

## Comparative bibliometric and network analysis of maritime transport/shipping literature using the Web of Science database

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### Abstract

This paper presents a bibliometric analysis of maritime transport/shipping-related publications between 1975 and November 2018 in order to describe the profile and research themes. Comprehensive queries were used to reveal the general structure of maritime transport/shipping-related literature in the context of the Science Citation Index-Expanded (SCI-Expanded) and Social Sciences Citation Index (SSCI) databases. The analysis was conducted using bibliometric mapping. Five years of maritime/shipping literature was also comparatively presented. The results indicated major research areas, leading authors, countries, organizations, journals, and publications with the contributions of the comments of leading authors. Within the five-year period, maritime surveillance research and marine engineering research clusters were identified as developing clusters that expanded and received increased interest. Economic studies decreased, while operations research increased in the maritime transport/shipping literature. Optimization research and marine engineering research appear to be growing research clusters. Interdisciplinary research appears to have a high chance of being published in SCI-Expanded and SSCI in the future. The main contribution of this paper was the identification of areas of current research interests which allowed the quantification and visualization of changes in the entire body of shipping literature over a short time period.

### Introduction

Bibliometric research is vital for analyzing research trends and for investigating the structure, characteristics, and patterns of related disciplines (Mao et al., 2015) and can even provide foresight for research activities (van Raan, 2005). A traditional bibliometric analysis evaluates publications by assessing publication types, authors, countries, organizations, source titles, and research areas (Zhuang et al., 2013). The number of bibliometric researches in a broad range of disciplines indicates there is increasing interest in bibliometric analysis (e.g., Hou et al., 2015; Muñoz-Leiva, Porcu & del Barrio-García, 2015; Song, Heo & Lee, 2015).

From this point of view, it appears there is a need for comprehensive research on maritime transport/shipping-related bibliometric analysis in order to provide insight into this broad and diverse research area. Accordingly, the aim of this study is to determine the structure of maritime transport/shipping literature by carrying out a detailed bibliometric analysis within the scope of SCI and SSCI publications. Comparisons for the 5-year period between 2013 and 2018 were conducted. In addition to analyzing the current characteristics of the maritime transport/shipping literature, this study also provides an understanding of the literature and some evaluations.

## Literature review

Maritime transport/shipping literature has developed at an increasing rate in recent decades, making it increasingly important to summarize the knowledge in this area. The number of research works using methods like content analysis has significantly increased in various disciplines within this field (Ducruet et al., 2014). However, there are still few comprehensive studies that include bibliometric methods. Ng et al. (Ng et al., 2012) retrieved publications from the Web of Science “Transportation” area and contributed a statistical analysis that consisted of highly-cited publications, top journals, and organizations. Moreover, they conducted a similar, more comprehensive study in 2013 (Ng et al., 2013). On the other hand, Ng (Ng, 2013) investigated the trends in port geography by focusing on the publication years and journals by reviewing 155 related articles to provide some preliminary observations on port geography research trends. Lau et al. (Lau et al., 2013) reviewed container shipping within the scope of major scholarly journals, research topics, research cooperation, and geographical focus. Afterward, Ng and Ducruet (Ng & Ducruet, 2014) studied port geography by reviewing 399 publications. The cohesiveness of the port geography publications was analyzed by co-authorships, geographical coverage, and the distribution of journal papers under different disciplines and citations. Ducruet et al. (Ducruet et al., 2014) carried out a pioneering bibliometric analysis on container shipping research based on the co-occurrence of words in paper titles in order to reveal the container shipping structure. More recently, Lau et al. (Lau et al., 2017) expanded this research with collaborative and semantic patterns of container shipping based on the co-occurrence of title words. Another bibliometric study was performed by Chen et al. (Chen et al., 2018) which identified port and maritime transport literature in terms of the core authors/affiliations, their rankings, and collaboration patterns. Similarly, Davarzani et al. (Davarzani et al., 2016) studied green ports and maritime logistics publications using bibliometric and network analysis. Shin et al. (Shin et al., 2018) used bibliometric analysis with text mining in order to reveal the structure of the sustainability literature in maritime studies. A comprehensive bibliometric analysis was also used to explore the evolution of shipping finance and investment research by Alexandridis et al. (Alexandridis et al., 2018). Recently, Munim and Saeed (2019) and Wagner (2019) (Munim & Saeed, 2019; Wagner, 2019) contributed

