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Review of existing studies on maritime clusters

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ABSTRACT

Maritime clusters benefit both business operations and the national economy. They have existed for a long time, and have contributed significantly to both global and regional economic development, yet only in recent decades has research into the effects of clustering gained much attention. Most of such research is similar to studies of general industry clustering, with little consideration given to the unique nature of the shipping industry. This study analyzes the key elements of maritime cluster studies during the past 20 years, including conceptual development, industry sectors included, research methods, factors for clustering, studies of specific clusters, and the relationships among maritime service businesses. Misunderstandings about the difference between International Maritime Centers and a maritime cluster are also clarified. Such analysis allows us to identify possible issues and deficiencies in the existing studies, and to point out directions for future research on maritime clusters.

KEYWORDS

Maritime cluster; conceptual development; research method evolution; clustering factors; international Maritime Centre

1. Introduction

Maritime clusters are very important for both business operations and the national economy. From the perspective of business operations, companies can enhance their competitiveness by joining a maritime cluster, in which they can enjoy a skilled labor pool, share information, and have a closer relationship with clients. A comprehensive maritime cluster is an ecosystem in itself, one in which maritime-related companies and institutions can grow, develop and benefit each other. For example, in the Netherlands, many important suppliers are in the same maritime cluster, and over half of the firms' expenditure is spent within the maritime cluster (de Langen 2002). It is also found that nearly 40% of business knowledge comes from actors inside a maritime cluster, which indicates that knowledge spillover exists within a maritime cluster (de Langen 2002). Important suppliers pool and share expenditure inside the cluster, and knowledge spillover shows that benefits exist inside a maritime cluster that are vital for business operation.

From the perspective of the national economy, maritime clusters play a vital role in both regional and domestic economies. Many countries treat the development of a maritime cluster as an important strategy for regional development. Taking the Netherlands as an example, in 2017 the total production value of the Dutch maritime cluster was around €55.1 billion, and the total value added amounted to about €22.8 billion. About 3.1% of the total GDP of the Netherlands was supported by the maritime cluster in 2017, and 3.3% in 2016. The maritime

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sector also provided 260,000 jobs, which accounted for 2.85% of total employment in the Netherlands (Maritime by Holland 2018). Also, as a traditional maritime country, UK maritime clusters contribute significantly to its national economy. In 2017, the maritime sector generated about £17 billion in Gross Value Added (GVA) and supported about 220,100 jobs for UK employees. The sector also contributed £5.3 billion in tax revenues, which represented 0.7% of total tax revenues. In terms of exported goods and services, the UK maritime sector accounted for 2% of total exports (Maritime UK 2019). In addition, with a developed maritime cluster, Hong Kong is regarded as an international shipping center in the Asia-Pacific area, the maritime industry being one of the pillar industries in Hong Kong. In 2016, the maritime and port industry generated about HK$ 28.3 million towards the GDP, which is 1.2% of the total GDP, and provided 85,720 persons with employment, which accounted for 2.3% of the total employment in Hong Kong (THB 2018). These examples highlight the significant contribution that maritime clusters make to national economies. As Shinohara (2010) pointed out, a maritime cluster has a 'ripple' effect. Indeed, maritime clusters can contribute to the local economy, increase employment, and benefit both upstream and downstream industries, such as manufacturing and export-oriented businesses in coastal countries (de Langen 2002). For many countries and regions, developing a maritime cluster not only has strategic importance for the regional economy and logistic development, but also for national economic development.

Important as they are, though, maritime clusters did not gain sufficient attention from the academic society until two decades ago, when the world commercial center shifted to Asia, even though shipping has a more than 5000-year history. This study aims to review the existing studies on maritime clusters and analyze their key elements, including conceptual development, industry sectors included, research methods, factors affecting clustering, studies of specific clusters, and the various maritime service businesses and their relationships. Although there have been a few reviews on maritime clusters, each has different perspectives. For example, Doloreux (2017)'s review emphasizes on the definition of maritime cluster. Koliousis et al. (2019) analyzed the correlation between strategic management and academic impact in a review of existing studies. Shi et al. (2020) also summarized the existing studies using 'what-why-how' logic, following the traditional method used by Maskell and Kebir (2006) in the conceptual analysis of a general industry cluster. In addition to the difference in perspectives, our analysis helps to identify possible issues in the current studies, as well as deficiencies that exist for meeting the needs of maritime cluster development.

Most of the current studies about maritime clusters are very general and largely similar to those of general industry clusters, not only in their definition, but also with regard to the clustering factors and research methods. The unique natures of maritime businesses, such as shipping companies being footless (they often relocate to find the best business environment) and maritime service companies being global (they serve global customers), have not therefore been fully considered. The relationship between different business sectors in the shipping industry and their contributions to a specific cluster, are also not well studied. In addition, there are misunderstandings over the differences between an International Maritime Center (IMC) and a maritime cluster. Further research is thus required to consider these specific features, so that support is given to both business clustering decisions and to public policies on maritime industry development.

