Seaport competitiveness research: the past, present and future

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Abstract: This study presents a review of articles with a focus on seaport competitiveness from the maritime literature. We investigated how port competitiveness research has evolved during the last two decades using bibliometric citation analysis tools and techniques. Bibliography data, collected from the ISI Web of Science database, consisted of 267 research papers by 465 authors in 117 journals. Based on citation analysis, we identified the key universities, journals and articles and their impact on port competitiveness research. Also, seven key research streams with few sub-streams were revealed as a result of a mixed co-citation and in-depth content analysis of the most cited articles. A bibliometric co-citation mapping technique was used to show how the key articles are built on each other. Key research papers and their concepts, methods and findings are also discussed. Finally, we present some strategic research challenges and future research agendas.

Keywords: literature review; bibliometric analysis; co-citation analysis; port competitiveness; port management; port competition.

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1 Introduction

Over the last two decades, the number of articles focusing on seaport research increased rapidly, especially in the 2000s (Woo et al., 2011). Although research on seaport competitiveness can be found in academic journals as early as in the 1960s (Britton, 1963), the evolution of port research began in the 1980s (Murphy et al., 1989; Warf and Kleyn, 1989; Williams, 1988). Competitiveness is a fuzzy and multi-layered concept (Budd and Hirmis, 2004), which can be defined as "[a] function of dynamic progressiveness, innovation, and an ability to change and improve" [Porter, (1992), p.40]. Based on the maritime literature, the term includes the development of different innovative and progressive strategic alternatives with which ports compete, and the efficient application of those strategies to attract more port users (Frankel, 1987; Heaver, 1995). Typically, ports compete with each other for higher port throughput, greater port facilities, better service quality and good location (Song and Yeo, 2004). Goss (1990) categorised five distinct forms of port competition:

1 among port clusters

2 among ports in different countries

3 among ports within a country

4 among terminals within a port

5 among transport modes. Research on port competition today falls within these five categories.

Today, 80% of international trade by volume is handled by ports worldwide (UNCTAD, 2017). The quality of port infrastructure differ from country to country (sometimes region to region within a country, terminal to terminal within a port), and significantly affects the logistics performance and seaborne trade of a country (Munim and Schramm, 2018). Thus, ports compete both regionally and internationally, to provide better service to their users (primarily shippers and carriers) and to be selected as a port-of-call by the shipping lines. Due to the number of shareholders involved in port operations, port competitiveness is a complex issue and has been studied from different perspectives

(Van de Voorde and Winkelmans, 2002). From this context, Pallis et al. (2010) identified four themes under the port competitiveness category, namely, port competition, strategy analysis, port performance and port choice. Similar sub-themes in port competitiveness research are found by Woo et al. (2012), too. This signifies the importance to study port competitiveness in further detail to explore the underlying sub-themes.

In the maritime literature, not many studies have used bibliometric citation analysis techniques to explore the intellectual structure of the field (or a topic), thus, providing us the opportunity to utilise this technique. Bibliometric analysis can be of different types: analysis of citation counts, co-citation, co-author, co-word, bibliographic coupling, etc. The most recent study by Lau et al. (2017) explored the container shipping research literature relying on the co-occurrence network analysis technique. Lagoudis et al. (2017) adopted a systematic literature review approach to review the port competition literature, but followed a deductive approach in framing the study instead of an inductive approach to explore the field. Woo et al. (2012) used a structured literature review approach to investigate trends and themes in seaport research between the 1980s and 2000s, identifying eight themes. Furthermore, Woo et al. (2011) analysed methodological issues in seaport research since the 1980s. Pallis et al. (2010) reviewed the port economics and management literature using analysis of citation counts and co-authorships. Pallis et al. (2011) reviewed the seaport literature during 1997–2008, using cross-citation analysis to examine the characteristics, development and themes in this emerging research field. Later, using the meta-analysis technique, Odeck and Bråthen (2012) compared the two most used port efficiency benchmarking tools: data envelopment analysis (DEA) and stochastic frontier analysis (SFA).

Furthermore, a historical review on the evolution of maritime economics literature covering issues from the 18th century until the 20th exists (Goss, 2002). However, despite the effort of Pallis et al. (2011) to link different port study categories, a clear view of how the research themes, concepts and methods in port competitiveness research are interrelated or build on each other is still lacking. To further analyse the progress of port competitiveness research, we conducted bibliometric co-citation analysis, as recommended by Pallis et al. (2010). Co-citation, which means two articles are related when they are cited together in another article, differs from citation analysis and bibliographic coupling. Citation analysis emphasises the frequency of citation, and bibliographic coupling occurs when an article is cited in two different articles that may be related (Egghe and Rousseau, 2002).

Literature review papers can be of different types depending on the focus, methodology and expected outcome, among other perspectives (Cooper, 1988). Based on our aim to explore and map the port competitiveness literature, a bibliometric review approach using citation and co-citation analysis coupled with qualitative content analysis is adopted to address the following three research questions (RQs):

1 How has the port competitiveness research evolved over time and where is it heading?

2 Which journals, articles and authors are the most cited, and therefore, carry the most weight for future research in port competitiveness?

3 Which institutions (as attributed by universities) are the most influential, and therefore, contribute most to port competitiveness research?

In presenting answers to RQ2 and RQ3, this literature review makes an important contribution to scholars by identifying all the key journals, universities, authors and articles to be taken into account for future research in port competitiveness. In addition, to answer RQ1, we present key methods, concepts, research approach and findings, and identify and synthesise emerging research streams. Therefore, this study provides a comprehensive reference for maritime researchers, particularly those focusing on port competitiveness.

The remainder of this paper is structured as follows: the concept and method of bibliometric citation analysis are introduced in Sections 2 and 3. Results of the empirical analysis follow in Section 4. In Section 5, we use a co-citation map to sketch port competitiveness research streams and sub-streams. Finally, we present future questions and challenges in port competitiveness research in Section 6.

