranking Analysis

*3.3.1. Affiliation Ranking for 2000-2015.* Table 6 displays affiliation rankings for 1996-2016. In paper counts, the National

Table 2: Rankings by author.

| Rank | Author | No. papers | Rank | Author | Impact Score | Rank | Author | Citation Score |
|---|---|---|---|---|---|---|---|---|
| **1** | Meng, Qiang | 61 | 1 | Wang, Shuaian | 47.95 | 1 | Kim, Kap Hwan | 1713 |
| **2** | Wang, Shuaian | 52 | 2 | Meng, Qiang | 41.66 | 2 | Imai, Akio | 1214 |
| **3** | Kim, Kap Hwan | 47 | 3 | Notteboom, Theo | 25.63 | 3 | Christiansen, Marielle | 1189 |
| **4** | Fagerholt, Kjetil | 45 | 4 | Lam, Jasmine Siu Lee | 25.00 | 4 | Fagerholt, Kjetil | 1147 |
| **5** | Lam, Jasmine Siu Lee | 36 | 5 | Kim, Kap Hwan | 23.63 | 5 | Meng, Qiang | 1107 |
| **5** | Notteboom, Theo | 36 | 6 | Fagerholt, Kjetil | 23.06 | 6 | Papadimitriou, Stratos | 1083 |
| **7** | Wang, Jin | 31 | 7 | Celik, Metin | 20.41 | 7 | Voss, Stefan | 1030 |
| **8** | Christiansen, Marielle | 30 | 8 | Lee, Chung-Yee | 19.00 | 8 | Nishimura, Etsuko | 1021 |
| **9** | Lee, Loo Hay | 28 | 9 | Song, Dong-Ping | 17.44 | 9 | Stahlbock, R | 960 |
| **10** | Parola, Francesco | 26 | 10 | Zhen, Lu | 17.35 | 10 | Wang, Shuaian | 751 |
| **10** | Lu, Chin-Shan | 26 | 11 | Monios, Jason | 17.10 | 11 | Cullinane, Kevin | 744 |
| **10** | Chew, Ek Peng | 26 | 12 | Ding, Ji-Feng | 15.76 | 12 | Laporte, Gilbert | 680 |
| **10** | Lee, Paul Tae-Woo | 26 | 13 | Ng, ManWo | 14.41 | 13 | Kozan, Erhan | 659 |
| **14** | Luo, Meifeng | 25 | 14 | Lu, Chin-Shan | 13.99 | 14 | Song, Dong-Wook | 624 |
| **15** | Lun, Y. H. Venus | 24 | 15 | Talley, Wayne K | 13.45 | 15 | Vis, Iris F. A. | 614 |
| **16** | Celik, Metin | 23 | 16 | Tovar, Beatriz | 13.27 | 16 | Notteboom, Theo | 577 |
| **16** | Lee, Der-Horng | 23 | 17 | Lee, Paul Tae-Woo | 12.62 | 17 | Meisel, Frank | 562 |
| **16** | Song, Dong-Ping | 23 | 18 | Thai, Vinh V | 12.56 | 18 | Park, YM | 540 |
| **19** | Cheng, T. C. Edwin | 22 | 19 | Ducruet, Cesar | 12.56 | 19 | Wang, Jin | 522 |
| **19** | Cullinane, Kevin | 22 | 20 | Christiansen, Marielle | 12.15 | 20 | Liu, JY | 519 |
| **22** | Ng, Adolf K. Y. | 21 | 21 | Lun, Y. H. Venus | 11.75 | 21 | Ronen, David | 506 |
| **21** | Thai, Vinh V | 21 | 22 | Lee, Loo Hay | 11.65 | 22 | Wan, YW | 505 |
| **21** | Yang, Zaili | 21 | 23 | Luo, Meifeng | 11.61 | 23 | Steenken, D | 500 |
| **24** | Chang, Young-Tae | 20 | 24 | Petering, Matthew E. H. | 11.22 | 24 | Bierwirth, Christian | 484 |
| **24** | Lee, Chung-Yee | 20 | 25 | Wilmsmeier, Gordon | 11.18 | 25 | Lee, Der-Horng | 450 |
| **24** | Li, Kevin X | 20 | 26 | Lee, Der-Horng | 11.14 | 26 | Lu, Chin-Shan | 436 |
| **27** | Lai, Kee-hung | 19 | 27 | Lai, Kee-hung | 10.96 | 27 | Tongzon, J | 431 |
| **27** | Laporte, Gilbert | 19 | 28 | Akyuz, Emre | 10.91 | 28 | de Koster, R | 424 |
| **29** | Huynh, Nathan | 18 | 29 | Cullinane, Kevin | 10.76 | 29 | Lee, Loo Hay | 422 |
| **29** | Papadimitriou, Stratos | 18 | 30 | Parola, Francesco | 10.54 | 30 | Linn, RJ | 422 |
| **31** | Ducruet, Cesar | 17 | 31 | Wang, Jin | 10.17 | 31 | Celik, Metin | 411 |
| **31** | Imai, Akio | 17 | 32 | Boysen, Nils | 10.09 | 32 | Andersson, Henrik | 395 |
| **31** | Tovar, Beatriz | 17 | 33 | Chou, Chien-Chang | 10.08 | 33 | Legato, Pasquale | 391 |
| **31** | Yip, Tsz Leung | 17 | 34 | Dong, Jing-Xin | 9.88 | 34 | Kujala, Pentti | 389 |
| **35** | Hu, Hao | 16 | 35 | Wang, Xinchang | 9.83 | 35 | Chew, Ek Peng | 385 |
| **35** | Kavussanos, Manolis G | 16 | 36 | Meisel, Frank | 9.62 | 36 | Song, Dong-Ping | 375 |
| **35** | Lim, Andrew | 16 | 37 | Ng, Adolf K. Y. | 9.52 | 37 | Murty, Katta G. | 368 |
| **35** | Monios, Jason | 16 | 38 | Chew, Ek Peng | 9.47 | 38 | Lam, Jasmine Siu Lee | 360 |
| **35** | Pisinger, David | 16 | 39 | Laporte, Gilbert | 9.47 | 39 | Ng, WC | 320 |
| **35** | Song, Dong-Wook | 16 | 40 | Yang, Yi-Chih | 8.98 | 40 | Wang, Teng-Fei | 317 |
| **35** | Talley, Wayne K | 16 | 41 | Yang, Zaili | 8.90 | 41 | Kavussanos, Manolis G. | 312 |
| **35** | Yang, Zhongzhen | 16 | 42 | Chang, Young-Tae | 8.81 | 42 | Zhang, CQ | 291 |
| **35** | Zhen, Lu | 16 | 43 | Kujala, Pentti | 8.57 | 43 | Hummels, David | 286 |
| **44** | Ferrari, Claudio | 15 | 44 | Psaraftis, Harilaos N. | 8.56 | 44 | Pisinger, David | 282 |
| **44** | Hvattum, Lars Magnus | 15 | 45 | Cheng, T. C. Edwin | 8.44 | 45 | Gue, KR | 270 |
| **44** | Kozan, Erhan | 15 | 46 | Cariou, Pierre | 8.24 | 46 | Lun, Y. H. Venus | 269 |
| **44** | Kujala, Pentti | 15 | 47 | Yip, Tsz Leung | 8.20 | 47 | Ng, Adolf K. Y. | 249 |
| **44** | Voss, Stefan | 15 | 48 | Pisinger, David | 8.13 | 48 | Cheng, T. C. Edwin | 240 |
| **44** | Wilmsmeier, Gordon | 15 | 49 | Sun,Zhuo | 8.09 | 49 | Er, I. Deha | 237 |
| **44** | Wilson, William W | 15 | 50 | Bell, Michael G. H. | 7.90 | 50 | Hasle, Geir | 233 |

Table 3: Ranking dynamics of authors.