This paper first presents a brief review of maritime cluster studies over the past 20 years, using 57 papers written in English and published in peer-reviewed international journals. Then six key elements of maritime cluster studies are analyzed, including their conceptual development, industry sectors included, research methods, clustering factors, studies of specific clusters, and the relationships among various maritime businesses. This is followed by a clarification of the conceptual differences between an IMC and a maritime cluster. Finally, we present the summary and conclusion.

2. Description of existing research

To understand current developments in the study of maritime clusters, a systematic method is used to collect the publications on this topic from many databases, including ProQuest (about.proquest.com), ScienceDirect (www.sciencedirect.com), Dialnet (dialnet.unirioja.es), Taylor & Francis (www.tandfonline.com), and Sage Premier (journals.sagepub.com). These databases cover most of the journals involved in maritime cluster study, which ranges from business and economics to geography and regional science. The keywords used for searching are 'maritime cluster', 'shipping cluster' and 'maritime agglomeration'. The publication period is set from 1890 to 2019, since the study of industry clusters began in the 1890s. However, the first published study on maritime clusters as a specific branch of general industry clusters only appeared in 1999. A total of 56 papers are collected from 27 peer-reviewed international journals in the English language. Among them, 13 are Science Citation Index (SCI)/Social Science Citation Index (SSCI) indexed (see Table 1). Marine Policy and Maritime Policy & Management are the two main journals that have published most of the articles on this subject. The number of publications from 1999 to 2019 is shown in Table 2.

In addition to journal publications, some conference papers and reports from international conferences and related consulting companies are included. A total of 63 published articles and reports from the past two decades are collected. Many papers on maritime clusters have also been published in Chinese, due to the fast growth of the Chinese maritime industry over the past 5 years. Some are very inspiring, but due to the language problem have not been included in this study.

Table 1. Journals and number of publications in maritime cluster studies.

SCI/SSCI Journal	non-SCI/SSCI Journal
Marine Policy (12)	Canadian Journal of Regional Science (1)
Business History Review (1)	Entrepreneurship & Regional Development (1)
European Planning Studies (1)	International Journal of e-Navigation and Maritime Economy (1)
Geoforum (1)	International Journal of Maritime History (2)
Journal of Transport Geography (1)	International Journal of Transport Management (1)
Maritime Economics & Logistics (1)	International Studies of Management & Organization (1)
Maritime Policy & Management (9)	Journal of East-West Business (1)
Sustainability (1)	Journal of Maritime Research (3)
Transportation Research Part A (3)	Ocean & Coastal Management (3)
Urban Studies (1)	Procedia-Social and Behavioral Sciences (2)
Research in Transportation Business & Management (1)	Revista de Estudios Regionales (1)
Technovation (1)	The Journal of Maritime Business (1)
Transport Policy (1)	Urban, Planning and Transport Research (1)
	WMU Journal of Maritime Affairs (1)
	Transportation research procedia (1)
	Transport Systems and Processes: Marine Navigation and Safety of Sea Transportation (1)
	Procedia Economics and Finance (1)

Table 2. Number of publications on maritime clusters from 1999.

Year	Number	Year	Number
1999	1	2010	2
2000	1	2011	4
2001	0	2012	2
2002	1	2013	7
2003	2	2014	9
2004	0	2015	3
2005	3	2016	8
2006	2	2017	5
2007	0	2018	2
2008	1	2019	2
2009	1		

Table 3. Maritime cluster policies.

Country/Region	First proposal of maritime cluster	Document	Note	Reference
Japan	2000	Ministry of Transport of Japan	The ministry named the Japanese cluster 'Maritime Japan'.	Shinohara 2010
Portugal	2007	ALGARVE 21 Regional Operational Programme for 2007–2013		Ortega, Nogueira, and Pinto 2014
Québec	2015	Québec's Maritime Strategy	Major policy initiatives have cluster component	Doloreux, Shearmur, and Figueiredo 2016
Europe	2006	Green Book on Maritime Europe	'European Network of Maritime Clusters' was launched in 2005	"Maritime Policy Green Paper" 2006
North Sea region	2012	Maritime Transport and Future Policies Perspectives from the North Sea Region		Flitsch et al. 2014
Panama	2006	Intracorp and Asesores Estratégicos, 2006		Pagano et al. 2016

Although journal papers on maritime clusters first appeared fairly recently in 1999, maritime clusters actually appeared much earlier in history. The use of steamships in cargo trade in the late 18th century marked the start of the era of the modern shipping industry and stimulated modern trade and rapid industry development throughout the 19th century. Maritime clusters had already appeared in many regions at that time, such as in London and Rotterdam.

Finally, we find that researches into maritime clusters are often motivated by government policy. Table 3 shows the first appearance of 'maritime cluster' in the government policy of different regions. However, there is always a lag between the publication of government policy and industry development. For example, the EU's global maritime strategy 'Maritime Policy Green Paper' in 2006 encourages private maritime sectors to reorganize and *form into networks of maritime excellence, or 'clusters'* to achieve long-term development ("Maritime Policy Green Paper" 2006). This strategy was later adopted by many member countries to enhance maritime clusters, which then attracted researchers. This largely explains the recent surge in maritime cluster studies (Shinohara 2010; Ortega, Nogueira, and Pinto 2014; Doloreux, Shearmur, and Figueiredo 2016; Flitsch et al. 2014), which is the result of a top-down approach in economic planning (Flitsch et al. 2014).