2 Bibliometric citation analysis

Bibliometrics, a statistical measure of the impact of published articles, includes bibliometric citation analysis, a well-recognised meta-analytical research also known as 'meta-review;' of literature (Garfield, 1983; Harsanyi, 1993). The basic assumption of bibliometric analysis is that researchers publish their most significant findings in academic journals, and embark on new research projects primarily based on articles published in similar journals (Van Raan, 2003). Bibliometrics can be used to identify core articles in a particular research area and illustrate the linkages among them by analysing the number of times those articles are cited or co-cited in other published articles (Fetscherin and Usunier, 2012). Outputs are not only useful to measure the popularity of articles or authors, but also their impact. In addition, bibliometrics identifies underlying research streams and theoretical frameworks in a given research field (Borgman and Furner, 2002). Beyond a simple count of the number of publications in which a research article is cited, citation analysis helps to identify centres of influence (Fetscherin and Usunier, 2012), and the linkages among articles in a particular research field (Kim and McMillan, 2008). Therefore, bibliometric reviews of articles help researchers gauge the worthiness of a study (Garfield, 1983).

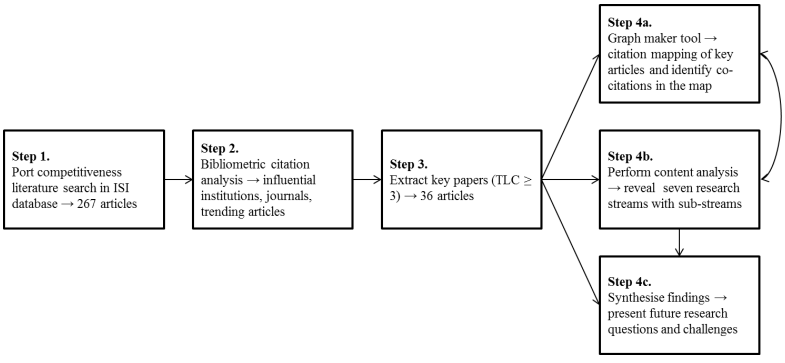
3 Method

We collected data from the most renowned academic database, ISI Web of Science, a database that many bibliometric studies used (for example, Coronado et al., 2011; Fetscherin and Heinrich, 2015; Schildt et al., 2006; Alon et al., 2018; Maditati et al., 2018). We found 267 relevant publications for the topic of port competitiveness, starting with the publication year 1963 (Britton, 1963).

Following a two-step approach to collect comprehensive data, we first identified 267 articles concerning port competitiveness, using 'port competitiveness' and 'port competition' (limited to article title, keywords and abstract) as keywords in the ISI database. It might be noted that the initial search provided 313 articles; after a careful review of the titles and abstracts, 267 were found relevant to the port competitiveness research. In the second step, we recorded the author name(s), article title, journal name,

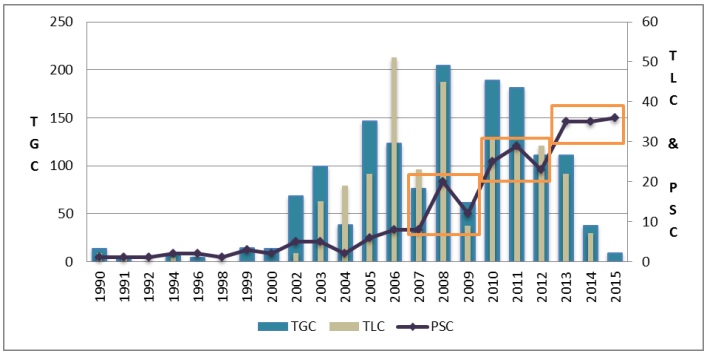
volume, number, pages, date of publication, cited references and abstract for each relevant article. We used the bibliometric software tool, HistCite, for analysing and recognising citation linkages among selected articles. The software's "inputs are bibliographic records (with cited references) from ISI Web of Science and outputs are various tables and graphs with indicators about the knowledge domain under study" [Fetscherin and Usunier, (2012), p.736]. While other software such as BibExcel, VosViewer, Gephi, etc. exists for similar purposes, HistCite is a comparatively user friendly one, and offers both citation analysis and visualisation in one package. The workflow of this study is depicted in Figure 1.

Figure 1 The research methodology



Note: TLC: total local citations.

Figure 2 Number of publications and citations (1990–2015) (see online version for colours)



Note: P_{SC} = number of articles published related to seaport competitiveness; TLC = total local citations received; TGC = total global citations received.

Source: Author's own compilation based on ISI Web of Science data

Figure 2 displays an overview of the 262 published articles related to port competitiveness (P_{SC}) (out of 267 identified, of which only five were published before 1990)[1] and shows the exponential increase in research on the topic since 2004. The graph also shows total global citations (TGC), in other words, how frequently the articles were cited outside the sample of 267 articles on port competitiveness, and total local citations (TLCs), that is how frequently the citations appeared within the port competitiveness research community (that is, among the 267 articles). It might be noted that, in the case of multiple authors from multiple institutions, P_{SC}, TGC and TLC calculations were unweighted giving one credit to all authors and institutions. TLC and TGC were relatively low in recent years because it takes some time for research to create impact and receive citations. Meanwhile, the increasing number of research on the topic confirms evolving interest, which is expected to continue. One may argue that, growth in number of articles published during 2013 and 2015 seems stable. But the number of publications on a particular topic in a particular year could be affected by many factors. Thus, we grouped the number of publications in Figure 2 by each three years for the last nine years (using squared boxes), and the growth is evidently visible.

4 Results

The results of our bibliometric citation analysis include an evaluation of leading academic institutions with a connection to published articles on port competitiveness as well as the highly cited journals and articles. The key disciplines reflected in the 267 articles selected as our sample from the ISI Web of Science database were transportation (42%), economics (23%), geography (11%) and management (9%), a distribution that clearly indicates the interdisciplinary nature of this research field. Statistics, tables and rankings outlined in the upcoming sections address our three main RQs.