to the shipping literature with bibliometric studies to reveal trends and set a research agenda. Munim and Saeed (Munim & Saeed, 2019) focused on seaport competitiveness, while Wagner (Wagner, 2019) looked for green shipping practices. Davarzani et al. reviewed specific aspects of maritime literature (Davarzani et al., 2016).

Despite these studies, a holistic view of the literature is still missing. In order to fill this gap, this study aims to provide a comprehensive and detailed analysis of a wide range of maritime transport/shipping publications within a certain time span. The change in the academic outputs of the shipping/maritime literature, the change of the research topics and related disciplines, and major contributors to the literature are the main topics addressed in the study.

## Data sources and methodology

As a first stage, to identify the sample of this research and review the prior literature, Web of Science (WoS), the citation database of Thomson Reuters, was searched for maritime transport/shipping-related topics to obtain a bibliography of all related publications. While deciding which database to choose, the coverage of WoS and Scopus were investigated by searching for source titles with maritime or shipping and ship keywords. WoS covered 30 sources, and Scopus listed 36. However, most of the journals overlapped, and sources that were not listed in WoS tended to have few citations. WoS-indexed journals also have impact factors and WoS also provides standard and many widely-used tools for bibliometric researches (Meho & Yang, 2007). Therefore, WoS was selected as the data source. In order to obtain bibliographies, a data set was compiled from The SCI-Expanded and SSCI databases under the Web of Science core collection from 1975 – November 2018. Before determining which keywords to search, a series of search terms was used to find the proper query. Finally, the following nine queries were used to collect data to provide a comprehensive number of publications related to maritime transport/shipping literature. TS implies that the search occurred in Topic Field (Title, Abstract, Author Keywords, and Keywords Plus). The first query was composed of keywords of eight other queries to eliminate duplicates from counting publications more than once.

**Query 1:** TS = Maritime AND Shipping OR TS = Port AND Ship\* OR TS = Port AND Maritime OR TS = “Maritime Transport” OR TS = Maritime AND Logistics OR

TS = “Marine Transportation” OR TS = “Marine Engineering” OR TS = “Marine Tourism” **Search Date:** 11.10.2018

**Query 2:** TS = “Marine Transportation” **Search Date:** 20.10.2018

**Query 3:** TS = “Marine Engineering” **Search Date:** 20.10.2018

**Query 4:** TS = “Marine Tourism” **Search Date:** 21.10.2018

**Query 5:** TS = Maritime AND TS = Shipping **Search Date:** 14.11.2018

**Query 6:** TS = Port AND TS = Ship\* **Search Date:** 16.11.2018

**Query 7:** TS = Port AND TS = Maritime **Search Date:** 17.11.2018

**Query 8:** TS = “Maritime Transport” **Search Date:** 18.11.2018

**Query 9:** TS = Maritime AND TS = Logistics **Search Date:** 18.11.2018

Within the framework of this study, traditional bibliometric analyses of data such as document types, authors, countries, publication years, source title, organizations, and Web of Science categories were assessed. Refining the results with WoS tools provides bibliometric analysis, along with counting frequencies. Moreover, to evaluate the research performance and following scientific developments (van Raan, 1999), a network map was also created using VOSviewer 1.6.3. All searched queries were exported with a full record and cited references in tab-delimited format from WoS and processed in VOSviewer. VOSviewer is a software tool developed by the Centre for Science and Technology Studies and is appropriate for visualizing large maps (Cobo et al., 2011).