| | Author | Impact Score (1996-2000) | Author | Impact Score (2001-2005) | | Author | Impact Score (2006-2010) | | Author | Impact Score (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Kim, Kap Hwan | 3.82 | Kim, Kap Hwan | 3.75 | - | Celik, Metin | 9.05 | - | Wang, Shuaian | 34.45 | - |
| 2 | Bennett, P | 2.44 | Suryanata, K | 1.65 | ▲ | Chou, Chien-Chang | 8.37 | - | Meng, Qiang | 31.03 | ▲ |
| 3 | Peterson, K | 1.52 | Peterson, K | 1.52 | - | Notteboom, Theo | 7.79 | ▲ | Notteboom, Theo | 17.98 | - |
| 4 | Lei, J | 1.45 | Lei, J | 1.45 | - | Er, I. Deha | 6.54 | ▲ | Lam, Jasmine Siu Lee | 14.10 | - |
| 5 | Zhou, JJ | 1.45 | Zhou, JJ | 1.45 | - | Kim, Kap Hwan | 6.22 | ▼ | Fagerholt, Kjetil | 12.40 | ▲ |
| 6 | Hartmann, Soenke | 1.44 | Hartmann, Soenke | 1.44 | - | Ding, Ji-Feng | 5.86 | - | Song, Dong-Ping | 11.55 | - |
| 7 | Hemp, P | 1.37 | Imai, Akio | 1.41 | ▲ | Lai, Kee-hung | 5.83 | - | Zhen, Lu | 9.98 | - |
| 8 | Matthews, HS | 1.35 | Nishimura, Etsuko | 1.41 | ▲ | Petering, Matthew E. H. | 5.79 | ▲ | Lee, Chung-Yee | 9.66 | - |
| 9 | Hart, R | 1.23 | Papadimitriou, Stratos | 1.41 | ▲ | Lee, Der-Horng | 5.40 | ▲ | Kim, Kap Hwan | 9.38 | ▼ |
| 10 | Wang, Jin | 1.08 | Lillie, N | 1.38 | ▲ | Roso, Violeta | 4.41 | - | Lee, Loo Hay | 8.85 | - |
| 11 | Holden, H | 1.00 | Hemp, P | 1.37 | ▼ | Imai, Akio | 3.81 | ▲ | Akyuz, Emre | 7.63 | - |
| 12 | Gierloff-Emden, HGR | 0.96 | Matthews, HS | 1.35 | ▼ | Song, Dong-Wook | 3.79 | - | Dong, Jing-Xin | 7.31 | ▲ |
| 13 | van Driel, Hugo | 0.93 | Oakley, Susan | 1.29 | - | Vis, Iris F. A. | 3.74 | - | Ng, ManWo | 7.17 | - |
| 14 | Suryanata, K | 0.89 | Hart, R | 1.23 | ▼ | Hummels, David | 3.43 | - | Yang, Zaili | 7.05 | - |
| 15 | Umemoto, KN | 0.89 | Karlsen, A | 1.17 | - | Chen, Jiang Hang | 3.42 | - | Kujala, Pentti | 6.98 | - |
| 16 | Krasnopolsky, VM | 0.89 | Cullinane, Kevin | 1.15 | ▲ | Roe, Michael | 3.33 | - | Tovar, Beatriz | 6.94 | - |
| 17 | Schiller, H | 0.89 | Wang, Jin | 1.13 | ▼ | Lu, Chin-Shan | 3.32 | ▼ | Ducruet, Cesar | 6.74 | ▲ |
| 18 | Lillie, N | 0.88 | Ng, WC | 1.08 | - | Goodchild, Anne V | 2.99 | - | Chew, Ek Peng | 6.57 | - |
| 19 | Zhang, CQ | 0.85 | Holden, H | 1.00 | ▼ | Ducruet, Cesar | 2.95 | - | Wilmsmeier, Gordon | 6.56 | - |
| 20 | Jetlund, AS | 0.84 | Gierloff-Emden, HGR | 0.96 | ▼ | Papadimitriou, Stratos | 2.80 | ▼ | Ng, Adolf K. Y. | 6.42 | ▲ |
| 21 | Karimi, IA | 0.84 | van Driel, Hugo | 0.93 | ▼ | Hirashima, Yoichi | 2.79 | - | Celik, Metin | 6.28 | ▼ |
| 22 | Fossen, Thor I. | 0.82 | Umemoto, KN | 0.89 | ▼ | Fremont, Antoine | 2.77 | - | Liu, Zhiyuan | 6.21 | - |

Table 3: Continued.

| | Author | Impact Score (1996-2000) | Author | Impact Score (2001-2005) | | Author | Impact Score (2006-2010) | | Author | Impact Score (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | Park, YM | 0.82 | Liu, Jiyin | 0.89 | - | Demaria, Federico | 2.75 | - | Yang, Yi-Chih | 5.99 | - |
| 24 | Ronen, D. | 0.80 | Wan, Yat-wah | 0.89 | - | Fagerholt, Kjetil | 2.74 | ▲ | Cariou, Pierre | 5.85 | - |
| 25 | Jacobson, A | 0.80 | Krasnopolsky, VM | 0.89 | ▼ | Kozan, Erhan | 2.69 | - | Monios, Jason | 5.69 | - |
| 26 | Farrell, JA | 0.79 | Schiller, H | 0.89 | ▼ | Asteris, Michael | 2.67 | - | Rudd, Murray A. | 5.68 | - |
| 27 | Li, W | 0.79 | Tongzon, Jose | 0.85 | - | Meng, Qiang | 2.67 | - | Talley, Wayne K. | 5.67 | - |
| 28 | Lee, RM | 0.78 | Zhang, CQ | 0.85 | ▼ | Paulauskas, Vytautas | 2.67 | - | Sun, Zhuo | 5.65 | - |
| 29 | Linn, RJ | 0.76 | Legato, Pasquale | 0.84 | ▲ | Meisel, Frank | 2.63 | - | Laporte, Gilbert | 5.65 | - |
| 30 | Imai, Akio | 0.76 | Jetlund, AS | 0.84 | ▼ | Ng, Adolf K. Y. | 2.61 | - | Pisinger, David | 5.56 | - |
| 31 | Nishimura, Etsuko | 0.76 | Karimi, IA | 0.84 | ▼ | Vasiliauskas, Aidas Vasilis | 2.55 | - | Psaraftis, Harilaos N. | 5.52 | - |
| 32 | Papadimitriou, Stratos | 0.76 | Ronen, D. | 0.80 | ▼ | Sharma, Mithun J. | 2.53 | - | Petering, Matthew E. H. | 5.43 | ▼ |
| 33 | Ausloos, M | 0.76 | Jacobson, A | 0.80 | ▼ | Yu, Song Jin | 2.53 | - | Lee, Paul Tae-Woo | 5.37 | - |
| 34 | Ivanova, K | 0.76 | Lu, Chin-Shan | 0.79 | - | Nishimura, Etsuko | 2.51 | ▼ | Goerlandt, Floris | 5.34 | - |
| 35 | Fagerholt, Kjetil | 0.75 | Farrell, JA | 0.79 | ▼ | Lee, Yusin | 2.50 | - | Wang, Hua | 5.24 | - |
| 36 | Fairlie, DP | 0.73 | Li, W | 0.79 | ▼ | Konings, Rob | 2.47 | - | Hvattum, Lars Magnus | 4.98 | - |
| 37 | Lucke, AJ | 0.73 | Donderi, DC | 0.78 | - | Saeed, Naima | 2.43 | - | Yip, Tsz Leung | 4.92 | - |
| 38 | Singh, Y | 0.73 | McFadden, S | 0.78 | - | Merrick, Jason R. W. | 2.43 | - | Christiansen, Marielle | 4.91 | - |
| 39 | Tyndall, JDA | 0.73 | Lee, RM | 0.78 | ▼ | Ramirez-Marquez, Jose Emmanuel | 2.33 | - | Hanninen, Maria | 4.89 | - |
| 40 | Fung, Michael K. | 0.72 | Bish, EK | 0.77 | ▲ | Kahraman, Cengiz | 2.29 | - | Wang, Jin | 4.83 | ▼ |

Table 3: Continued.