4.1 Centres of excellence

To identify the centres of excellence in port competitiveness research, we measured the academic weights and importance of different academic institutions (on the aggregate level of universities) based on total number of published articles related to port competitiveness research (P_{SC}) and the citations received. We used two types of scores for the citations received: the TLC score represented the number of times a paper was cited in other papers in our sample; the TGC score represented the number of times a paper was cited based on the full ISI Web of Science count, a database that currently holds over 46 million records across all sciences (http://www.thomsonreuters.com).

The leading institutions in the port competitiveness research in Table 1 showed great diversity. The most influential institutions were located in Hong Kong, the Netherlands, Singapore, Belgium, Canada, the USA and the UK. The most influential researchers were from diverse institutions, such as (alphabetical order): Concordia University, Edinburgh Napier University, Hong Kong Polytechnic University, Inha University, Nanyang Technology University, University of Antwerp and University of Plymouth. Table 1 provides an overview of the most influential institutions involved in port competitiveness research, based on the number of published articles (P_{SC}) and their TLC. We considered these institutions as ‘centres of excellence’ for port competitiveness research.

Table 1 Most influential institutions

Rank	*Rank based on PSC*				*Rank based on TLC*			
	Institution	*PSC*	*TLC*	*TGC*	*Institution*	*PSC*	*TLC*	*TGC*
1	Hong Kong Polytech University	17	55	188	Nanyang Technology University	10	64	144
2	University of Antwerp	15	47	146	Hong Kong Polytech University	17	55	188
3	Erasmus University	12	7	62	University of Antwerp	15	47	146
4	Nanyang Technology University	10	64	144	University of Hong Kong	3	22	47
5	National University Singapore	9	11	76	Concordia University	2	19	65
6	Edinburgh Napier University	8	8	18	University of Le Havre	1	19	63
7	University of British Columbia	7	15	30	University of Newcastle, Upon Tyne	1	19	37
8	Delft University of Technology	6	4	22	University of British Columbia	7	15	30
9	North Dakota State University	6	4	23	University of Plymouth	5	14	53
10	Chinese University Hong Kong	5	12	22	Inha University	2	14	46

Note: PSC = number of articles published related to port competitiveness; TLC = total local citations received; TGC = total global citations received.

4.2 Most influential journals

Researchers can use bibliometric citation analysis to assess journal impact. In maritime literature, various journals focus on different sub-areas of research. We sought to identify those journals that lead the field of port competitiveness research. Table 2 shows the top 20 journals in the total number of articles published related to port competitiveness (P_{SC}) and the average annual TLC (TLC/t) and average annual TGC (TGC/t). Apart from the key maritime journals such as *Maritime Policy and Management*, *Maritime Economic and Logistics*, the influential journals for this research area were transportation and logistics journals, such as *International Journal of Shipping and Transport Logistics*, *Transportation Research Part E-Logistics* and *Transportation Review* and, *Journal of Transport Geography*.

Table 2 Ranking of top 20 journals

*Rank**	*Journal*	*Label*	P_{SC}	*TLC/t*	*TGC/t*
1	*Maritime Policy & Management*	MPM	31	24	119
2	*Journal of Transport Geography*	JTG	16	20	127
3	*Transport Reviews*	TR	14	58	177
4	*International Journal of Shipping and Transport Logistics*	IJSTL	13	3	26
5	*Maritime Economics & Logistics*	MEL	11	21	55
6	*Transportation Research Part A – Policy and Practice*	TR-PP	11	52	158
7	*Transportation Research Part E –Logistics and Transportation Review*	TR-LTR	8	7	54
8	*Journal of Transport Economics and Policy*	JTEP	7	15	43
9	*International Journal of Transport Economics*	IJTE	6	0	24
10	*Transportation Research Record*	TRR	6	0	37
11	*Transport Policy*	TP	5	4	17
12	*International Journal of Logistics – Research and Applications*	IJLRA	4	3	8
13	*Marine Policy*	MP	4	9	43
14	*Tijdschrift Voor Economische En Sociale Geografie*	TESG	4	10	25
15	*Transportation Research Part B – Methodological*	TR-M	4	9	15
16	*Applied Economics*	AE	3	14	96
17	*Economic Geography*	EG	3	9	42
18	*Environment and Planning A*	EP	3	2	18
19	*Growth and Change*	GC	3	5	23
20	*Transportation Journal*	TJ	3	1	4

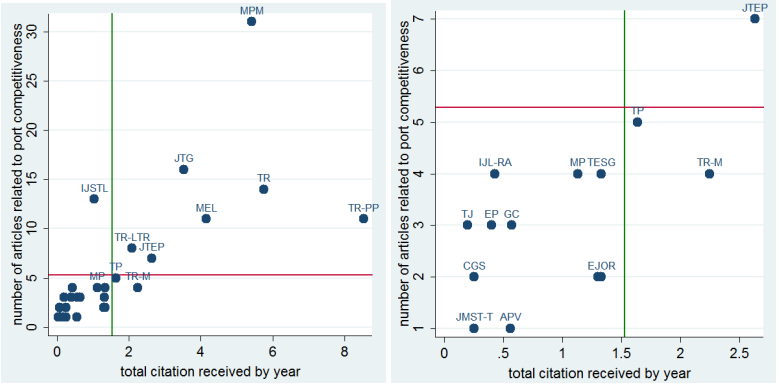
Notes: PSC = number of articles published related to port competitiveness; TLC/t = average local citations received per year; TGC/t = average global citations received per year. *Ranked by PSC.

To scrutinise the results further, we used P_{SC} as a proxy for output and TLC/t a proxy for impact. Figure 3 illustrates a 2 × 2 matrix in which TLC/t is plotted on the x axis and the PSC of each journal on the y axis. By calculating the mean total number of published articles (P_{SCM} = 5.29) and mean TLC (TLC/t M = 1.53), we could distinguish four main journal groups: quadrant A, high focus on port competitiveness and high impact; quadrant B, low focus on port competitiveness but high impact; quadrant C, low focus on port competitiveness and low impact; and quadrant D, high focus on port competitiveness but low impact.