## Results and discussion

### Bibliometric analysis

Publications related to maritime transport/shipping literature were identified between 1975 and November 2018. In eight queries, a total of 6,416 publications were identified, with 5067 publications in the first query. The most frequently published document type was “article,” between 87.29% – 93.62%. Under the first query, the number of publications has increased nearly two times in the past five years. As consistent with most of the single-query searches, article numbers increased at 1.33% while, and conference papers decreased by 1.82%. Other document types were found to remain nearly constant, with small increases according to the 2013 search. For the Maritime AND Shipping query, there were 1354 publications up until 2013. Within the five years (from 2013 to 2018), the publication count more than doubled, and articles and reviews increased two times as well. However, there was only a slight increase in proceedings. In the same way, the publication count of the Port AND Maritime query doubled, and article numbers increased while the conference papers decreased. Unlike with the other queries, the “Maritime Transport” query showed an increase in reviews, book reviews, and editorial materials. Articles increased 0.4% at the fifth query within a five-year period, and proceedings papers, editorial materials, and reviews increased by 1.06%, 1.29%, and 0.81%, respectively. Under the “Marine Transportation” and “Marine Engineering” query, only 107 and 100 publications were added to the literature, respectively. Under the “Marine Tourism”

**Table 1. Contributions of the leading countries between 1975 – November 2018**

Countries / Number of Publications															
Maritime AND Shipping	Port AND Ship*	Port AND Maritime	“Maritime Transport”	Maritime AND Logistics	“Marine Transportation”	“Marine Engineering”	“Marine Tourism”								
USA	469	USA	732	USA	227	Spain	46	USA	68	USA	90	PRC	63	Australia	18
PRC	313	PRC	389	PRC	147	USA	42	England	55	PRC	37	USA	29	USA	15
England	277	England	220	England	130	England	38	PRC	51	Canada	23	England	22	New Zealand	9
Norway	179	Canada	192	Spain	103	PRC	33	Italy	41	Taiwan	17	Germany	11	Taiwan	7
Germany	160	Australia	201	Italy	101	France	32	Spain	35	Turkey	17	Taiwan	10	South Africa	7
Italy	153	Italy	154	Australia	75	Germany	30	S. Korea	32	Australia	13	Japan	9	Brazil	4
Canada	139	S. Korea	147	France	75	Norway	29	Canada	31	Japan	12	Italy	9	Indonesia	4
Australia	123	Spain	138	Canada	55	Italy	24	Germany	31	Norway	9	Turkey	8	Netherlands	4
France	122	Singapore	113	Netherlands	55	Australia	21	Singapore	26	France	7	Norway	7	Canada	4
S. Korea	120	Taiwan	110	S. Korea	55	Netherlands	19	Netherlands	25	Iran	7	Iran	6		

\* The ranking of countries was determined by the position of the affiliated institution of each author. The leading countries were listed in total publications.

query, a 5% growth in articles was observed within five years.

As shown in Table 1, the USA was the most productive country in almost every query. The People's Republic of China (PRC) and England were also prominent countries with regards to publication count. USA was encountered in every query, while the PRC was found seven of the queries. Moreover, Australia, Canada, England, and Italy were found in six queries. England and Italy presented the same search patterns. Seven of these countries were from Europe, eight countries were in Asia, two countries were in North America, one country was in Africa, two countries were in Oceania, one country was in S. America.