| | Author | Impact Score (1996-2000) | Author | Impact Score (2001-2005) | | Author | Impact Score (2006-2010) | | Author | Impact Score (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | Bish, EK | 0.67 | Linn, RJ | 0.76 | ▼ | Hastings, Justin V. | 2.27 | - | Featherstone, David | 4.82 | - |
| 42 | Yun, JE | 0.67 | Ausloos, M | 0.76 | ▼ | Cebi, Selcuk | 2.18 | - | Lee, Der-Horng | 4.77 | ▼ |
| 43 | Marin, PL | 0.66 | Ivanova, K | 0.76 | ▼ | Panayides, Photis M | 2.18 | - | Hu, Zhi-Hua | 4.77 | - |
| 44 | Sicotte, R | 0.66 | Umemoto, K | 0.76 | - | Goulielmos, Alexander M. | 2.11 | - | Kontovas, Christos A. | 4.76 | - |
| 45 | Legato, Pasquale | 0.66 | Sciomachen, Anna | 0.75 | - | Cao, Jin Xin | 2.10 | - | Knapp, Sabine | 4.52 | - |
| 46 | Bhargava, HK | 0.66 | Koutsavdis, E | 0.74 | - | Park, Changkyu | 2.09 | - | Luo, Meifeng | 4.51 | ▼ |
| 47 | Snoap, KJ | 0.66 | Rhee, SH | 0.74 | - | Seo, Junyong | 2.09 | - | Nathan Huynh | 4.50 | - |
| 48 | Altiok, T | 0.64 | Fairlie, DP | 0.73 | ▼ | Wu, Wei-Ming | 2.07 | - | Yeo, Gi-Tae | 4.43 | - |
| 49 | Cullinane, Kevin | 0.63 | Lucke, AJ | 0.73 | ▼ | Fossen, Thor I. | 2.05 | ▼ | Meisel, Frank | 4.41 | ▼ |
| 50 | Gold, C | 0.62 | Singh, Y | 0.73 | ▼ | Low, Joyce M. W | 2.03 | - | Bell, Michael G. H. | 4.40 | - |

Table 4: The most prolific paired authors.

| Rank | Paired authors | Number of joint publications | Rank | Paired authors | Number of joint publications |
|---|---|---|---|---|---|
| **1** | Meng, Q, Wang, SA | 34 | **11** | Papadimitriou, S, Nishimura, E | 12 |
| **2** | Chew, EP, Lee, LH | 25 | **12** | Fagerholt, K, Christiansen, M | 12 |
| **3** | Lai, KH, Cheng, TCE | 17 | **13** | Tan, KC, Chew, EP | 11 |
| **4** | Cheng, TCE, Lun, YHV | 15 | **14** | Tan, KC, Lee, LH | 11 |
| **5** | Yang, ZL, Wang, J | 15 | **15** | Wang, SA, Liu, ZY | 11 |
| **6** | Boile, M, Theofanis, S | 14 | **16** | Monios, J, Wilmsmeier, G | 10 |
| **7** | Lai, KH, Lun, YHV | 14 | **17** | Parola, F, Satta, G | 10 |
| **8** | Lee, DH, Chen, JH | 13 | **18** | Lee, DH, Cao, JX | 10 |
| **9** | Papadimitriou, S, Imai, A | 13 | **19** | Lai, KH, Wong, CWY | 9 |
| **10** | Imai, A, Nishimura, E | 12 | **20** | Christiansen, M, Andersson, H | 9 |

Table 5: The top 10 articles of port and maritime research area.

| Authour | Title | Citation |
|---|---|---|
| Steenken, D; Voss, S; Stahlbock, R | Container terminal operation and operations research - a classification and literature review | 500 |
| Stahlbock, Robert; Voss, Stefan | Operations research at container terminals: a literature update | 423 |
| Vis, IFA; de Koster, R | Transshipment of containers at a container terminal: An overview | 290 |
| Christiansen, M; Fagerholt, K; Ronen, D | Ship routing and scheduling: Status and perspectives | 270 |
| Hummels, David | Transportation costs and international trade in the second era of globalization | 242 |
| Bierwirth, Christian; Meisel, Frank | A survey of berth allocation and quay crane scheduling problems in container terminals | 228 |
| Imai, A; Nishimura, E; Papadimitriou, S | The dynamic berth allocation problem for a container port | 222 |
| Kim, KH; Park, YM | A crane scheduling method for port container terminals | 200 |
| Tongzon, J; Heng, W | Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals) | 169 |
| Cullinane, K; Wang, TF; Song, DW; Ji, P | The technical efficiency of container ports: Comparing data envelopment analysis and stochastic frontier analysis | 168 |

University of Singapore (NUS), Hong Kong Polytechnic University (HKPU), Norwegian University of Science and Technology, Delft University of Technology, and the University of Antwerp (UA) are in the top 5. The top schools are all strong regardless of how they are ranked. The most productive school, NUS, published 184 papers and was followed by HKPU with 174 papers. As with the authors' ranking, the gap between the second and third in the affiliation rankings is also relatively large (60 papers). Below these schools, the gap between the subsequent affiliations is no longer substantial. The top ten affiliations for 1996-2016 published 986 papers, which equate to an annual average of 46.87 papers. The best performing schools is still NUS. Another notable point is the sudden increase of Nanyang Technological University (NTU) in the ranking. As for the rank of citation score, it is stable and similar to the rank of impact score except for some slight fluctuations. But there is still some sudden increase that needs to be noteworthy. Univ Georgia Inst Technol's rank ups 16 places to 9th. Univ Hamburg is not among the top 50 in the impact score but places to 5th in citation score.

The affiliation ranking shows a similar pattern to author rankings. NUS have an outstanding container port and maritime researcher; Meng and HKPU have Wang. The two authors publish in impact score journals in container port and maritime research. It seems to indicate a direct relationship between research infrastructure and researchers. The size of the research infrastructure and the number of researchers available in the field may impact the researchers' effectiveness and strength of knowledge conversion. In other words, the more the numerous researchers and knowledge, the higher

Table 6: Rankings by affiliations.

| Rank | School | No. Paper | Rank | School | Impact Score | Rank | School | Citation Score |
|---|---|---|---|---|---|---|---|---|
| **1** | Natl Univ Singapore | 184 | **1** | Natl Univ Singapore | 148.06 | **1** | Natl Univ Singapore | 3342 |
| **2** | Hong Kong Polytech Univ | 174 | **2** | Hong Kong Polytech Univ | 130.64 | **2** | Norwegian Univ Sci & Technol | 2525 |
| **3** | Norwegian Univ Sci & Technol | 114 | **3** | Norwegian Univ Sci & Technol | 69.67 | **3** | Pusan Natl Univ | 2179 |
| **4** | Delft Univ Technol | 93 | **4** | Delft Univ Technol | 64.03 | **4** | Hong Kong Polytech Univ | 1558 |
| **5** | Univ Antwerp | 84 | **5** | Nanyang Technol Univ | 59.83 | **5** | Univ Hamburg | 1075 |
| **6** | Erasmus Univ | 82 | **6** | Erasmus Univ | 58.04 | **6** | Erasmus Univ | 1052 |
| **7** | Nanyang Technol Univ | 73 | **7** | Pusan Natl Univ | 56.32 | **7** | Istanbul Tech Univ | 951 |
| **8** | Shanghai Jiao Tong Univ | 68 | **8** | Dalian Maritime Univ | 53.49 | **8** | Univ Antwerp | 934 |
| **9** | Pusan Natl Univ | 66 | **9** | Istanbul Tech Univ | 52.56 | **9** | Georgia Inst Technol | 868 |
| **10** | Dalian Maritime Univ | 62 | **10** | Tech Univ Denmark | 50.78 | **10** | Hong Kong Univ Sci & Technol | 802 |
| **11** | Univ Genoa | 61 | **11** | Univ Antwerp | 50.53 | **11** | Univ Calif Berkeley | 785 |
| **12** | Univ Piraeus | 58 | **12** | Natl Taiwan Ocean Univ | 47.26 | **12** | Natl Cheng Kung Univ | 777 |
| **13** | Natl Taiwan Ocean Univ | 55 | **13** | Univ Genoa | 46.33 | **13** | Tech Univ Denmark | 758 |
| **14** | Istanbul Tech Univ | 54 | **14** | Hong Kong Univ Sci & Technol | 43.11 | **14** | Delft Univ Technol | 719 |
| **15** | Hong Kong Univ Sci & Technol | 53 | **15** | Natl Cheng Kung Univ | 42.08 | **15** | HEC Montreal | 699 |
| **16** | Tech Univ Denmark | 52 | **16** | Natl Kaohsiung Marine Univ | 41.71 | **16** | Kobe Univ | 689 |
| **17** | Univ Plymouth | 51 | **17** | Univ Plymouth | 41.24 | **17** | Univ Plymouth | 645 |
| **18** | Natl Cheng Kung Univ | 47 | **18** | Old Dominion Univ | 39.36 | **18** | Univ Hong Kong | 635 |
| **18** | Rutgers State Univ | 47 | **19** | Univ Piraeus | 38.91 | **19** | Univ Calabria | 618 |
| **20** | Cardiff Univ | 43 | **20** | Shanghai Jiao Tong Univ | 38.59 | **20** | Nanyang Technol Univ | 574 |
| **21** | Georgia Inst Technol | 40 | **21** | Cardiff Univ | 32.64 | **21** | Liverpool John Moores Univ | 569 |
| **22** | Natl Kaohsiung Marine Univ | 39 | **22** | Natl Tech Univ Athens | 31.14 | **22** | Norwegian Marine Technol Res Inst MARINTEK | 559 |