Among the 31 journals in the dataset (except those with TLC/t = 0), 24 belonged in quadrant B, C, and D, meaning below the average output (P_{SCM} = 5.29) and/or below average impact (TLC/t M = 1.53). Only seven journals had above average output and impact (quadrant A). Only nine had above average impact (quadrants A and B), and 22 journals had below average output and/or impact (quadrants C and D). Figure 3(a)

illustrates a broad view of the four identified quadrant groups, providing a 'big picture' of journals' focus and impact on port competitiveness. Not a surprise, *Maritime Policy and Management* was the most influential journal in port competitiveness research. Journals in quadrants B and C are labelled in Figure 3(b) for better detail.

Figure 3 Journal focus and impact on *port competitiveness* research, (a) big picture (b) concentrated view (see online version for colours)



Note: In Figure 3, for illustrative and readability purposes, only journals with at least two published articles regarding seaport competitiveness between 1990 and 2015 and/or at least 0.20 average citations per year were considered.

Source: Authors' compilation

4.3 Most influential and trending articles

We used a multi-step approach to discover the most impactful authors and articles in port competitiveness research, which are shown in Table 3 through Table 5. All tables show TLC/t and TGC/t, but Table 3 and 4 also show TLC and TGC. The ranking in Table 5 is based on the ratio of local citations in the ending (LCSe).

A closer look at the rankings in Table 3 reveals that all articles listed were highly influential. Table 3 ranks the top ten articles according to annual TLC and Table 4 ranks them by annual TGC; thus Table 4 sorts the top articles according to impact and application beyond the boundaries of port competitiveness research.

Another important aspect of this study was to identify the fundamentals of port competitiveness research and uncover emerging articles. We sought to identify not only where port competitiveness research was coming from, but where it might be headed; therefore, we used LCSe to identify the most trending articles. LCSe refers to citations received by an article at the end of the time period of bibliometric analysis (Fetscherin and Heinrich, 2015), which is the last three years until 2015 in our case. The measure allows us to assess not only which articles have been cited during a fixed time period, but also whether the citations occurred recently, indicating an emerging topic. Table 5 ranks the most trending papers according to LCSe values.

Table 3 Ranking of top ten articles by annual TLC

*Rank**	*Authors*(*s*) (*year*)	*TLC*	*TLC/t*	*TGC*	*TGC/t*
1	Luo et al. (2012)	9	2.25	13	3.25
2	Slack and Frémont (2005)	19	1.73	63	5.73
3	Yap and Lam (2006)	17	1.7	37	3.7
4	Yap et al. (2006)	17	1.7	26	2.6
5	Wan and Zhang (2013)	5	1.67	8	2.67
6	Ishii et al. (2013)	5	1.67	8	2.67
7	Cullinane et al. (2004)	19	1.58	37	3.08
8	Wang et al. (2012)	6	1.5	8	2
9	Lam and Yap (2011)	7	1.4	12	2.4
10	Saeed and Larsen (2010a)	8	1.33	11	1.83

Note: TLC = total local citations received; TLC/t = average local citations received per year; TGC = total global citations received; TGC/t = average global citations received per year.

Table 4 Ranking of top ten articles by annual TGC

*Rank**	*Authors*(*s*) (*year*)	*TLC*	*TLC/t*	*TGC*	*TGC/t*
1	Gelareh et al. (2010)	1	0.17	35	5.83
2	Slack and Frémont (2005)	19	1.73	63	5.73
3	Gonza´lez and Trujillo (2008)	10	1.25	45	5.63
4	Notteboom (2010)	6	1	33	5.50
5	Lam and Gu (2013)	1	0.33	16	5.33
6	Wang and Meng (2011)	0	0	25	5.00
7	Yeo et al. (2008)	10	1.25	38	4.75
8	Chang et al. (2008)	9	1.13	38	4.75
9	Cullinane and Song (2003)	7	6	60	4.62
10	Debrie et al. (2013)	1	0.33	13	4.33

Note: TLC = total local citations received; TLC/t = average local citations received per year; TGC = total global citations received; TGC/t = average global citations received per year.

5 Citation mapping

Co-citation mapping technique helps to identify the comprehensive themes in any research field, herein port competitiveness research. So, we used it to visualise reciprocal citation and co-citation of articles. We included articles with TLC $\geq$ 3 since the 1980s for the co-citation mapping visualisation analysis. We scrutinised competing models using TLC $\geq$ 1, TLC $\geq$ 3 and TLC $\geq$ 4, and found similar results that varied only in level of detail about the research streams and number of articles. As our aim was to identify the

'skeleton' or core structure of port competitiveness research, we selected the threshold of TLC ≥ 3 as the cut-off criteria. Other studies and disciplines may use different thresholds. For example, Fetscherin and Heinrich (2015) used TLC ≥ 5, and analyses of studies in medicine may use a particularly high TLC. For our analysis, TLC ≥ 3 yielded 36 articles as the most frequently cited among the sample of 267, or about 13.48% of the most influential works in port competitiveness. We briefly discuss these 36 articles under each of the related research streams and sub-streams.

Table 5 Ranking of trending articles

*Rank**	*Authors(s)/year/title*	*Journal*	*LCSe*	*TLC/t*	*TGC/t*
1	Yap and Lam (2006). Competition dynamics between container ports in East Asia	TR-PP	9	1.7	3.7
2	Yeo et al. (2008). Evaluating the competitiveness of container ports in Korea and China	TR-PP	9	1.25	4.75
3	Gonza´lez and Trujillo (2008). Reforms and infrastructure efficiency in Spain's container ports	TR-PP	8	1.25	5.63
4	Cullinane et al. (2004). Container terminal development in Mainland China and its impact on the competitiveness of the port of Hong Kong	TR	7	1.58	3.08
5	Slack and Frémont (2005). Transformation of port terminal operations: From the local to the global	TR	7	1.73	5.73
6	Saeed and Larsen (2010a). An application of cooperative game among container terminals of one port	EJOR	7	1.33	1.83
7	Yuen et al.(2008). Effects of gateway congestion pricing on optimal road pricing and hinterland	JTEP	6	0.88	1.38
8	Yap et al. (2006). Developments in container port competition in East Asia	TR	5	1.7	2.6
9	Jacobs (2007). Port competition between Los Angeles and long beach: an institutional analysis	TESG	5	1	2.11
10	Notteboom (2010). Concentration and the formation of multi-port gateway regions in the European container port system: an update	JTG	5	1	5.5

Notes: LCSe = ratio of local citations in the ending; TLC/t = average local citations received per year; TGC/t = average global citations received per year. *Ranked by LCSe.