According to the results of the Maritime AND Shipping query, within the five-year span, there was a four-fold increase in the number of publications by the PRC. Australia and S. Korea also published nearly three times more. However, Greece was found in the contributing countries list of 2013, but not 2018. As for the Port AND Ship\* query, the PRC increased its number of publications by nearly four times. Italy, S. Korea, and Singapore also increased their number of scientific publications more than two times. However, Japan and Germany lost their places in the top ten list in 2018. Identically, the PRC published only 30 papers in 2013 but has increased its publication count by more than four times. Unlike in the other queries, the USA was not at the top of the list in the "Maritime Transport" query. Similarly, the PRC has increased its number of publications by five times in the Maritime AND Logistics query, while Singapore increased three times. In the "Marine Transportation" query, Turkey increased its number of publications by a factor of three. The PRC placed number

one in the "Marine Engineering" query, and the USA dropped to second place, with only six publications within these five years. Similarly, in the "Marine Tourism" query, the USA dropped to second place with 5 publications between these years and was replaced with Australia.

The most productive authors within the 8 queries are listed in Table 2. Since 2013, contributing authors listed at the fourth query have changed many times. Fagerholt, K. from Norwegian University of Science and Technology was the leading author in three queries. Moreover, Christiansen, M. also contributed intensely to three queries. Meng, Q. and Wang, S.A. also appeared as pioneering authors for port-related research. Laxe, F.G. was also found in four queries. The most contributing author in each query is listed at the top of each column.

The top-performing organizations were also considered. For the Maritime AND Shipping query, Liverpool University and the National University of Singapore were not listed as top-performing universities after five years and were replaced by the Aalto University and Nanyang Technological University. As for the Port AND Ship\* query, Kobe University and National Taiwan University switched places with Dalian Maritime University and Nanyang Technological University within the five-year period. Norwegian University of Science and Technology and Hong Kong Polytechnic University were the most encountered organizations in the searched queries. Genova University published only 9 publications for the third query in 2013, but it increased its publication count by four times.

Liverpool John Moores University has increased publications four times and managed to find a place among the top five universities. Unlike the other

**Table 2. Contributions of the leading authors between 1975 – November 2018**

Authors / Number of Publications									
Maritime AND Shipping	Port AND Ship*	Port AND Maritime	"Maritime Transport"	Maritime AND Logistics	"Marine Transportation"	"Marine Engineering"	"Marine Tourism"		
Fagerholt, K.	40 Wang, SA.	40 Ducruet, C.	17 Ducruet, C.	9 Song, DW.	9 Grabowski, M.	7 Wang, J	5 Saayman, M.	5	
Çelik, M.	28 Meng, Q.	36 Christiansen, M.	16 Wong, Y.D	7 Lam, J.S.L.	7 Lin, CY.	6 Çelik, M.	4 Van Der Merwe, P.	4	
Kujala, P.	26 Lam, JSL.	26 Yang, Z.L.	15 Yang, Z.L.	7 Parola, F.	7 Chou, CC.	4	Slabbert, E.	4	
Wang, J.	25 Ruiz, GM.	23 Fagerholt, K.	13 Yuan, K.F.	7 Kim, KH	6 Corbett, JJ.	4	Ku, KC.	3	
Christiansen, M.	22 Macisaac, HJ.	20 Lee, P.T.W	13 David, M.	5 Laxe, FG	6 Mohajerani, A	4	Chen, TC.	3	
Akyuz, E.	21 Christiansen, M.	18 Wang, SA.	13 Gollasch, S.	5 Lee, P.T.W	6 Munro, M.C	4			
Goerlandt, F.	21 Fagerholt, K.	16 Parola, F.	11 Lam, J.S.L.	5 Legato, P.	6 Wang, KH.	4			
Montewka, J.	21 Notteboom, T.	16 Lam, J.S.L.	10 Martinez-Zarzoso, I.	5 Sciomachen, A.	6				
Soares, C.G.	20 Bailey, SA.	15	Thai, V.V.	5					
Yan, XP	18 Gollasch, S.	15	Wilmsmeier, G.	5					

\* Some columns have fewer than 10 entries because many authors had the same number of publications.

queries, organizations in the “Maritime Transport” query changed, and only Edinburg Napier University was listed in 2018. Under the Maritime AND Logistics, “Marine Transportation”, and “Marine Tourism” queries, most of the organizations changed over the five-year period. However, under the “Marine Engineering” query, the same organizations were observed, and only their order changed. Norwegian University of Science and Technology, National University of Singapore, Hong Kong University, Nanyang Technology University, Hong Kong Polytechnic University, National Taiwan Ocean University, Dalian University, Northwest University South Africa were the leading institutions under each query.