Table 6: Continued.

| Rank | School | No. Paper | Rank | School | Impact Score | Rank | School | Citation Score |
|---|---|---|---|---|---|---|---|---|
| **23** | Univ Rijeka | 38 | **23** | Vilnius Gediminas Tech Univ | 31.00 | **23** | Univ Genoa | 559 |
| **24** | Edinburgh Napier Univ | 37 | **24** | Edinburgh Napier Univ | 30.94 | **24** | Univ Halle Wittenberg | 539 |
| **24** | Liverpool John Moores Univ | 37 | **25** | Georgia Inst Technol | 29.72 | **25** | Univ Wisconsin | 525 |
| **24** | Natl Tech Univ Athens | 37 | **26** | Shanghai Univ | 29.51 | **26** | Univ London Imperial Coll Sci Technol & Med | 513 |
| **27** | Old Dominion Univ | 36 | **27** | Aalto Univ | 29.35 | **27** | Rutgers State Univ | 492 |
| **27** | Texas A&M Univ | 36 | **28** | Liverpool John Moores Univ | 27.55 | **28** | Univ Michigan | 488 |
| **29** | Univ Aegean | 35 | **29** | Inha Univ | 26.71 | **29** | Shanghai Jiao Tong Univ | 461 |
| **30** | Inha Univ | 34 | **30** | Univ Las Palmas Gran Canaria | 26.42 | **30** | Aalto Univ | 458 |
| **30** | Norwegian Marine Technol Res Inst MARINTEK | 34 | **31** | Univ Hong Kong | 26.02 | **31** | Univ Piraeus | 421 |
| **30** | Univ Hong Kong | 34 | **32** | Univ Calabria | 24.92 | **32** | Univ Elect Sci & Technol China | 416 |
| **33** | Univ Calif Berkeley | 32 | **33** | Norwegian Marine Technol Res Inst MARINTEK | 24.05 | **33** | Chalmers University of Technology | 411 |
| **34** | Chung Ang Univ | 31 | **34** | Univ Wollongong | 24.02 | **34** | Cardiff Univ | 409 |
| **34** | Univ Valencia | 31 | **35** | Shanghai Maritime Univ | 23.97 | **35** | Natl Tech Univ Athens | 409 |
| **36** | Shanghai Maritime Univ | 30 | **36** | Univ Aegean | 23.03 | **36** | Univ Tecn Lisboa | 369 |
| **36** | Shanghai Univ | 30 | **37** | Univ Belgrade | 21.50 | **37** | Queensland Univ Technol | 363 |
| **38** | HEC Montreal | 29 | **38** | Queensland Univ Technol | 21.50 | **38** | Kobe Univ Mercantile Marine | 354 |
| **38** | Univ Calabria | 29 | **39** | Univ Wisconsin | 20.74 | **39** | Univ Newcastle Upon Tyne | 346 |
| **38** | Univ Illinois | 29 | **40** | Chalmers | 20.68 | **40** | Univ Maryland | 344 |
| **41** | Eindhoven Univ Technol | 28 | **41** | Chang Jung Christian Univ | 20.53 | **41** | City Univ Hong Kong | 342 |

Table 6: Continued.

| Rank | School | No. Paper | Rank | School | Impact Score | Rank | School | Citation Score |
|---|---|---|---|---|---|---|---|---|
| **41** | MIT | 28 | **42** | Eindhoven Univ Technol | 20.27 | **42** | Dalian Maritime Univ | 336 |
| **41** | Univ Las Palmas Gran Canaria | 28 | **43** | Texas A&M Univ | 20.09 | **43** | Molde Univ Coll | 336 |
| **44** | Aalto Univ | 27 | **44** | Wuhan Univ Technol | 19.05 | **44** | Univ Las Palmas Gran Canaria | 334 |
| **45** | Univ Hamburg | 26 | **45** | Rutgers State Univ | 18.60 | **45** | Univ Southampton | 332 |
| **45** | Univ Oviedo | 26 | **46** | Chung Ang Univ | 18.59 | **46** | Natl Kaohsiung Marine Univ | 329 |
| **45** | Univ Wisconsin | 26 | **47** | Univ Illinois | 18.49 | **47** | Purdue Univ | 324 |
| **45** | Wuhan Univ Technol | 26 | **48** | Univ London Imperial Coll Sci Technol & Med | 18.29 | **48** | Antwerp Maritime Acad | 318 |
| **49** | Chalmers | 25 | **49** | Univ Seville | 18.04 | **49** | Chinese Acad Sci | 305 |
| **49** | City Univ Hong Kong | 25 | **50** | Univ Valencia | 18.03 | **50** | Ecole Polytech | 303 |

the probability of the affiliation obtaining substantial knowledge conversion.

*3.3.2. Ranking Dynamics for Affiliations.* In Table 7, the change of dynamic ranking of affiliations is relatively small. HKPU, NUS, and EU are consistently high. As we mentioned above, there seems to be a direct relationship between the affiliations and researchers. According to Foray and Lundvall [24], human capital (including graduates, highly skilled personnel, and public and private researchers) somewhat tends to flow to have more of the benefits from positive spillovers. Conversely, if there is not too much of a brain drain, the dynamics of affiliation ranking will remain relatively stable. However, if affiliations seek to remain competitive, it will have to retain a positive welfare system and take care of its producers in order to stem a brain drain.

*3.3.3. Collaboration Patterns.* We also analyzed the cooperation pattern of affiliations. Table 8 shows the top ten paired affiliations. The result indicates that affiliations do not stay in static cliques. They are willing to cooperate with new partners in order to achieve diversity and novelty. Core affiliations in the maritime field play the role of spreading advanced research results and promoting the development of the field.

## 4. Analysis of the Countries/Regions

Table 9 displays country rankings from 1996 to 2016. USA, China, and England are the top 3 countries irrespective of the scoring method. Although none of the authors or affiliations in the USA reached the top five, it still has dominant positions in these fields. It is true that local academic researchers could contribute to the competitiveness of the territory. However, in the context of world metropolis, the competition is no longer subject to natural geographical constraints, but more dependent on the territory itself to attract and retain human capital. The advantage of country competitiveness is actively built and not passively suffered. This may also indicate that the American government is good at attracting and promoting research.

Going further into country publications in the port and maritime transport system field, the top 20 countries ranking by the annual number of publications are discussed. Figure 2 shows the change among the top 20 countries over time. It can be seen that the general trend of annual journal publication has increased. Over the past decade, however, the publications of China have grown much faster than in the United States and other countries. In addition, China has kept up with the United States approximately with the same number of journal publications in the port and maritime transport system field since 2014, as indicated in Figure 2. Interestingly, the pioneers are not American or Chinese, even though they are the most influential countries in this field, since they did not publish papers from the beginning.