In Figure 4, the publication years are arranged on the vertical axis, and each of the nodes represents one of the 36 most frequently cited articles, with a unique numerical ID. The size of the node varies according to the TLC, with those with more citations having a larger node indicating higher influence of the article. In addition, the closer a node is to another node, the more likely they fall under the same research stream. If one paper (node) cites another, an arrow points to that paper node, indicating a citation relationship between the two [Fetscherin and Usunier, (2012), p.740]

Finally, coupled with co-citations, we conducted a detailed content analysis of the 36 selected papers. Suggested by Salipante et al. (1982), we formed a concept matrix for this purpose. As a result, we identified seven distinct but interrelated research streams

and a few sub-research streams. This involved an iterative process of analysing the contents of the key articles. The key research streams were:

1 port competition

2 port efficiency

3 institutional transformation

4 port pricing

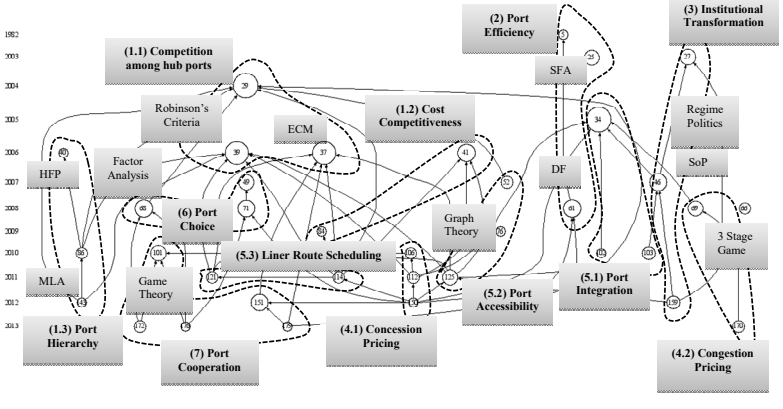
5 port embeddedness

6 port choice

7 port cooperation.

In the following sections, we discuss the key articles, topics and methods of these research streams and their sub-streams.

Figure 4 Citation mapping of *port competitiveness* research



Note: (*Method/theory*, abbreviation) *HFP*: hierarchical fuzzy process; *MLA*: multiple linkage analysis; *ECM*: error correction model; *SFA*: stochastic frontier analysis; *DF*: distance function; *SoP*: structure of provision.

5.1 Port competition

Although competition among seaports has been scrutinised for many decades, the centre of investigation has changed following development of new concepts and methodologies. Here, we emphasise the progression of this research stream during the last decade. In the early 2000s, competition for developing hub ports dominated this topic, but the focus swiftly shifted to cost competitiveness to attract more port users. Throughout the last decade, researchers have been interested in determining a hierarchy of container ports in their respective networks. Hence, we distinguished three sub-streams of port competition stream, competition among hub ports, cost competitiveness and port hierarchy.

5.1.1 Competition among hub ports

Many nations have invested heavily in developing hub ports for their regions, which is a challenging process that requires analysis of many factors involved in a fiercely competitive market. Therefore, inter-port competition among hub ports was a mainstream topic in the research. Studies under this sub-stream usually looked at ports in a particular region; for example, three key papers focused on East Asia. Cullinane et al. (2004) (29 in Figure 4) analysed the ports of Shenzhen and Hong Kong using Robinson's criteria for hub port development and found that Hong Kong would dominate despite Shenzhen's competitive advantages. Yap et al. (2006) (39 in Figure 4) also investigated the competitiveness of hub ports in East Asia, considering Busan, Hong Kong, Kaohsiung and mainland Chinese ports. Their findings were similar to Cullinane et al. (2004), indicating Hong Kong's dominance. Also, they argued that the intensified competitiveness of mainland Chinese ports could outperform Japanese and Taiwanese ports. Yap and Lam (2006) (37 in Figure 4), who constructed an error correction model (ECM) to determine short-term inter-port dynamics, found that inter-port competition could sometimes be beneficial; for instance, Hong Kong and Pusan had enjoyed competitive benefits for three decades. Aligning with Yap et al. (2006), the study concluded that, inter-port competition in East Asia would intensify as gravity of cargo volume shifted to mainland China. This sub-stream of port competition keeps the research window open for investigations of competition based on price and service levels, concentration of shipping lines and level of cooperation between ports.

5.1.2 Cost competitiveness

At the core of this stream is cost optimisation. Maintaining quality service while minimising costs is always crucial, but cost minimisation also can be a strategy to attract more customers. Lam and Yap (2006) (41 in Figure 4) applied Cournot's simultaneous quantity-setting model to scrutinise cost competitiveness of terminal operators in Singapore, Port Klang and Tanjung Pelepas. According to their results, terminal operators in Port Klang and Tanjung Pelepas reduced the gap in cost competitiveness with Port of Singapore Authority Corporation (PSAC) in the period 1998–2002, although PSAC still maintained the dominant share of the container handling market in Southeast Asia. Fan et al. (2009) (84 in Figure 4) examined port competition in the US-Canadian market following Canada's transformed logistics system and the expansion of Panama Canal. They used an optimisation model based on cost minimisation function to estimate the container traffic flow in US ports. The model could determine ship size, optimal route, optimal port, and hinterland shipping channels.

Most of the studies in this sub-stream assumed linear demand function for the terminal operations while constructing models to investigate cost competitiveness. Constructing a model assuming nonlinearity of terminal demand function would be interesting.