The most active journals under each of the eight queries were also determined. For the Port and Maritime query, three journals replaced the top five leading journals. Maritime Economics and Logistics, Transportation Research Part E, Transportation Research Part D were listed in 2018 instead of these three sources: Proceedings of the Institution of Civil Engineers Maritime Engineering, Marine Policy and Transportation Research Record. Maritime transport/shipping-related publications were concentrated in these top journals. Maritime Policy and Management was the leading journal in five queries but was not listed in any of the other queries. Marine Policy and Maritime Economics and Logistics were also encountered in four queries. Ocean Engineering was the most contributing journal for the “Marine Transportation” and “Marine Engineering” queries, while Ocean Coastal Management was the most contributing journal for “Marine Tourism”. The maritime transport/shipping-related publications were searched using Web of Science categories. As for the Maritime AND Shipping query, environmental sciences were one of the five major topics in 2013 but was listed in 2018. According to the results of the Port AND Ship\* query, environmental sciences were at the top of the list, and marine freshwater biology and economics were also in the top five WoS subject categories in 2013.

After five years, WoS subject trends were differentiated. The economics category dropped from the list within the five years in the Port AND Maritime query. Instead of economics, the operations research management science category became a trending topic. Under the “Marine Transportation” query, environmental studies dropped from the list and were replaced by the engineering marine category. As for “Marine Engineering” and “Marine Tourism” queries, the WoS categories remained the

same within the five years, and only their rankings changed. In summary, it was found that the transportation category was the most contributing category for Maritime AND Shipping, Port AND Ship\*, Port AND Maritime, “Maritime Transport”, Maritime AND Logistics queries, environmental sciences for the “Marine Transportation” query, oceanography for “Marine Engineering” query, and environmental sciences for the “Marine Tourism” query.

Table 3 lists the publication trends, country distribution, author productivity, top-listed organizations, publication sources, and Web of Science categories for the first query which consisted of all eight queries. With this search, duplications, which refers the same publication appeared in at two or more query, were eliminated. According to Table 3, the USA was the most productive country with the largest number of publications, followed by England, and PRC. Therefore, some important points were observed by comparing the above findings with the 2013 maritime/shipping structure. USA, England, Australia, Spain, and France were at the same rank as 2013. PRC published three times more publications and replaced Canada. Italy and S. Korea published more than two times as many and received higher ranks as well. However, Germany and Australia dropped two and one ranks, respectively. Although PRC publishes large quantities of publications and places highest when it is investigated query-by-query, in total, the USA and England were the most productive countries. With regards to author productivity, Fagerholt, K. contributed the greatest number of publications (44), followed by Meng, Q. (43), and Wang, S.A. (42). In 2013, the most productive author was Fagerholt, K. Except for Fagerholt, K. the rankings were unchanged between nearly the same authors, and only three authors changed in the list within the five-year period. Lee, P.T.W., Kujala, P., Yang, Z.L. were also found in the 2018 search. In order to determine publication trends, annual publications were listed in descending order, and the number of articles steadily increased after 2007.