## 5. Analysis of Research Terms

In bibliometric analysis, it is useful to select several keywords as a representation of important research topics in this field if a researcher wants to explore every facet of a field's major

Table 7: Ranking dynamics of affiliations.

| | school | impact score (1996-2000) | school | impact score (2001-2005) | | school | impact score (2006-2010) | | school | impact score (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Pusan Natl Univ | 6.44 | Pusan Natl Univ | 7.12 | - | Natl Univ Singapore | 34.97 | ▲ | Natl Univ Singapore | 98.16 | - |
| 2 | Natl Univ Singapore | 3.68 | Natl Univ Singapore | 4.33 | - | Istanbul Tech Univ | 24.40 | - | Hong Kong Polytech Univ | 42.30 | ▲ |
| 3 | Chinese Acad Sci | 3.14 | Hong Kong Polytech Univ | 3.33 | ▲ | Hong Kong Polytech Univ | 19.92 | - | Norwegian Univ Sci & Technol | 39.96 | ▲ |
| 4 | Univ Queensland | 2.93 | Univ Hawaii Manoa | 3.30 | ▲ | Pusan Natl Univ | 18.40 | ▼ | Nanyang Technol Univ | 33.29 | ▲ |
| 5 | Hong Kong Polytech Univ | 2.73 | Chinese Acad Sci | 3.14 | ▼ | Natl Kaohsiung Marine Univ | 12.50 | - | Dalian Maritime Univ | 32.20 | ▲ |
| 6 | Univ Edinburgh | 2.44 | Univ Queensland | 2.93 | ▼ | Univ Calabria | 12.16 | ▲ | Pusan Natl Univ | 31.76 | ▼ |
| 7 | Penn State Univ | 2.39 | Univ Hong Kong | 2.60 | ▲ | Univ Genoa | 10.31 | ▲ | Delft Univ Technol | 29.53 | ▲ |
| 8 | Norwegian Univ Sci & Technol | 2.36 | Norwegian Univ Sci & Technol | 2.56 | - | Erasmus Univ | 10.01 | ▲ | Univ Antwerp | 29.44 | ▲ |
| 9 | Erasmus Univ | 2.28 | Erasmus Univ | 2.52 | - | Georgia Inst Technol | 9.90 | ▲ | Erasmus Univ | 28.32 | ▼ |
| 10 | Carnegie Mellon Univ | 2.25 | Univ Genoa | 2.52 | ▲ | Univ Wisconsin | 9.85 | - | Shanghai Maritime Univ | 27.10 | ▲ |
| 11 | Hong Kong Univ Sci & Technol | 1.89 | Univ Texas | 2.44 | - | Univ Hong Kong | 9.64 | ▼ | Tech Univ Denmark | 25.07 | - |
| 12 | Univ Hawaii Manoa | 1.78 | Hong Kong Univ Sci & Technol | 2.29 | ▼ | Norwegian Univ Sci & Technol | 9.54 | ▼ | Old Dominion Univ | 24.22 | - |
| 13 | Univ So Calif | 1.76 | Carnegie Mellon Univ | 2.25 | ▼ | Univ Piraeus | 8.96 | ▲ | Univ Wollongong | 22.55 | - |
| 14 | World Bank | 1.71 | Univ Piraeus | 2.02 | ▲ | Univ Antwerp | 8.41 | - | Univ Genoa | 22.01 | ▼ |
| 15 | Univ Tennessee | 1.52 | Natl Tech Univ Athens | 1.99 | ▲ | Natl Cheng Kung Univ | 8.39 | ▲ | Aalto Univ | 21.88 | - |
| 16 | Univ Genoa | 1.51 | Natl Cheng Kung Univ | 1.83 | ▲ | Delft Univ Technol | 8.06 | - | Univ Plymouth | 21.64 | ▲ |
| 17 | Univ Calif Riverside | 1.40 | Univ So Calif | 1.76 | ▼ | Univ Plymouth | 7.70 | - | Shanghai Univ | 19.62 | ▲ |
| 18 | Georgia Inst Technol | 1.38 | World Bank | 1.71 | ▼ | Shanghai Maritime Univ | 7.62 | - | Shanghai Jiao Tong Univ | 19.36 | ▼ |
| 19 | Natl Tech Univ Athens | 1.36 | Univ Calabria | 1.68 | ▲ | Univ So Calif | 7.29 | ▼ | Natl Kaohsiung Marine Univ | 18.79 | ▼ |
| 20 | Univ Calabria | 1.32 | Queensland Univ Technol | 1.67 | ▲ | Vrije Univ Amsterdam | 6.75 | - | Natl Taiwan Ocean Univ | 18.51 | ▲ |

Table 7: Continued.

| | school | impact score (1996-2000) | school | impact score (2001-2005) | | school | impact score (2006-2010) | | school | impact score (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Florida Int Univ | 1.28 | Georgia Inst Technol | 1.61 | ▼ | Chinese Acad Sci | 6.66 | ▼ | Hong Kong Univ Sci & Technol | 18.46 | ▼ |
| 22 | Univ Piraeus | 1.25 | Florida Int Univ | 1.60 | ▼ | Chalmers | 6.46 | - | Istanbul Tech Univ | 17.41 | ▼ |
| 23 | USN | 1.24 | Univ Tennessee | 1.52 | ▼ | Univ Washington | 6.16 | - | Cardiff Univ | 16.12 | ▼ |
| 24 | Swedish Univ Agr Sci | 1.23 | Fluent Inc | 1.48 | - | Chang Jung Christian Univ | 5.86 | - | Liverpool John Moores Univ | 15.03 | ▼ |
| 25 | Kobe Univ Mercantile Marine | 1.19 | Univ Calif Riverside | 1.40 | ▼ | Cardiff Univ | 5.46 | - | Tongji Univ | 13.87 | - |
| 26 | Liverpool John Moores Univ | 1.17 | Penn State Univ | 1.32 | ▼ | Shanghai Jiao Tong Univ | 5.19 | - | Norwegian Marine Technol Res Inst MARINTEK | 13.81 | - |
| 27 | Univ Hong Kong | 1.03 | Univ Adelaide | 1.29 | - | Univ Western Australia | 5.17 | - | Univ A Coruna | 13.19 | - |
| 28 | Univ Liege | 1.00 | Liverpool John Moores Univ | 1.27 | ▼ | Univ London Imperial Coll Sci Technol & Med | 5.14 | - | Edinburgh Napier Univ | 13.16 | - |
| 29 | Calif State Univ Bakersfield | 0.96 | Univ Missouri | 1.25 | ▲ | Vilnius Gediminas Tech Univ | 5.10 | - | Univ La Laguna | 13.12 | - |
| 30 | Univ Sydney | 0.93 | Swedish Univ Agr Sci | 1.23 | ▼ | Rutgers State Univ | 5.10 | ▲ | Natl Tech Univ Athens | 13.06 | ▲ |
| 31 | Rutgers State Univ | 0.92 | Kobe Univ Mercantile Marine | 1.19 | ▼ | Univ Portsmouth | 5.08 | - | Univ Las Palmas Gran Canaria | 12.88 | - |
| 32 | Univ Glamorgan | 0.92 | World Maritime Univ | 1.16 | - | Natl Taiwan Ocean Univ | 5.04 | ▲ | Univ London Imperial Coll Sci Technol & Med | 12.08 | ▼ |
| 33 | Univ Ottawa | 0.90 | Natl Taiwan Ocean Univ | 1.05 | - | Queensland Univ Technol | 4.69 | ▼ | Univ Calabria | 12.06 | ▼ |
| 34 | Korea Adv Inst Sci & Technol | 0.90 | Texas A&M Univ | 1.04 | - | Kobe Univ | 4.63 | ▲ | Univ Aegean | 11.41 | - |

Table 7: Continued.