5.1.3 Port hierarchy

Changes in the centre of trade flow over time alter the hierarchy (or ranking) of competing container ports; therefore, an investigation of port hierarchy is relevant. Yeo and Song (2006) (40 in Figure 4), who developed a hierarchical fuzzy process (HFP) to

investigate empirically the competitiveness of Asian seaports, found the ports of Singapore and Hong Kong to be the most competitive. Their process took human judgement and knowledge into account while constructing a mathematical framework. The authors argued that HFP could overcome major drawbacks of the analytic hierarchy process (AHP) and hierarchical fuzzy integral (HFI) method, and also could be used to analyse competitiveness in other transport and logistics industries. Ducruet et al. (2010) (86 in Figure 3) argued that many of the port competitiveness studies employ methods that use too much aggregated data that might not reflect a port's real position in its network. Therefore, they used traditional network analysis to investigate how the hierarchy of hub ports in Northeast Asia evolved between 1996 and 2006. They found a strong association between local port policies and the development of a shipping network. Another significant study in this sub-stream was done by Cullinane and Wang (2012) (143 in Figure 4) who employed multiple linkage analysis (MLA) on the liner network of 39 major East Asian ports. The results revealed a strong association between the port's hierarchical position and several significant connections into and out of the port. Existing knowledge on port hierarchy studies may be extended using mentioned approaches using daily vessel movement or trade flow data or by incorporating more variables or applying them in new geographic port networks.

5.2 Port efficiency

A port's productive performance affects its competitive position. Key to improving productivity is an understanding of the production processes in ports, which are rather different from other businesses. A port's efficiency can be characterised by optimal berth length, ship turnaround time, optimum ship stowage, optimum utilisation of cranes and yard operations (Cullinane et al., 2005). An early study of port efficiency compared centralised port planning with decentralised competitive ports (Bobrovitch, 1982) (5 in Figure 4). This study considered ports as congestion-prone systems, and employed a mathematical model based on the approach of Hotelling (1929), which revealed equivalence in centralised and decentralised systems.

The development and implementation of different methodologies are at the core of port efficiency benchmarking research. Many complicated stochastic models have been applied in port efficiency research, including parametric and non-parametric (e.g., DEA) and complex econometric methods. In a comparison of the productive efficiency of Korean container terminals with those in the UK, Cullinane and Song (2003) (25 in Figure 4) applied parametric SFA, and found that privatisation and/or deregulation of markets enhanced a port's productive efficiency. Analysing technical efficiency of Spanish ports, Trujillo and Gonzalez (2008) (61 in Figure 4) used the distance function (DF) in their examination of the port reformation in 1990s. They argued that the reforms resulted in technological change, but technical efficiency was transformed very little in comparison, although overall, technical efficiency improved. Most port efficiency studies have focused on inputs and outputs of a port, and have not taken into account the port's ability to attract new users and customers, which plays a key role in maximising port output.

5.3 Institutional transformation

A significant influence on research in port competitiveness has been the globalisation of containerisation and changing patterns in governance, which was instigated from the US perspective. Hall (2003) (27 in Figure 4) explored institutional transformation associated with containerisation processes at the Port of Baltimore. Evidence from this study supports a notion of institutional transformation in which regional institutional diversity is maintained, but in new forms. Jacobs (2007) (46 in Figure 4) also explored the institutional transformation process in the US, selecting ports of Los Angeles and Long Beach. The author employed a structure of provision (SoP) approach and regime politics to analyse and compare the two ports. The results revealed that competitive performance is not always as decisive an interest to ports than the territorially rooted institutional power structure.

Wang et al. (2012) (159 in Figure 4) applied game theory to investigate how the port of Hong Kong used alliance formation with other Pearl River Delta (PRD) ports to mitigate the challenges of its segregation from China's national economy. An examination of the profit maximisation alliance between Hong Kong and Shenzhen indicated an increase in price at both ports. If service in both ports were substitutable, the alliance could benefit Hong Kong, but not Shenzhen. In this stream, too, inter-port competition was sketched as beneficial for ports in the same geographic region, and the importance of human agency was emphasised.

5.4 Port pricing

Pricing port services are appropriately important to generate profits and payback the huge investments in ports. Research in this area has focused on two strategies: how to set a price for use and operation of the port and how to attach a price to the congestion generated from port operation.

5.4.1 Concession pricing

To stay competitive, ports must generate profit, and the key profit generation technique is to charge port users and operators. Determining how much to charge is not an easy task. Applications of game theory models are noticeable in this stream. Saeed and Larsen (2010b) (106 in Figure 4) used game theory to analyse the effect of concession contract types on profits of terminal operators and port users in Pakistan, often a controversy issue because of the boom in public-private partnerships in port operation. The study found that a long-term fixed fee contract between the Karachi Port Authority and its private terminals would be profitable for the port authority, while a percentage fee concession contract would be profitable for port users.

Kaselimi et al. (2011) (112 in Figure 4) also analysed concession contract using game theory, but focusing mainly on the impact of dedicated terminals operated by shipping lines on intra-port and inter-port competition. Xiao et al. (2012) (150 in Figure 3) focused on governance mechanism and port ownership structure while investigating port pricing

strategy. The authors discussed institutional influence on port pricing, making the connection between competitiveness research and that of pricing. However, according to researchers in this stream, it is often difficult to accommodate the extensive data requirements (such as traffic volume, price, capital cost per unit capacity, congestion price function, and so on) to develop superior models.

5.4.2 Congestion pricing

Small peripheral ports handling a large volume of throughput are often congested due to capacity constraints (Munim et al., 2018). Also, transport of cargo and containers out of ports through roads or rail can cause congestion in the nearest hinterland. One way to control this problem is to attach a cost to the congestion. Yuen et al. (2008) (69 in Figure 4) investigated the effect of congestion pricing on a gateway port's road congestion, the hinterland's optimal road pricing and social welfare. They found that a gateway port's charge would increase if the port maximises the joint profit between itself and its oligopoly carriers. As a consequence, road tolls would decrease even if the tolls were the same for transit and gateway traffic. While investigating effect of road congestion on two competing ports, Wan and Zhang (2013) (170 in Figure 4) found that increasing road capacity or tolls might increase a port's revenue while reducing its competitor's revenue. Therefore, considering that the value of time is greater for shippers than commuters, road tolls could be even more than the marginal congestion price. An interesting research topic would be to examine the impact of a hinterland infrastructure facility on port congestion and to design an equilibrium scenario to consider seasonal variations in port throughput.