Moreover, Maritime Policy and Management was the most contributed-to journal, with 156 publications, followed by Marine Pollution Bulletin (232), and the Maritime Pollution Bulletin (157). Transportation Research Part D Transport and Environment had the highest IF value (3.445) among these journals, followed by Transportation Research Part E: Logistics and Transportation Review (3.289). When compared with the 2013 search, four source titles changed in the 2018 list. Transportation Research Part E Logistics and Transportation Review,

**Table 3. Structure of the Maritime Transport/Shipping Publications**

TS = Maritime AND Shipping OR TS = Port AND Ship\* OR  
 TS = Port AND Maritime OR TS = "Maritime Transport" OR  
 TS = Maritime AND Logistics OR TS = "Marine Transportation" OR TS = "Marine Engineering" OR TS = "Marine Tourism"

Total Number of Documents: 4676

Country	No.*	Author	No.*	Year	No.*
USA	1358	Fagerholt, K.	44	2018	639
England	789	Meng, Q.	43	2017	711
PRC	563	Wang, S.A.	42	2016	607
Canada	383	Wang, J.	40	2015	574
Australia	361	Lam, J.S.L.	36	2014	494
Italy	346	Celik, M.	33	2013	477
Spain	317	Yang, Z.L.	32	2012	419
Germany	301	Christiansen, M.	29	2011	381
France	252	Lee, P.T.W.	28	2010	356
South Korea	275	Kujala, P.	27	2009	267
Organizations					No.*
Hong Kong Polytechnic University					110
National University of Singapore					108
Norwegian University of Science and Technology					92
Dalian Maritime University					86
Nanyang Technological University					78
Istanbul Technical University					71
Shanghai Maritime University					67
National Taiwan Ocean University					56
University of Genoa					54
Liverpool John Moores University					53
Source Title			No.*	IF**	
Maritime Policy and Management			232	1.741	
Marine Pollution Bulletin			157	3.241	
Marine Policy			150	2.109	
Ocean Engineering			149	2.214	
Transportation Research Part E Logistics and Transportation Review			126	3.289	
Maritime Economics and Logistics			105	1.588	
International Journal of Shipping and Transport Logistics			103	0.982	
Transportation Research Part D Transport and Environment			91	3.445	
The Journal of Navigation			90	1.580	
Transportation Research Record			90	0.695	
Maritime Policy and Management			232	1.741	
WOS Categories					No.*
Transportation					1107
Environmental Sciences					882
Engineering Civil					708
Oceanography					688
Operations Research Management Science					646
Transportation Science Technology					556
Engineering Marine					588
Economics					538
Marine Freshwater Biology					417
Environmental Studies					384

\*No.: Number of publications. \*\*IF: Impact factor. Note: Impact factor of Maritime Policy and Management in 2017

Transportation Research Part D Transport and Environment, Ocean Engineering, Maritime Economics Logistics are new contributing journals in the 2018 list. Maritime Policy Management and Marine Pollution Bulletin were swapped places on the list 2013 and 2018.

Similarly, five organizations changed within the five-year period, and only Hong Kong Polytechnic University, National University of Singapore, Norwegian University of Science and Technology, Istanbul Technical University and National Taiwan Ocean University were in both the 2013 and 2018 searches. The University of Singapore was the most contributing organization in 2013. However, although it published nearly two times as many publications, it was replaced by Hong Kong Polytechnic University, which published more than two times and placed first in the 2018 rankings. Moreover, National Taiwan Ocean University and Istanbul Technical University dropped four and one rank, respectively, while the Norwegian University of Science and Technology stayed at the same rank. Finally, the same WoS categories were found in the 2013 and 2018 search, and only the rankings of these categories changed.

#### Network map analysis

An international cooperative network map of maritime transport/shipping literature was drawn according to the collected dataset. The font of each circle shows the publication weight of each country. The following countries and regions have contributed to the maritime transport literature according to their node sizes and connecting lines with other countries. Figure 1 is composed of clusters where the size and font of each circle indicates the publication weight of each country, and the color of the circle represents the cluster to which the country belongs. In Figure 1, the right side displays the international co-authorship network. Among the 142 encountered countries for 2018, only 57 countries met the requirement of a minimum of  $\geq 10$  publications. The left side shows the co-authorship network among the 117 encountered countries for 2013, and only 43 countries met the requirement of a minimum of  $\geq 10$  publications.