3. Key elements in maritime cluster studies

In this section, we analyze the key elements involved in the research of maritime clusters, namely: What are maritime clusters? What industry sectors are included in a maritime cluster? What methods are used in existing studies? What are the determinants of a maritime cluster? What studies have been made of specific clusters? What are the relationships between players inside a cluster? As a maritime cluster is a specific industry cluster, we study it by comparing it with studies of general industry clusters, thereby hoping to identify research gaps in the specific research on maritime clusters.

3.1. The general concept of a maritime cluster

Maritime clusters have a long history, although who used the term first is not known, due to the lack of a written record. It first appeared in de Langen (2002) referring to the performance of the Dutch maritime cluster. Brett and Roe (2010) defined it as *a selection of industries that are usually located*

at, or originally centered on, the trading activities of a port. This specifies the importance of a port in order to start a maritime cluster. However, such maritime clusters are heavily reliant on physical cargo movement, whereas maritime service clusters are not. Thus, a new concept is required.

Chang (2011) defined a maritime cluster as *a network of firm, research, development and innovation units and training organizations which cooperate with the aim of technology innovation and of increasing maritime industry's performance*. This included the many entities in a maritime cluster, which gave to the word cluster an 'aim' on innovation. It does not require a port, which provides some flexibility.

Doloreux, Shearmur, and Figueiredo (2016) formulated the definition of a maritime cluster as *a geographic concentration of firms in maritime sectors, of research and education organizations which are active in related fields, and of public support mechanisms operated by the government and regional stakeholders*. Like Porter's, this definition focuses on the geographical agglomeration. Doloreux (2017) further described it from three aspects: as an industrial complex, as an agglomeration, and as a community-based network, this being based on the concept of a general industry cluster. However, the unique nature of maritime clusters, such as the global nature of the world shipping business, is not reflected here. A new concept of 'supercluster' was then proposed by Doloreux and Shearmur (2018), focusing on the complete value-chain of the maritime industry and encouraging cross sector collaboration. However, the difference between maritime cluster and 'supercluster' is not made clear in their paper.

In short, although many studies have discussed the concept of maritime clusters, their definition is still evolving. The consensus is that it is a concentration of maritime-related firms and organizations, with innovation and knowledge spillovers, and possibly involves government policy. However, the unique nature of a maritime cluster has not yet been considered. For traditional maritime clusters, the key player is shipping companies, not ports, although they are always developed around a port. Such clusters are not stable, as shipping companies are 'footless'. However, maritime service clusters, although developed from traditional maritime clusters, are more likely located in the place with the best business environment. Therefore, it is necessary to distinguish the concept of these two types of maritime clusters, as they need different policies for cluster development.

3.2. Industry sectors within a maritime cluster

Many people use maritime clusters to refer to different industry sectors. In existing studies, the following industry sectors are included in maritime clusters, though each maritime cluster is made up very differently.

a) *Marine biological resources*: Industries such as fishery and aquaculture (Fernández-Macho et al. 2015; Morrissey 2014);

b) *Physical maritime transportation activity*: Port and shipping activities such as port logistics and liner shipping industries (Shinohara 2010; Othman, Bruce, and Hamid 2011; Makkonen, Inkinen, and Saarni 2013);

c) *Maritime services*: Sectors that serve the transportation of goods, which can be divided into traditional maritime services (e.g. freight forwarder) and high-end maritime services (e.g. legal services and maritime education) (Morrissey and Cummins 2016; Benito et al. 2003);

d) *Maritime technologies*: Shipbuilding and ship repair (Shinohara 2010; Salvador, Simões, and Guedes Soares 2016; Pagano et al. 2016);

e) *Others*: Off-shore activity/navy/sea-related recreation/others (Shinohara 2010).

Among all the papers and reports we reviewed, 23 papers and 3 reports have discussed at least one specific sector. Figure 1 presents the distribution on the number of papers in the above five sectors. The number of times a paper is counted depends on the number of sectors it includes.

Among these five sectors, two have been studied by the highest number of publications: physical maritime transportation activity, and maritime technologies. These are the traditional sectors of the

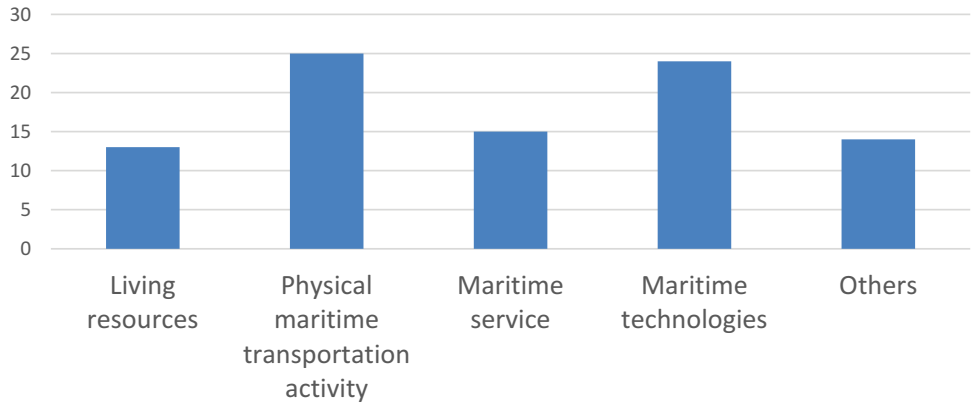

Figure 1. Number of publications in five sectors in maritime clusters.

maritime industry and nearly all the port cities and historical maritime clusters have stemmed from them. The first and fifth industries are often not included within the maritime industry, because they are not related to the transportation of cargo.