| | school | impact score (1996-2000) | school | impact score (2001-2005) | | school | impact score (2006-2010) | | school | impact score (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Univ Missouri | 0.90 | Univ Delaware | 1.02 | ▲ | Nanyang Technol Univ | 4.29 | - | ExxonMobil Res & Engn Co | 11.34 | - |
| 36 | GKSS Forschungszentrum Geesthacht GmbH | 0.89 | Univ Liege | 1.00 | ▼ | Univ Halle Wittenberg | 4.24 | - | Eindhoven Univ Technol | 11.33 | - |
| 37 | NOAA | 0.89 | Newcastle Univ | 0.98 | - | Univ Politecn Cataluna | 4.19 | - | Chung Ang Univ | 11.11 | - |
| 38 | Cornell Univ | 0.88 | Calif State Univ Bakersfield | 0.96 | ▼ | Natl Tech Univ Athens | 4.19 | ▼ | Univ Seville | 11.07 | - |
| 39 | Univ Delaware | 0.88 | Univ Sydney | 0.93 | ▼ | Univ Ulsan | 4.18 | - | Inha Univ | 10.97 | - |
| 40 | Univ Illinois | 0.81 | Kobe Univ | 0.91 | - | Scottish Agr Coll | 4.13 | - | Univ Piraeus | 10.66 | ▼ |
| 41 | Univ E Anglia | 0.80 | Univ Ottawa | 0.90 | ▼ | Univ N Carolina | 4.10 | - | Univ S Carolina | 10.35 | - |
| 42 | Queensland Univ Technol | 0.76 | Univ Michigan | 0.89 | - | Molde Univ Coll | 3.96 | - | Univ British Columbia | 10.18 | - |
| 43 | Aplus Flash Technol Inc | 0.75 | GKSS Forschungszentrum Geesthacht GmbH | 0.89 | ▼ | Dalian Maritime Univ | 3.82 | - | Univ Bergen | 10.18 | - |
| 44 | Kyungsung Univ | 0.74 | NOAA | 0.89 | ▼ | Univ Calif Berkeley | 3.77 | - | Newcastle Univ | 9.76 | ▼ |
| 45 | Univ Carlos III Madrid | 0.73 | Cornell Univ | 0.88 | ▼ | Stevens Inst Technol | 3.76 | - | Univ Sydney | 9.50 | ▼ |
| 46 | Natl Cheng Kung Univ | 0.73 | Fern Univ Hagen | 0.82 | - | CNR | 3.56 | - | Georgia Inst Technol | 9.47 | ▼ |
| 47 | Univ Pittsburgh | 0.72 | Univ Illinois | 0.81 | ▼ | Hanyang Univ | 3.48 | - | Univ Valencia | 9.27 | - |
| 48 | Korea Maritime Inst | 0.72 | Univ E Anglia | 0.80 | ▼ | Purdue Univ | 3.43 | - | Univ Politecn Valencia | 9.08 | - |
| 49 | Tech Univ Berlin | 0.72 | McGill Univ | 0.78 | - | Tsinghua Univ | 3.36 | - | Wuhan Univ Technol | 9.04 | - |
| 50 | Univ Wales Coll Cardiff | 0.72 | CNRS ULP | 0.78 | - | Univ Sci & Technol China | 3.29 | - | Univ Wisconsin | 8.81 | ▼ |

Table 8: The most prolific paired affiliations.

| Rank | Paired affiliations | Number of joint publications |
|---|---|---|
| 1 | Norwegian Marine Technol Res Inst MARINTEK, Norwegian Univ Sci & Technol | 27 |
| 2 | Univ Naples Parthenope, Univ Genoa | 19 |
| 3 | Natl Univ Singapore, Univ Wollongong | 14 |
| 4 | Antwerp Maritime Acad, Univ Antwerp | 14 |
| 5 | HEC Montreal, Norwegian Univ Sci & Technol | 11 |
| 6 | Nanyang Technol Univ, RMIT Univ | 11 |
| 7 | Hong Kong Polytech Univ, Shanghai Univ | 11 |
| 8 | Hong Kong Polytech Univ, Chung Ang Univ | 8 |
| 9 | Nanyang Technol Univ, Univ Antwerp | 8 |
| 10 | Dalian Maritime Univ, Univ Antwerp | 8 |

research topics and their relationships down to the finest detail. Term Frequency-Inverse Document Frequency (TF-IDF) promoted by Salton and Buckley [25] is a typical method of identifying important terms by combining their popularity and discrimination. The TF-IDF method can also be applied to bibliometric analysis. For example, Jaboska-Sabuka et al. [26] used TF-IDF to identify informative words from publication keywords of the research domain in order to predict research trends. Roche [27] used TF-IDF to select publication keywords of scientific fields and categorized them into unusual terms, established terms, and cross-sectional terms. $(\mathrm{tf} - \mathrm{idf}_t)$ is calculated for each word. Salton et al. [28] from the following equation:

$$tfidf_t = \sum_{d}^{N} tf_{t,d} \times \log \frac{N}{df_t} \quad (4)$$

where $tf_{t,d}$ is frequency of the word t in the document d, N is number of the articles, and $df_t$ is the number of articles where word t existed.

*5.1. Overall Analysis.* Various research terms are observed in articles published in the time period from 1996 to 2016. Table 10 shows the top 60 research terms of these fields. From Table 10, we can indicate that port and maritime transport system field have been classified in the literature in terms of shipping or port research and their respective methodologies applied in the research. We also built the word cooccurrence table to create highly cooccurring word sets. The input words in the table satisfy the following two limitations. First, the tf-idf factor of these words is greater than the A threshold value. Second, the number of publications which contained a candidate word is within the specified range by the B threshold. An analysis of Table 11 reveals that the specific shipping topics include seafarers, short sea shipping, shipping performance/management, shipping finance, and shipping safety. Specific port topics include port governance/privatization, port performance, port state control, port competition, and port choice.

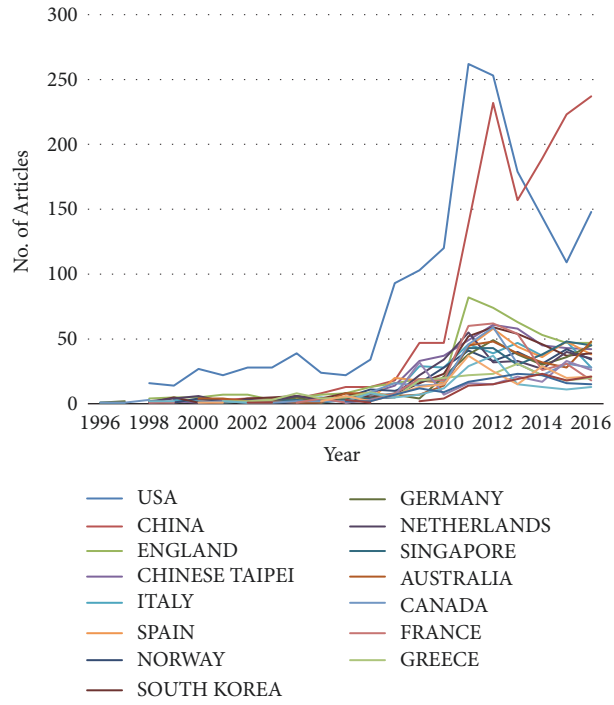


Figure 2: Trend of the countries/regions.