5.5 Port embeddedness

In the earlier research streams, ports were studied mostly as single entities. However, ports are embedded in a network of global transport nodes, and the performance of one node in a network affects the performance of others. Therefore, ports must be considered from a chain perspective, investigating the port's integration into the network and its accessibility and connectivity with the hinterland through other transportation modes.

5.5.1 Port integration

Recently, port users have foreseen the benefit of expanding their operations into other sectors. Vertical integration between shipping lines and terminal operators could facilitate effective management of global door-to-door services. In one of the most influential articles in port competitive research, Slack and Frémont (2005) (34 in Figure 4) explored the roots of internalisation of the port terminal industry. They differentiated Europe and North America from the diffusion context of international companies. Lead actors have arisen out of the port industry itself in Europe, while shipping lines are the lead actors in North America. This differentiation had a significant impact on port competition, as one was based on multi-user berth operations and the latter on dedicated berth use. However, as the choice of one mode of global port management system has substantial operational and economic consequences, a need to explore the spatial dimensions of factors embedded in regional institutional processes remained (Slack and Frémont, 2005). From

a transaction cost economics and resource based view, Franc and Van der Horst (2010) (102 in Figure 4) investigated the transformation of ports from a local maritime hub to a lead actor in the hinterland transportation chain. They discussed a number of cases from the Hamburg-Le Havre range in which the ability of a port to integrate into the hinterland transportation chain was a key determinant of port competition. Notteboom (2010) (103 in Figure 4) presented a review of key trends and issues in the European container port system, including integration of ports into the hinterland network, formation of multi-port gateway regions and the process of port regionalisation. In European ports, an increased network orientation among market players was observed. Although the feeder shipping network has matured, the development of a shortsea network has received little attention until recently, which Notteboom (2010) also mentioned.

5.5.2 Port accessibility

A port's accessibility refers to its potential for movement of containers and cargoes within the broader transport network, which impacts a port's competitiveness and market share. Comtois and Dong (2007) (52 in Figure 4) analysed spatial patterns of inland container distribution to examine the competitiveness of the Shanghai and Ningbo ports, based on actual market coverage. The study revealed that despite having many other ports, the Yangtze River Delta was quite dependent on the Shanghai port because of its accessibility. Using quantitative tools, Cullinane and Wang (2009) (76 in Figure 4) developed an index of individual port accessibility of the world's top ten container ports, incorporating port prices, inland logistics costs and estimates of comparative efficiency. By analysing shipping companies' calling patterns, Lam and Yap (2011) (125 in Figure 4) investigated how container ports were embedded into the supply chain systems at the PRD in South China. Results revealed significant inter-port complementarity between Shenzhen and Hong Kong along with intense port competition between them. However, there is a still lack of knowledge about accessibility of ports from the context of creating value in the global logistics chain service.

5.5.3 Liner route scheduling

Liner shipping companies must develop scheduling strategies to accommodate changing patterns in port systems and cope with global supply chains. Yap and Notteboom (2011) (114 in Figure 4) developed a direct, practical approach to evaluate container port competition, based on shipping line dynamics and preference. They also highlighted the need to understand the nature, extensity and intensity of competitive relationships between ports.

Lam (2011) (121 in Figure 4) analysed maritime supply chains using empirical data on slot capacity from container shipping lines. The study found that maritime supply chain dynamics were affected by geographical location and changes in players' strategies. The significance of liner shipping calling patterns and connectivity of a port also were emphasised. Both the studies followed slot capacity analysis as a methodology and argued for potential application of this method in other research streams, such as, port cluster development, service routing, cargo flow analysis, port competition and port cooperation analysis.

5.6 Port choice

With the declining monopoly of ports, shipping lines have greater control of their choice of ports. Ports that shipping lines select for mainline trade routes induce higher cargo handling and more profit for the ports. Traditional port choice studies usually collect data through interviews or surveys and use factors analysis as a methodology. With this methodology, Yeo et al. (2008) (68 in Figure 4) identified that hinterland conditions, port service, convenience, availability, regional centres, logistics costs and connectivity were determining factors to stay competitive in extreme conditions. Tongzon and Sawant (2007) (49 in Figure 4) used a survey for an empirical investigation of port choice among major shipping lines in Malaysia and Singapore. The authors criticised the 'stated preference' approach of port choice over the 'revealed preference' approach. The findings revealed that port charges and a wide range of port services were significant factors in a shipping line's choice strategy. In another survey-based study of port choice, Chang et al. (2008) (71 in Figure 4) identified five choice categories through factor analysis: physical/operational ability of port, advancement/convenience of port, marketability, operational condition of shipping lines and port charges. Overall, port charge was the most sensitive factor for port choice. An interesting area for future research would be the application of innovative approaches, such as qualitative case studies (Welch et al., 2011), to understand the behaviour of shipping lines and drive towards theorising in port choice.

5.7 Port cooperation

The increased proximity of ports and the greater variety of services available from port agencies, including freight forwarders and shipping line, has spiked competition among ports and related businesses to new levels. To sustain themselves in competition, port and port agencies often form various cooperative strategies. Researchers who have studied these strategies often employ game theory models. Saeed and Larsen (2010a) (101 in Figure 4) applied a two-stage game to inspect the coalition options for three container terminals in Karachi Port (Pakistan), and revealed that the 'grand coalition' of all three terminals would yield the best payoff. Asgari et al. (2013) (176 in Figure 4) used a game theory network model to study competition and cooperation strategies among three parties, two major hub ports (Hong Kong and Singapore) and shipping companies. To maximise profit and market share, the authors suggested a dynamic pricing strategy in the short-term, formation of an alliance with shipping companies in the midterm, and an alliance with rival ports in the long-term.