It is worth noticing that the third sector, maritime service businesses, has the least number of publications. This sector is derived from and can be located away from the transport of cargo or ship operations, which is the major content in traditional maritime clusters. Recently, these have become a hot topic, as London and Hong Kong, famous for their traditional maritime clusters in the past, continue to develop their maritime industry in the service sector. From the empirical study by Jacobs, Koster, and Hall (2011), the location of maritime services is largely determined by its clients, shipowners and port-related industry, but not necessarily by port throughput. Ghiara and Caminati (2017) also found that Advanced Maritime Producer Services (AMPS) would like to position its international office closer to their customers—global liner shipping companies. As maritime service clusters are new in the evolution of maritime clusters, and are also an important element for regional economic development, the popularity of maritime services will no doubt increase in future studies.

3.3. Research methods used in current literature

The methods used in existing studies can be divided into four phases, as shown in Table 4. In the early stage (1999–2003), the studies are mostly descriptive, based on survey and evaluation, and some qualitative studies using the Porter Diamond model (Benito et al. 2003). Later on (2004–-2008), some new methods were adopted, including input-output analysis (Kwak, Yoo, and Chang 2005), and comparative case study analysis (de Langen and Visser 2005). Between 2009 and 2013, diversified research methods were applied, including not only the descriptive approach, but also quantitative modeling, data evaluation, and regression, etc. Some new approaches emerged during this stage, including social network analysis (Pinto and Cruz 2012), the Delphi method (Brett and Roe 2010) and SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis (Chang 2011).

During the last period (2014–2020), the studies are not only descriptive studies but are also quantitative and analytical studies. Many new methods, such as statistical evaluation, review study, logit model, Markov Chains and the agglomerative hierarchical clustering approach appeared in this period. Lee et al. (2014) utilized an analytic hierarchy process (AHP) to identify and evaluate five major factors affecting the competitiveness of a country's maritime industry. Pinto, Cruz, and Combe (2015) used a logit model to study the important factors leading to cooperation among the maritime sectors. They found that innovation and absorptive capacity can help to promote cooperation. Stavroulakis and Papadimitriou (2017) formulated a model to evaluate the strategic

Table 4. Evolution of methods used in the study of maritime clusters.

1999–2003	2004–2008	2009–2013	2014–2020
• Descriptive (3) • Porter Diamond model (1) • Survey & evaluation (1)	• Comparative case studies (2) • Computer assisted telephone interviews (1) • Descriptive (2) • Input-output analysis (1)	• Actor-network theory (1) • Benchmark analysis (1) • Case study (1) • Comparative case studies (1) • Data evaluation (1) • Delphi Method (1) • Descriptive (3) • Empirical analysis (regression) (1) • Porter Diamond model (1) • Proposal (1) • Social network analysis (1) • Strength Indicator Model (1) • Survey & Descriptive statistics (1) • SWOT analysis (1) • Symbiosis theory and Lotka-Volterra model (1)	• Comparative analysis (2) • Crosstab methodologies and/or Markov chains (1) • Data evaluation (1) • Delphi method & Analytic hierarchy process (1) • Descriptive (8) • EFA and CFA (1) • Empirical analysis (2) • Input-output analysis (3) • Interview (1) • Location quotients (1) • Logit model (1) • Lotka-Volterra model (1) • Marnet theoretical framework/agglomerative hierarchical clustering approach (1) • Qualitative research (1) • Review (2) • Scarcity theory (1) • Survey (1) • Typology (1)

management of maritime clusters and applied it on the case of the European maritime cluster. Zhang and Siu Lee Lam (2017) introduced symbiosis theory and the Lotka-Volterra model to study the inter-relationship among shipping sectors in a maritime cluster. Koliousis et al. (2018) discussed the condition that allows maritime cluster development under limited resources. Recently, Djoumessi, Chen, and Cahoon (2019) utilized Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to evaluate the factors affecting innovation in a maritime cluster. Factor analysis is seldom used in maritime cluster studies, but Djoumessi's try paved the way for future study.

Many papers in the latest period applied input-output (IO) analysis. Morrissey and Cummins (2016), Salvador, Simões, and Guedes Soares (2016) and Pagano et al. (2016) studied intra-cluster linkages in the Irish maritime cluster, Portuguese Maritime Cluster and Panama's maritime cluster, respectively. Morrissey and Cummins (2016) investigated four pillar sectors of the Irish maritime cluster, namely: Shipping, logistics and transport; marine energy; maritime safety and security; and yachting products and services. They found that these four pillars have low correlation with each other, but they share similar inputs and outputs. Salvador, Simões, and Guedes Soares (2016) also found that the Portuguese maritime cluster has weak intra-cluster linkages. Pagano et al. (2016) revealed the low correlation of sectors in Panama's maritime cluster.