Table 12 shows the dynamics of the research terms. Although there are several new words that arise throughout time, the rise and fall of research terms are prominent in the port and maritime transport system field. In 2006-2010, some new words such as berth and vessel turned up as new research objects. In 2001-2015, the word emission turned up as a new research topic and reached the top 5. This may be caused by some environment protection policy such as Regulation 14 of the IMO that required ships to switch to low sulfur fuels in ECA areas. Another notable point is the rank change of the words risk and liner. Risk was a top 8 word in 1996-2000, but fell to 18th in 2011-2015. By inspecting

Table 9: The ranking of the countries/regions.

| Rank | Country | No. papers | Rank | Country | Impact Score |
|---|---|---|---|---|---|
| **1** | USA | 993 | **1** | USA | 1170.25 |
| **2** | PEOPLES R CHINA | 714 | **2** | PEOPLES R CHINA | 972.35 |
| **3** | ENGLAND | 305 | **3** | ENGLAND | 384.71 |
| **4** | CHINESE TAIPEI | 263 | **4** | CHINESE TAIPEI | 354.65 |
| **5** | SOUTH KOREA | 205 | **5** | SPAIN | 269.14 |
| **6** | ITALY | 196 | **6** | NORWAY | 265.79 |
| **7** | SPAIN | 194 | **7** | SINGAPORE | 263.14 |
| **8** | NORWAY | 189 | **8** | ITALY | 263.10 |
| **9** | GERMANY | 183 | **9** | NETHERLANDS | 246.82 |
| **10** | NETHERLANDS | 182 | **10** | GERMANY | 246.18 |
| **11** | SINGAPORE | 172 | **11** | SOUTH KOREA | 244.03 |
| **12** | AUSTRALIA | 154 | **12** | AUSTRALIA | 212.31 |
| **13** | CANADA | 141 | **13** | FRANCE | 212.21 |
| **14** | FRANCE | 141 | **14** | CANADA | 197.57 |
| **15** | GREECE | 131 | **15** | TURKEY | 166.71 |
| **16** | TURKEY | 107 | **16** | GREECE | 161.82 |
| **17** | JAPAN | 99 | **17** | BELGIUM | 117.86 |
| **18** | BELGIUM | 87 | **18** | DENMARK | 113.96 |
| **19** | SWEDEN | 78 | **19** | SWEDEN | 108.00 |
| **20** | DENMARK | 74 | **20** | JAPAN | 107.91 |
| **21** | CROATIA | 69 | **21** | PORTUGAL | 76.12 |
| **23** | PORTUGAL | 56 | **22** | INDIA | 69.68 |
| **24** | SCOTLAND | 52 | **23** | SCOTLAND | 67.00 |
| **25** | IRAN | 51 | **24** | FINLAND | 64.27 |
| **26** | INDIA | 49 | **25** | IRAN | 61.00 |
| **27** | RUSSIA | 49 | **26** | BRAZIL | 58.16 |
| **28** | POLAND | 40 | **27** | SWITZERLAND | 44.00 |
| **29** | BRAZIL | 39 | **29** | WALES | 40.62 |
| **30** | FINLAND | 38 | **30** | POLAND | 39.64 |
| **31** | WALES | 36 | **31** | CROATIA | 36.24 |
| **32** | LITHUANIA | 33 | **32** | LITHUANIA | 34.05 |
| **33** | SWITZERLAND | 26 | **33** | SERBIA | 27.93 |
| **34** | CHILE | 24 | **34** | ISRAEL | 24.99 |
| **35** | ISRAEL | 23 | **35** | CYPRUS | 21.23 |
| **36** | SLOVENIA | 23 | **36** | NEW ZEALAND | 21.16 |
| **37** | SERBIA | 20 | **37** | RUSSIA | 21.15 |
| **38** | MALAYSIA | 18 | **38** | AUSTRIA | 20.00 |
| **39** | NEW ZEALAND | 16 | **39** | CHILE | 19.75 |
| **40** | SOUTH AFRICA | 16 | **40** | MALAYSIA | 19.25 |
| **41** | AUSTRIA | 14 | **41** | SLOVENIA | 17.52 |
| **42** | CYPRUS | 12 | **42** | U ARAB EMIRATES | 16.55 |
| **43** | MEXICO | 12 | **43** | SOUTH AFRICA | 14.76 |
| **44** | U ARAB EMIRATES | 12 | **44** | MEXICO | 13.88 |
| **45** | UKRAINE | 11 | **45** | THAILAND | 12.11 |
| **46** | MONTENEGRO | 10 | **46** | LEBANON | 10.98 |
| **47** | IRELAND | 8 | **47** | IRELAND | 9.59 |
| **48** | LEBANON | 8 | **48** | CZECH REPUBLIC | 9.18 |
| **49** | THAILAND | 8 | **49** | NIGERIA | 6.83 |
| **50** | ARGENTINA | 6 | **50** | MONTENEGRO | 6.49 |

Table 10: The top 60 research terms.

| Word | TF-IDF | Word | TF-IDF |
|---|---|---|---|
| port | 201.99 | management | 58.21 |
| container | 171.73 | simulation | 57.80 |
| terminal | 130.71 | supply | 57.59 |
| shipping | 121.37 | dynamic | 56.89 |
| ship | 120.68 | liner | 56.88 |
| cost | 100.25 | company | 56.76 |
| transport | 97.69 | logistics | 56.56 |
| control | 92.95 | cargo | 56.49 |
| network | 90.09 | factor | 56.44 |
| service | 86.66 | impact | 56.28 |
| algorithm | 85.17 | route | 55.70 |
| maritime | 82.58 | rate | 55.62 |
| vessel | 77.78 | planning | 55.03 |
| market | 75.80 | development | 54.87 |
| transportation | 74.55 | optimization | 54.57 |
| risk | 73.53 | safety | 54.32 |
| freight | 72.68 | yard | 54.17 |
| approach | 72.35 | truck | 53.48 |
| operation | 71.54 | price | 52.32 |
| optimal | 70.83 | trade | 52.11 |
| data | 67.46 | traffic | 51.59 |
| efficiency | 64.82 | heuristic | 51.58 |
| crane | 64.69 | marine | 51.10 |
| scheduling | 63.60 | capacity | 51.04 |
| process | 63.14 | level | 50.22 |
| policy | 61.66 | economic | 50.06 |
| strategy | 60.64 | flow | 48.94 |
| emission | 59.64 | sea | 48.66 |
| chain | 59.52 | condition | 47.73 |
| industry | 58.51 | function | 47.45 |

Table 11: The top 6 words cooccurrence table for port and shipping.

| Cooccurrence word | Frequent | Cooccurrence word | Frequent |
|---|---|---|---|
| shipping management | 603 | port perform | 824 |
| shipping perform | 354 | port state control | 383 |
| shipping network | 232 | port governance/government | 209 |
| shipping short-term | 168 | port choice | 188 |
| shipping safety | 157 | port competition | 183 |
| shipping finance | 91 | port private(privatization) | 135 |

the papers that include the word risk, we determined that the author Jin Wang published numerous papers examining maritime risk in 1996-2000, but he did not publish as much from 2011 to 2015, and his rank fell from 10 to 40. We can draw an obvious conclusion that Shuaian Wang is a specialized researcher investigating liners, and he is the top author in 2011-2015. This finding indicates that a specific research may be influenced by one or two authors.

Table 12: Ranking dynamics of research terms.

| | Word | TF-IDF (1996-2000) | Word | TF-IDF (2001-2005) | | Word | TF-IDF (2006-2010) | | Word | TF-IDF (2011-2015) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | freight | 2.88 | container | 3.46 | ▲ | port | 16.37 | ▲ | port | 20.67 | - |
| 2 | network | 2.34 | port | 3.24 | ▲ | container | 14.64 | ▼ | container | 18.52 | - |
| 3 | science | 2.11 | yard | 2.45 | - | shipping | 8.27 | ▲ | shipping | 14.50 | - |
| 4 | container | 2.09 | cost | 2.28 | ▲ | terminal | 8.07 | ▲ | ship | 13.86 | ▲ |
| 5 | carrier | 2.00 | truck | 2.19 | ▲ | cost | 7.86 | ▼ | emission | 12.10 | - |
| 6 | intermodal | 1.99 | heuristic | 1.98 | - | maritime | 7.45 | - | terminal | 11.02 | ▼ |
| 7 | transportation | 1.83 | ship | 1.90 | ▲ | transport | 7.42 | ▲ | cost | 9.75 | ▼ |
| 8 | risk | 1.82 | terminal | 1.86 | ▲ | market | 7.09 | ▲ | network | 9.46 | ▲ |
| 9 | port | 1.76 | vehicle | 1.76 | - | crane | 6.94 | ▲ | transport | 9.29 | ▼ |
| 10 | policy | 1.65 | safety | 1.76 | ▲ | transportation | 6.85 | ▲ | service | 8.69 | ▲ |
| 11 | terminal | 1.56 | policy | 1.73 | ▼ | yard | 6.27 | ▼ | freight | 8.48 | ▼ |
| 12 | truck | 1.56 | transport | 1.71 | ▲ | berth | 6.17 | - | control | 8.47 | - |
| 13 | ocean | 1.54 | crane | 1.67 | - | scheduling | 5.97 | - | algorithm | 8.43 | ▲ |
| 14 | service | 1.51 | transportation | 1.65 | ▼ | ship | 5.94 | ▲ | approach | 8.16 | ▲ |
| 15 | market | 1.50 | algorithm | 1.62 | - | network | 5.87 | ▼ | liner | 7.93 | - |
| 16 | operation | 1.49 | capacity | 1.61 | - | operation | 5.79 | - | crane | 7.91 | ▼ |
| 17 | ship | 1.45 | market | 1.57 | ▼ | service | 5.61 | ▲ | maritime | 7.73 | ▼ |
| 18 | transport | 1.44 | shipping | 1.48 | - | approach | 5.43 | - | risk | 7.66 | ▼ |
| 19 | cost | 1.41 | service | 1.48 | ▼ | vessel | 5.36 | - | optimal | 7.61 | - |
| 20 | safety | 1.31 | product | 1.44 | - | algorithm | 5.34 | - | cargo | 7.48 | - |