An examination of cooperation strategies among different port actors must also take into account the differing attributes of foreign or local owners. For example, Yuen et al. (2013) (179 in Figure 4) found that a container terminal was more efficient under some degree of Chinese ownership, but became less efficient when the Chinese ownership exceeded 50% and the Chinese partners were involved in key decision-making process. Two studies in this research stream, Ishii et al. (2013) (172 in Figure 4) and Luo et al. (2012) (151 in Figure 4), employed non-cooperative game theory approach. Ishii et al. (2013) used a non-cooperative game theory model to examine the effect of inter-port competition between the ports of Busan and Kobe. Luo et al. (2012) used a

non-cooperative two-stage duopoly game to investigate port capacity expansion decision of two ports serving the same hinterland, but under various competitive conditions. The authors emphasised cost savings over net revenue loss in capacity expansion to achieve positive gain. Both the studies recommended investigating cooperation and pricing strategies in the future for completing terminals owned by the same operator in the same port or different ports.

6 Conclusions and future research agendas

In this study, we identified the roots of port competitiveness research in the academic literature and how port research has evolved over the last decades. To address three RQs, we identified and investigated 267 articles related to port competitiveness from the maritime literature. According to citation analysis, the most influential journal was *Maritime Policy and Management*, followed by *Journal of Transport Geography* and *Transport Reviews*. Journals from other disciplines, such as *Applied Economics*, *Growth and Change*, also appeared in the list of top 20 journals.

Among the most influential papers based on TLC were Luo et al. (2012), Slack and Frémont (2005), and Yap and Lam (2006), as shown in Table 3. Ranked by TGC, the most influential papers were Gelareh et al. (2010), Slack and Frémont (2005) and Gonza´lez and Trujillo (2008), as shown in Table 4. In addition, Yeo et al. (2008), Yap and Lam (2006) and Trujillo and Gonzalez (2008) topped the ranking of trending articles (Table 5) in port competitiveness research. Hong Kong Polytechnic University, University of Antwerp and Erasmus University Rotterdam were the top three institutions excelling in port competitiveness research.

To shed more light on our first RQ, we identified seven underlying research streams in port competitiveness research:

1 port competition

2 port efficiency

3 institutional transformation

4 port pricing

5 port embeddedness

6 port choice

7 port cooperation.

Figure 4 depicts these streams and can help researchers and others interested in these topics become familiar with the important categories, concepts and methods in the field.

To highlight implications for the academic literature, some conclusions can be drawn based on the discussions of the underlying research streams in Section 5. Firstly, similarly as Ng (2013), we found that most of the port competitiveness studies in the past were concentrated on European, East-Asian and USA ports. Decentralising the concentration in port competitiveness research and exploring peripheral ports would help

the field to develop new knowledge. Overall, new theory development in the field is lacking. While majority of the studies borrow theories from the economics literature, Hales et al. (2016) proposed the *balanced theory of port competitiveness* recently. Many studies are also based on the *competitive advantage theory*, but combination of other theories such as *political-economy theory* (Maggi and Rodriguez-Clare, 2007) and *strategic-intent perspective* (Mantere and Sillince, 2007), might be explored too, to scrutinise cross-border cooperation between ports. However, this research field has made great progress in methodological applications, despite data availability remained as an unsolved issue. Among the methodological approaches, use of factor analysis in the port choice stream (Chang et al., 2008; Saeed, 2009), game theory in the port cooperation (Kaselimi et al., 2011; Saeed and Larsen, 2010a) and DEA in the port efficiency stream (Cullinane et al., 2005; Tongzon, 2001) were noticeable. While factor analysis ranks different port choice factors, Ng (2006) argued that the port choice behaviour of liner companies is often not based on a single factor but on a package of factors. This makes analytic network process a useful tool for port choice studies. Also, applications of game theory models have more potential than currently explored; for instance, using game theory to determine transhipment terminal handling charges and analyse reward/penalties on the environmental performance of a port. Meanwhile, DEA received some criticisms for its inability to provide a meaningful insights while comparing technical efficiency of ports of different sizes and backgrounds (Panayides et al., 2009).

A plenty of research is yet to be done. Technology is rapidly changing, as are customer requirements. Autonomous vessels are no more a dream, but to hit the terminals within a less decade time. This will change the way ports operate nowadays. Researchers should investigate future changes in demand for port service through identifying innovative and value-added services that ports could offer to stay competitive, such as automotive terminals, logistical parks, etc. De Martino et al. (2015) examined competitive advantage through value creation process of the Port of Naples. According to them, the value creation in the port should be further examined in port-networks rather than in single port actor. Also, Song et al. (2015) suggested further examining the competition behaviour of ports in a port network. As the shipping industry is an integral part of the global supply chain, uncertainty caused by internal and external factors is likely to increase. To further investigate port competition, extension of game theoretical models into the shipping network-level rather than port level would be also interesting (Wang et al., 2014). Researchers should explore future technical, economical and operational factors for port authorities to consider when planning or developing new ports or terminals. High technical efficiency of a port is regarded a good feature in existing port efficiency studies. But an informal investigation of ports with high technical efficiency by Cullinane and Wang (2010) found that such ports may not be the best ones in terms of service quality. Thus, research in this aspect should be attempted. Also, Wang et al. (2014) found that, it is more economic to expand ship capacity than updating frequency to meet required service level; thus, the debate on rapidly increasing size of ships should be scrutinised considering formation of alliances as an alternative to achieve economies of scale. Finally, environmental sustainability has been receiving great attention in the port industry recently. We already know that green management practices positively influence container terminal performance (Lun, 2011). In this respect, future research should focus on diffusion of green management practices in the maritime industry ranging from the macro (regional or national) to micro (organisational) level players.

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Notes

1 The five published articles on port competitiveness before 1990 are Britton (1963), Kenyon (1970), Garnett (1970), Sun and Bunamo (1973) and Bobrovitch (1982).