Examining the methods used in existing studies, one can hardly spot any special features aimed at maritime cluster analysis. For example, many applied Porter's theory in the study of maritime clusters, but this is more like analyzing competitiveness strategies rather than cluster theory. Just like the observation of Harrison (1992) that industrial agglomeration is just 'old wine in new bottles', which means just taking existing cluster theories for granted, the research into maritime clusters also lacks innovation and just follows that used for general cluster study. Also, very few (Koliousis et al. 2018) conducted analytical modeling on the dynamics inside a cluster, how firms benefit from a cluster, how utility differs between a cluster and a non-cluster, and what really attracts firms to join a cluster. The most popular research method in this field is that of descriptive study, maybe due to the difficulties in obtaining firsthand quantitative data in this field. With regard to quantitative methods, only regression analysis and IO approaches have been applied.

3.4. Factors affecting the emergence and development of maritime clusters

As far as general industry clusters go, there have been extensive studies on the factors leading to their emergence and development. These factors can basically be divided into two main categories: intrinsic and extrinsic factors. Intrinsic factors, including natural resource endowment, are important for starting a cluster. Extrinsic factors, such as government policy, legal support, financial support, and economic conditions, can help the cluster grow. As one type of industrial cluster, maritime clusters are found to have similar driving forces for cluster formation and development (de Langen 2002; Viederyte 2016; Viederytė 2014; Djoumessi, Chen, and Cahoon 2019). These factors are summarized in Table 5.

Many have also studied the intrinsic factors behind maritime clusters. Jacobs, Koster, and Hall (2011) found that advanced maritime services must start with a port, whereas their growth may not actually depend on it. Similarly, Ghiara and Caminati (2017) found that being a port city is an intrinsic factor for a maritime cluster. Chang (2011) stated that a manufacturing industry is a prerequisite for port development, and hence a required condition for a maritime cluster. da Silva et al. (2014) described the major factors driving development of the Algarve maritime cluster, namely, its natural conditions, maritime history and culture.

As for extrinsic factors, Pinto and Cruz (2012) found that regional authorities and research institutions such as a university are the key to a local maritime cluster. Othman, Bruce, and Hamid (2011) find that competition, effective connections between sectors, and chance can affect the competitiveness of Malaysian maritime clusters. Viederyte (2016) found that innovation, skill transmission and bargaining power are critical for European maritime clusters. Zhang and Siu Lee Lam (2017) concluded that interplay and inter-influence among individual firms are essential for the development of maritime clusters. A report by British Maritime Technology (BMT 2014) listed 11 potential factors supporting maritime clusters, with the factors directly affecting the shipping industry being the labor pool, professional services, tonnage owned within a cluster, the presence of regulatory bodies, and the physical proximity of shippers and charterers. Lee et al. (2014) identified factors that can enhance competitiveness of the maritime industry, including specialization and market share in shipping services, the number of shipping firms, competence, and quality of services. Stavroulakis and Papadimitriou (2016) concluded that factors such as agglomeration economies, domestic industry, and culture affect the competitiveness of a maritime cluster. Gailitis and Jansen (2011) analyzed the Latvian maritime cluster and concluded that geographical concentration, critical mass, and active business channels between stakeholders are very important for its development. Benito et al. (2003) discussed factors related to cluster conditions, such as strategy, structure and rivalry, demand conditions, suppliers and related industries, government, and chance.

Three observations can be made on such studies about the factors for maritime clustering. Firstly, most of the factors are general, like those for general industry clusters, such as its location

Table 5. Factors for emergence and development of maritime clusters.

	Factors
Intrinsic factors	near a port or manufacturing centers; natural conditions; maritime history, and culture.
Extrinsic factors	regional authorities and research institutions; competition, effective connections between sectors, and chance; innovation, skill transmission, and bargaining power; interplay and inter-influence among individual firms; labor pool, professional services, tonnage owned within a cluster, the presence of regulatory bodies, and physical proximity of shippers and charterers; specialization and market share in shipping service, the number of shipping firms, competence and quality of service; agglomeration economies, domestic industry, and culture; geographical concentration, critical mass, and active business channels; cluster conditions, strategy, structure and rivalry, demand conditions, suppliers and related industries, government, and chance.
Both	factor conditions; strategy, structure, and rivalry; demand conditions; suppliers, and related industries; government, and chance.

condition, innovation and culture. Very few factors are specific to the shipping industry. Secondly, although many have studied both the intrinsic and extrinsic factors, they have not studied the interactions among the different factors. For example, many have studied the contribution of preferential tax to a cluster's development. Is there a minimum market size for it to be effective? What is the substitution between the tax and the market size? Such studies could help a decision on the tax policy at different stages of a cluster's development. Thirdly, the combination of intrinsic and extrinsic factors may vary in different clusters. For example, for traditional maritime clusters, public policies on trade facilitation and logistics services are very important. However, for maritime service clusters, such as one specializing in ship financing, the financial services environment would be more important.