## 6. Conclusions

In this paper, we have analyzed maritime-related academic research. We utilized bibliometric analysis method to illustrate the evolution of this field. The two criteria used in ranking were the number of published papers and the impact score (reflecting the prestige of the journals). We focused on the papers published in journals included in the Science Citation Index and Social Science Citation Index.

Ranking criteria influences the overall rankings for authors and affiliations sensitively. In terms of the impact score, the most active researchers are S.A. Wang, Q. Meng, T. Notteboom, J.S.L. Lam, and K.H. Kim. The most active affiliations were the National University of Singapore, Hong Kong Polytechnic University, the Norwegian University of Science and Technology, Delft University of Technology, and the Nanyang Technology University. Affiliations rankings seem to have been affected by authors ranking. For example, the top affiliation has the top author. However, the network features of authors and affiliations are quite different. At the microlevel, overall research terms in the container port and maritime field are identified by the TF-IDF algorithm.

This paper has limitations. In terms of the scoring method, especially impact score, the impact factor does not reflect a journals quality perfectly. For instance, several highly respected journals have a low impact factor. There are several other indicators that can measure the impact, such as the H index and the number of citations for authors.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they are no conflicts of interest regarding the publication of this paper.

## References

[1] L. Zhen, "Tactical berth allocation under uncertainty," *European Journal of Operational Research*, vol. 247, no. 3, pp. 928–944, 2015.

[2] L. Zhen, "Modeling of yard congestion and optimization of yard template in container ports," *Transportation Research Part B: Methodological*, vol. 90, pp. 83–104, 2016.

[3] L. Zhen, E. P. Chew, and L. H. Lee, "An integrated model for berth template and yard template planning in transshipment hubs," *Transportation Science*, vol. 45, no. 4, pp. 483–504, 2011.

[4] C. Zhou, L. I. Haobin, W. Wang, L. H. Lee, and E. P. Chew, "Connecting the belt and road through sea-rail collaboration," *Frontiers of Engineering Management*, vol. 4, no. 3, pp. 315–324, 2017.

[5] W. Shi and K. X. Li, "Themes and tools of maritime transport research during 2000-2014," *Maritime Policy & Management*, vol. 44, no. 2, pp. 151–169, 2017.

[6] *Annual Review of Global Container Terminal Operators*, Drewry Shipping Consultants, London, 2016.

[7] Y.-Y. Lau, C. Ducruet, A. K. Y. Ng, and X. Fu, "Across the waves: a bibliometric analysis of container shipping research since the 1960s," *Maritime Policy & Management*, vol. 44, no. 6, pp. 667–684, 2017.

[8] C.-Y. Lee and D.-P. Song, "Ocean container transport in global supply chains: Overview and research opportunities," *Transportation Research Part B: Methodological*, vol. 95, pp. 442–474, 2017.

[9] K. Charles, "Marine science and blue growth: Assessing the marine academic production of 123 cities and territories worldwide," *Marine Policy*, vol. 84, pp. 119–129, 2017.

[10] S.-H. Woo, S. J. Pettit, D.-W. Kwak, and A. K. C. Beresford, "Seaport research: A structured literature review on methodological issues since the 1980s," *Transportation Research Part A: Policy and Practice*, vol. 45, no. 7, pp. 667–685, 2011.

[11] W. K. Talley, "Maritime transportation research: Topics and methodologies," *Maritime Policy & Management*, vol. 40, no. 7, pp. 709–725, 2013.

[12] Y. T. Chang, K. S. Choi, A. Jo, and H. Park, "Top 50 authors, affiliations, and countries in maritime research," in *Proceedings of the and countries in maritime research. International Journal of Shipping Transport Logistics*, vol. 10, p. 7, 2018.

[13] H. Davarzani, B. Fahimnia, M. Bell, and J. Sarkis, "Greening ports and maritime logistics: A review," *Transportation Research Part D: Transport and Environment*, vol. 48, pp. 473–487, 2015.

[14] S. A. Mansouri, H. Lee, and O. Aluko, "Multi-objective decision support to enhance environmental sustainability in maritime shipping: a review and future directions," *Transportation Research Part E: Logistics and Transportation Review*, vol. 78, pp. 3–18, 2015.

[15] E. Sharaf, M. Z. Shah, and A. S. Al-Iraqi, "Efficiency analysis of analysis of container port: a review," in *Proceedings of Seatuc Symposium*, 2014.

[16] T. E. Notteboom, "Container Shipping And Ports: An Overview," *Review of Network Economics*, vol. 3, no. 2, 2010.

[17] M. Saunders, P. Lewis, and A. Thornhill, "Research methods for business students (5th edn)," *Qualitative Market Research*, vol. 3, no. 4, pp. 215–218, 2009.

[18] J. Rowley and F. Slack, "Conducting a literature review," *Management Research News*, vol. 27, no. 6, pp. 31–39, 2004.

[19] S. Seuring and S. Gold, "Conducting content-analysis based literature reviews in supply chain management," *Supply Chain Management Review*, vol. 17, no. 5, pp. 544–555, 2012.

[20] C. R. Carter, D. B. Vellenga, J. J. Gentry, and B. J. Allen, "Affiliation of authors in transportation and logistics academic journals: A reassessment," *Transportation Journal*, vol. 44, no. 2, pp. 54–64, 2005.

[21] C. Hoeffel, "journal impact factors," *Allergy*, vol. 53, no. 12, pp. 1225-1225, 1998.

[22] D. C. Greenwood, "Reliability of journal impact factor rankings," *BMC Medical Research Methodology*, vol. 7, 2007.

[23] D. J. De Solla Price, "Networks of scientific papers," *Science*, vol. 149, no. 3683, p. 510, 1965.

[24] D. Foray and B. A. Lundvall, "The knowledge-based economy," *Modeled Measured Simulated Boca Raton Fl Universal*, vol. 50, no. 5, 1996.

[25] G. Salton and C. Buckley, "Term-weighting approaches in automatic text retrieval," *Information Processing & Management*, vol. 24, no. 5, pp. 513–523, 1988.

[26] M. Jaboska-Sabuka, R. Sitarz, and A. Kraslawski, "Forecasting research trends using population dynamics model with Burgers' type interaction," *Journal of Informetrics*, vol. 8, no. 1, pp. 111–122, 2014.

[27] I. Roche, D. Besagni, C. François, M. Hörlesberger, and E. Schiebel, "Identification and characterisation of technological topics in the field of Molecular Biology," *Scientometrics*, vol. 82, no. 3, pp. 663–676, 2010.

[28] G. Salton, A. Wong, and C. S. Yang, "A vector space model for automatic indexing," *Communications of the ACM*, vol. 18, no. 11, pp. 613–620, 1974.