In 2013 (left side of Figure 1), the USA, England, and Germany had the strongest links. Clusters were not remarked with neighborhoods, except for a few examples in each cluster. These varieties in the clusters signal strong international relations with the authors of the related literature. However, after five years of increasing literature, co-operation has

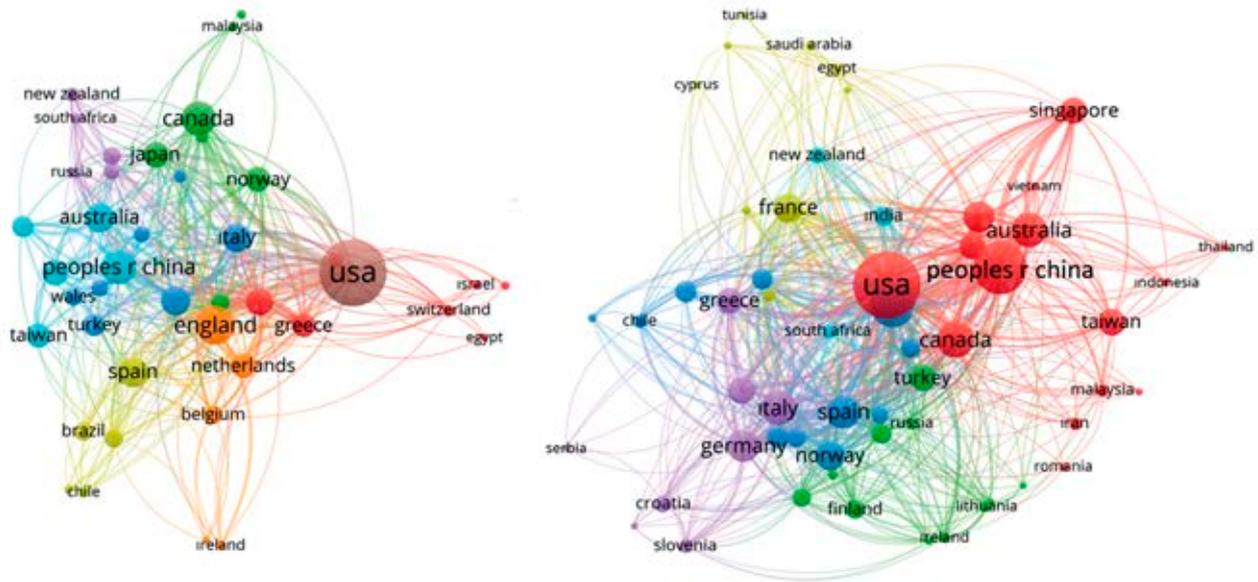


Figure 1. Bibliometric network map of the co-authorship of countries from 2013 to November 2018

developed and neighbouring relations have also risen. It was also found that in 2018, the USA, PRC, and England had the strongest link. This was consistent with the increasing number of publications by the PRC.

In 2018 (right side of Figure 1), the red cluster is the most cooperative and contributing cluster and is mainly composed of North America and Asia. The blue cluster is mainly composed of North European countries, alongside South American countries. The green cluster is composed of neighboring countries as Austria and the Czech Republic; Denmark, Estonia, Finland, Lithuania, Poland, Denmark, Estonia, Ireland, Russia; and Turkey and Israel. The purple cluster includes Middle and South Europe.

In Figure 2, the font size of each circle is proportional to the number of citations of a source. Closely-located circles are strongly associated with each other. Links between the circles illustrate the relationships that exist between the sources. Based on co-citation analysis, 195 sources met the requirement that a minimum number of citations of a source of  $\geq 50$  in 2013, whereas 433 sources meet the requirement in 2018. This indicates a growth in the maritime/shipping transport literature as well as citations.