3.5. Studies of specific maritime clusters

A total of 56 published papers have studied 19 maritime clusters (Table 6). Most of them are focused on Europe, because European maritime clusters have been around for nearly 200 years, ever since the emergence of steamships. The papers are regional specific, as their purpose is to help formulate public policies on maritime industry development. Brett and Roe (2010) investigated the potential clustering of maritime sectors in the Greater Dublin Region, and found that actually the Greater Dublin maritime transport sector had already formed a maritime cluster instead of just a simple agglomeration of firms. Fernández-Macho et al. (2015) examined Spanish maritime clusters, and also found that maritime clusters are region specific. Doloreux, Shearmur, and Figueiredo (2016) studied Québec's maritime cluster and its impacts on the local economy. They concluded that the sectors covered inside Québec's cluster policies developed slower than those not covered. Viederytė (2014) evaluated the Lithuanian maritime cluster using the number of employees, turnover and added value in the maritime industry. The study identified the most competitive sectors and sub-sectors in the Lithuanian maritime cluster. Other researchers in maritime studies, such as Morrissey and Cummins (2016), Pagano et al. (2016), and Kwak, Yoo, and Chang (2005) explored intra-cluster linkages in Irish maritime clusters, Portuguese maritime clusters, Panama's maritime cluster and Korea's maritime industry respectively.

As the world shipping center has only just, in recent decades, shifted to Asia, the number of papers focusing on Asia is small. Another possible reason is the research funding. Europe has many research programs granted for maritime study and even maritime cluster study, such as the North Sea Region Program 2014–2020, and the EU Strategy for Marine and Maritime Research (2008). The European Commission has also offered many funding opportunities to support maritime related researches. The number of papers shows an obvious increase after these programs. As one of the world famous maritime centers, the Hong Kong maritime cluster has had few appearances in an academic journal (Zhang and Siu Lee Lam 2017). Hong Kong has no research funding targeted specifically at maritime studies, only a General Research Fund (GRF). The percentage of GRF grants awarded to shipping-related projects in 2013 was 0.08%, in 2014 it was 0.19%, in 2015 it was none, in 2016 it was 0.05% and in 2017 it was 0.09% (University Grants Committee 2020). The funding support for Hong Kong maritime research neither matches its status as a maritime center in Asia, nor is it comparable with the government funding for maritime research in other maritime centers, such as Singapore.

3.6. Maritime service businesses and their relationships

As discussed in section 3.2, existing studies on maritime clusters are focused on traditional sectors such as ports, shipping activities and shipbuilding, with little attention being paid by academics to maritime service sectors. However, clustering of maritime services has been around for years in many historical port cities, and has now become a hot topic in the maritime industry. The development of traditional maritime clusters depends on cargo flow. Maritime service clusters,

Table 6. Studies of specific maritime clusters.

	Maritime Cluster	Location	Number of papers	Examples
1	Dutch maritime cluster	Netherlands	2	de Langen 2002; Nijdam & de Langen, 2003
2	Japanese maritime cluster	Japan	1	Shinohara 2010
3	Norwegian maritime cluster	Norway	4	Benito et al. 2003; Amdam & Bjarnar, 2015
4	Greek shipping industry	Greece	1	Grammenos and Choi 1999
5	Malaysian maritime cluster	Malaysia	1	Othman, Bruce, and Hamid 2011
6	English maritime cluster	United Kingdom	4	Chang 2011; Morrissey 2014; Stavroulakis and Papadimitriou 2017; Zhang and Siu Lee Lam 2017
7	Korean maritime cluster	Korea	1	Kwak, Yoo, and Chang 2005
8	Canadian maritime cluster	Canada	4	Doloreux & Shearmur, 2006, 2009; Doloreux, Shearmur, and Figueiredo 2016
9	Spanish maritime cluster	Spain	2	Ortega, Nogueira, and Pinto 2014; Fernández-Macho et al. 2015
10	Finnish maritime cluster	Finland	2	Makkonen, Inkinen, and Saarni 2013
11	Portuguese maritime cluster	Portugal	5	Pinto and Cruz 2012; da Silva et al. 2014; Salvador, Simões, and Guedes Soares 2016
12	Irish maritime cluster	Ireland	2	Brett and Roe 2010; Morrissey and Cummins 2016
13	Atlantic maritime cluster	Portugal, Spain, Ireland, and Scotland	1	Pinto, Cruz, and Combe 2015
14	Panama's maritime cluster	Panama	1	Pagano et al. 2016
15	Lower Mississippi port cluster	United States	1	de Langen and Visser 2005
16	Hong Kong maritime cluster	Hong Kong S.A.R.	1	Zhang and Siu Lee Lam 2017
17	Lithuanian maritime cluster	Lithuania	1	Viederytė 2014
18	Australian maritime clusters	Australia	1	Djoumessi, Chen, and Cahoon 2019
19	Latvian maritime cluster	Latvia	1	Gailitis and Jansen 2011

however, are relatively independent of port throughput (Jacobs, Koster, and Hall 2011). For example, even though London does not have a large port throughput, its high-end maritime services, such as shipping finance and law, still make it the leading international maritime capital (Shi et al. 2020). Therefore, developing maritime service clusters has become an aim of many port cities, including Hong Kong, even though their port throughputs may be declining.

To help with understanding the business components of maritime service clusters, this section summarizes the service-customer relationships within the shipping industry (Figure 2), which is centered on shipowners—the key player in the shipping industry. All other businesses serve shipowners, either directly or indirectly, as marked by the lines with arrows pointing to the customers being served. The direct service providers are shipbuilders, ship financers (Grammenos and Choi

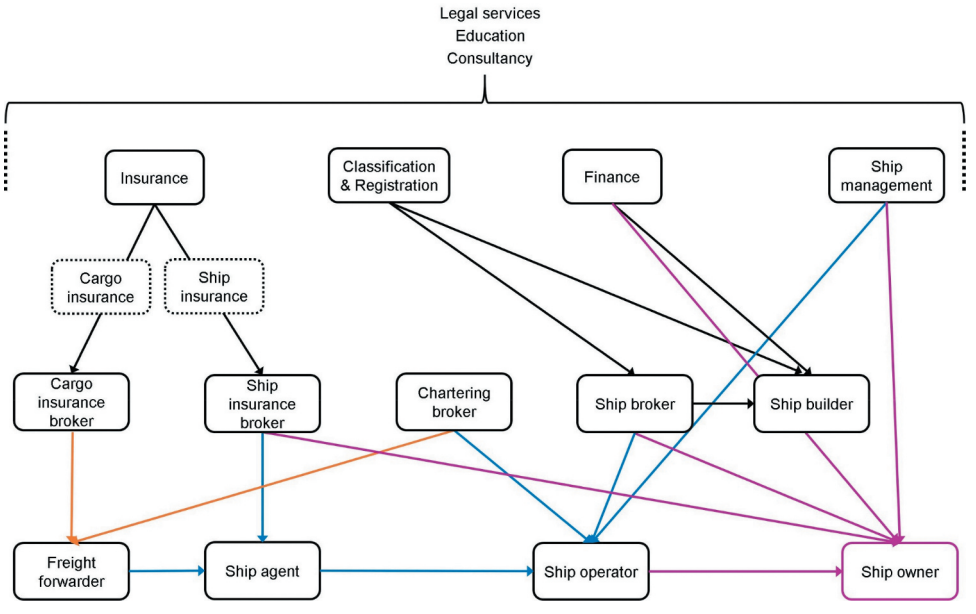

Figure 2. Service-customer relationship in shipping industry.

1999), shipbrokers, ship operators, ship management companies, and ship insurance brokers, as marked with purple arrows in Figure 2. In the past, they used to be located close to shipowners. Now, due to the developments in transportation and telecommunication facilities, where they are located is no longer a problem (Shi et al. 2020). For example, ship operators and ship financing banks, no matter where they are, can all serve the Greek shipowners. Because of this, service providers will now grow in a place with the best business environment for their development. For example, ship financing businesses will likely thrive in a global financial center, such as London or Hong Kong (Jacobs, Koster, and Hall 2011).

Ship operators are the ones who actually use the ship in the shipping business. They can either own the ship or charter it from other shipowners (Grammenos and Choi 1999). They are playing an increasingly bigger role in the shipping industry. For example, Maersk, Mediterranean Shipping Company (MSC), and China Ocean Shipping (Group) Company (COSCO), are now the main operators in the liner shipping market. These are multinational enterprises with headquarters in their home country and regional offices all over the world. They employ services directly from ship management companies, ship brokers, chartering brokers, and ship agents. A ship agent is a representative of the operators in a specific port, to help the operators in dealing with local businesses (Ghiara and Caminati 2017). The service-customer relationships are marked with blue links in Figure 2.

Freight forwarders (FFs) bridge the gap between ship operators and shippers (or cargo owners), help shippers to deal with the tedious exporting formalities, and help operators to secure the cargoes in the local area. Therefore, they must be located around the port, in the cargo generation area (Ghiara and Caminati 2017). The service providers of FF are marked with orange links in Figure 2. Its businesses depend on cargo volume. Therefore, it is a typical attribute of maritime clusters based on port throughputs.

In addition to the maritime businesses stated above, many other specific businesses have developed to serve the industry, such as insurance, finance, legal, education, information and consultancy services (Benito et al. 2003; da Silva et al. 2014). These require specific knowledge and skills in a particular field, as well as in the shipping industry. They are usually grouped under high-end maritime services—a very important direction for the future development of maritime

clusters. The service-customer relationships among them are shown with black links in Figure 2. Since education, legal and consultancy services can serve every maritime business, they are put at the top of the whole network.

To sum up, the four traditional sectors at the bottom of Figure 2 are the clients of maritime services. Above them, the maritime service clusters can grow given the business environment of the region. With the development of information technology and transportation facilities, the physical distance between maritime service businesses and their clients is now less important. Maritime service businesses can locate wherever the best business environment is. Therefore, to formulate policies for the development of maritime service clusters, it is important to study the best business environment that a place can offer to the maritime service businesses, including tax policies, the legal system, government support, and access to the global financing resources.