As for citation extend, the Marine Pollution Bulletin was the most frequently cited and co-cited source in the database, followed by Maritime Policy and Management and Journal of Geophysical Research: Atmospheres. From 195 sources, five clusters were extracted within the following subjects:

- Shipping business research (management, marketing, economics, finance, economy, logistics,

simulation, and computing are some of the sub-areas) (red cluster) (66);

- Geography and meteorology and marine transportation research (oceanic engineering, navigation, ship, communication, safety, atmosphere, waste are some of the sub-areas) (green cluster) (57);
- Biological and environmental research (biological invasions and maritime ecology are some of the sub-areas) (blue cluster) (49);
- Pollution research (Maritime pollution and toxics are some of the sub-areas) (yellow cluster) (20);
- Forest research (forest ecology are some of the sub-areas) (purple cluster) (3).

In addition to identifying research clusters, relations between the research clusters were also presented. Pollution, biological, and environmental research were closely located in the network map. Geography, meteorology, and marine transportation research were also located closely with both of these research clusters and shipping business research due to the comprehensiveness of these research areas.

From 2013 to 2018, some changes occurred in the co-citation network map of source titles. As for citation extend, Maritime Policy and Management found as the most frequently-cited and co-cited source in the database, followed by Marine Pollution Bulletin, Transportation Research Part E: Logistics, and Transportation Review. As for the research areas, co-citations distinguished 261 publication sources into 6 broad clusters that published in the following subjects:

- Shipping business research (management, marketing, economics, finance, economy, law, logistics,





shipping literature within the five-year period. The National Science Board (US), (National Science Foundation (US), 2018) also showed that the USA, China, Japan, Germany, S. Korea, France, India, and the UK have the largest R&D expenditures. These countries were also found in this study as the most contributing countries to maritime literature in 2018, except for India and Japan. As expected, these countries were also identified as the most co-operative countries. Within the five years, strong links were formed between neighbouring countries. In order to enhance the relationships, the number of conferences should be increased, which could also serve to counteract the decreasing number of conference papers.

Clusters identified in this study with a co-citation network map of document sources and co-occurrence network map revealed trends and the topics in the maritime/shipping literature. These clusters summarized the content of the publications in the maritime/shipping literature. Identifying keyword clusters could uncover potential research trends. Within the five-year period, maritime surveillance research and marine engineering research clusters developed and were expanded due to increased interest. As consistent with (Lau et al., 2017), it is found that the interest in economic studies decreased, while operations research increased. The strong links formed over the five years shows a likely increase in operations research in the future. Due to the observed decrease in environmental studies as queries, it is proposed that a slow increase began for environmental studies that rapidly increased in the previous years.

Identifying clusters of source titles reveals the publication trends from the viewpoint of the publishers. Optimization research and marine engineering research have been proposed as increasing research clusters, while forest research has decreased. Increasing connections formed between the related disciplines within the five years indicate future increases in interdisciplinary research and shows that interdisciplinary studies are more likely to be published in SCI-Expanded and SSCI indexes.

Finally, these two networks engaged in similar topics that could be proposed as shipping business research, marine transportation and engineering research, geography and meteorology research, biological and environmental research, pollution research, and optimization research.

As mentioned by Fetscherin and Heinrich (Fetscherin & Heinrich, 2015), bibliometric analysis is highly objective, but it also includes subjective judgements such as the time period, keywords used,

and research areas. Due to the nature of the bibliometric analysis, there are also some limitations that must be mentioned within the context of this study. First, the congruence of our findings within the maritime transport/shipping literature depends on the searched queries since only articles written in English were considered. However, the contribution of non-English articles should be investigated in the future. Expanding or varying these queries may provide a more detailed review of the shipping literature. Second, the present study relies on a single database for data collection (Web of Science), and other databases and bibliometric comparisons of these databases are recommended for future research. Since ESCI (Emerging Sources Citation Index) was only available until after 2015, it was not used in this study, but it could be included in future studies. In addition, articles that exist in non-indexed journals could be included.

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