4. International Maritime Centre

In the process of reviewing the existing studies on maritime clusters, we find that many have mixed up the concept of a maritime cluster with that of an International Maritime Centre (IMC), or have used the terms interchangeably. For example, Xiong (2010) claims that Wuhan is building its international maritime center. However, its maritime industry is localized, and can only be called a maritime cluster, not an IMC. Similar confusion occurs frequently in Chinese publications when discussing maritime clusters. This section aims to clarify these two concepts.

As pointed out by Ma (2011), the development of an IMC includes three generations. The first is the traditional maritime clusters represented by concentrated cargo flow or ship building activity. The second generation includes some services to shipping, such as freight forwarding, a ship agency, crew training and management, shipping finance, brokering, registration, insurance, legal services and arbitration. The third generation of an IMC is knowledge based, and its functions are to stipulate international laws and regulations, and publish worldwide standards to the shipping industry. Clearly, maritime clusters are the starting point of an IMC. However, they have different functions. For the former, the main function is to enable businesses to grow better. It is not really a concern if the cluster does not have international influence. For the latter, the main attributes are international influence and control. For example, London is recognized as an IMC because many international laws and regulations, professional standards, headquarters of shipping insurance companies, and ship financing banks are from there, and their activities have world-wide influence. Hong Kong is referred to as an IMC in Asia because its maritime service sectors have an influence on the shipping industries in this region. London and Hong Kong are both referred to as an IMC because they have international influence, in addition to having a maritime cluster. Of course, London has a greater influence than Hong Kong in terms of not only the scope, but also the geographical region and extent.

5. Current issues and future directions in maritime cluster study

To help with future research into maritime clusters, this section summarizes the identified issues in existing research and proposes possible ways to address these issues. The issues and relevant suggestions are listed below.

(1) Unique natures of maritime businesses are not fully considered. As discussed in Section 3.1, the existing definitions of a maritime cluster are rather broad and ambiguous, being very similar to those of general industry clusters. It is a good start, but a better concept is required, one more pertinent to the maritime industry. This observation is echoed in Shi et al. (2020), which commented that a clear definition of 'maritime cluster' is lacking. Therefore, in future studies about maritime clusters, the specific nature of the shipping industry should be given more consideration. Taking a traditional maritime cluster as an example, the businesses are

mostly global or non-local, such as shipping companies (Ghiara and Caminati 2017). Although often labelled as footless businesses with higher movability, they are the key to maritime clusters. It is, then, useful to incorporate this attribute into cluster research, not just with regard to its definition, but also about its stability and contribution to the local economy, as well as on policies for the future development of such clusters.

(2) Lack of studies on maritime service clusters. Unlike traditional maritime clusters that rely heavily on port throughput, maritime service businesses do not have this limitation (Jacobs, Koster, and Hall 2011), and hence are more stable for the regional economy. However, maritime service clusters have not gained enough attention from academia, even though their importance has already been recognized by governments with a maritime tradition, such as Hong Kong and Singapore, as they are competing to attract maritime service businesses and build international maritime service clusters. Thus, research by academics needs to catch up with actual practice, and thus support the government decision processes.

(3) Research methods in maritime clusters needs to be expanded. The research methods are mostly descriptive, or just borrowed from research on general industry clusters. Very few studies (Koliousis et al. 2018; Zhang and Siu Lee Lam 2017) have adopted a modelling (theoretical analysis) approach. For example, analytical modelling on the interactions among different factors are very common in industrial economics, but there are very few of such for maritime clusters. Although many factors have been identified (Table 5), the interactions among them have not been studied. For example, government policies on preferential tax to attract maritime services should consider the current condition of the region, strategic behavior of the competition from other regions, and the behavior of the maritime service providers. This may require analytical modeling and empirical analysis, which methods are not commonly used in maritime cluster studies.

(4) The confusion between maritime cluster and IMC. It is understandable that many port cities are trying to build an IMC. As discussed in Section 4, though, although an IMC is developed from a maritime cluster, it is more than just a maritime cluster, in that it has international influence. The study of traditional maritime clusters should focus on cargo flow, whereas that of maritime service clusters should emphasize the attractive business environment of a region. For the study of an IMC, the focus should be on its international influence.

6. Summary

A 'maritime cluster' is one specific branch of 'general industry cluster'. With 200 years of history, theories about general industry clusters have been well developed in many directions. Compared with that, theory development over maritime clusters is still in its initial stage, even though much effort has gone into examining maritime clusters closely. Therefore, understanding the evolution of maritime cluster study and its current status can help future researchers grasp the context of its development and fill this research gap. In addition, it can also provide a reference for policymakers with regard to regional planning for maritime industry development.

This paper first described how the 56 publications over the past 20 years were collected, the distribution of publication numbers over time, the major journals, and governmental policies for the development of maritime clusters. Then six key elements in maritime cluster study were discussed. This was followed by a clarification over the misunderstanding of the difference between an IMC and a maritime cluster. A discussion of the current issues in maritime cluster studies and future research directions are provided, to help the readers in their respective further research.

As maritime clusters are important for both business development and the national economy, research into maritime clusters can help not only business decisions in the private sector, but also public policies for maritime industry development. Hopefully, this review can help future researchers in identifying existing problems and deficiencies, determining maritime cluster research directions, and supporting business clustering decisions as well as public policies to assist maritime

industry development.

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