

Maritime Cluster Attractiveness Index

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Index

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Received 6 November 2018
Revised 20 February 2019
Accepted 27 February 2019

Abstract

Purpose – The role of clusters in the development and growth of local and national economies has been extensively studied and discussed in global literature. Different methodologies are used for analysing the impact these have in national and regional economies, such as the input–output (IO) and gravity models. This paper aims to detail the methodologies present in the literature and propose a new robust theoretical framework, which facilitates the evaluation and comparison among maritime clusters in terms of attractiveness assisting stakeholders to devise strategies, which will attract companies.

Design/methodology/approach – An index is created composed of five key categories, namely, infrastructure, financing, governance, manpower and institution/legislation. For the analysis of the index, multi-attribute utility theory (MAUT) is used as a tool to evaluate the importance and performance of the different attributes using both quantitative and qualitative criteria. The methodology has been tested via the use of the Piraeus maritime cluster.

Findings – The framework has been tested on its robustness and friendliness to the user providing useful insights to the stakeholders. Among the results has been the importance of the finance, manpower and infrastructure attributes, which appear to promote the cluster's attractiveness. In addition, legislation and institutional partnerships, along with Government support, need to take place to improve the performance of the cluster.

Research limitations/implications – A key limitation is the fact that the methodology has been tested in a single case. Applying the methodological framework in a wider sample of clusters will significantly improve the present work.

Originality/value – The proposed model takes further existing research in the field via adopting the philosophy of the World Bank's Logistics Performance Index. Among the benefits of the proposed index is that it offers the flexibility and robustness to compare among different maritime clusters globally and can be readily used as a benchmarking policy tool at national, regional and global levels at any given point in time and attribute dimension.

Keywords Index, Clusters, Attractiveness, Maritime

Paper type Research paper



Maritime Business Review
Vol. 4 No. 2 2019
pp. 169-189
Emerald Publishing Limited
2397-3757

DOI 10.1108/MABR-11-2018-0044

1. Introduction

Maritime industry is considered to be a basic industry with a guiding role in regional and global economic development. Business processes rely on shipping for the transportation of commodities and finished goods to the consumption and production areas (Lee *et al.*, 2014). Extra significance is also obvious according to IMO's estimations, which suggest that 90 per cent of global trade volumes is transported by sea, implying the significant transportation role of shipping. The complex nature of the maritime industry, which includes key players, such as, ports, shipping management companies, forwarders, distribution companies and logistics companies (de Langen and Haezendonck, 2012), makes clear the necessity for a systematic and thorough performance analysis of those companies serving this industry. When companies are interconnected and have a common labour pool, they are considered to form a cluster (Porter, 1998).

The role of clusters in the development and growth of local and national economies has been extensively studied and discussed in the literature (Porter, 1998). Cluster definition varies among different nations and industries (Brett and Roe, 2010). Thus, different methodologies are used for analysing the impact these have on national and regional economies, such as the input–output (IO) models, gravity models (Pagano *et al.*, 2012) and the Lotka–Volterra model (Zhang and Lam, 2013), as well as tools including interviews and questionnaires (Brett and Roe, 2010; Shinohara, 2010).

Delimiting a cluster starts by selecting a core cluster activity in a specific region (i.e. financial services in London). In the case of maritime clusters, core activities encompass all those related to cargo and shipping-related services between specific areas. Such activities are logistics, shipbuilding, repair, cargo handling, R&D, ports, bunkering, shipbroking, suppliers etc. Firms share state of the art infrastructure and services, specialised customer markets, human capital resources, know-how and information. These shared resources create synergies between industrial and regional economic development. In addition, clusters fuse indigenous strengths with global best practices from firms in a variety of countries having different institutional systems (Zhao *et al.*, 2009).

Such units and business geographically concentrated exist for decades globally, moreover on different business sectors. Policymakers have embraced the cluster concept, have identified regional clusters and have developed policies and strategies to enhance the development of clusters (Markusen, 1996). A large variety of clusters, each with different characteristics, have been identified. In the case of the maritime industry, the interrelationships between port authorities, terminal operators and suppliers of maritime services are so strong that maritime clusters are formed globally.

The strength of a maritime cluster is dependent on the significance of the interconnections among its members, with education being an essential component (Porter, 1998). Education and research are the primary sources for supply of manpower, knowledge and skills.

Europe has a mature maritime economy, which maintains a strong global position. Key to maintaining its leading position is the stimulation of entrepreneurship and innovation through scientific knowledge and a well-educated and skilled workforce. The European Network of Maritime Clusters was established in November 2005, comprising Denmark, Finland, Germany, The Netherlands, Norway, Poland, Sweden and the UK (European Network of Maritime Clusters). Given this background, this study aims at assessing the attractiveness of the maritime cluster of the port of Piraeus in Greece and identify policy implications.

Nevertheless, cluster analysis in the maritime industry lacks extended and empirical research due to the fact that it is considered as rare phenomenon rather than common practice (Rosenfield, 1997). According to Folta *et al.* (2006), economies of agglomeration like clusters, benefit firms in their capability to innovate and attract strategic alliances and

private equity partners. Regional development policies and strategies play significant role in the local and national economy of the cluster improving the standard of living. A maritime cluster is a network of intensive links among firms, ports, universities, institutions and public authorities, which cooperate as a whole. Successful maritime clusters guarantee that cluster development can achieve prosperity and sustainability (Othman *et al.*, 2011). Moreover, clusters aiming at enhancing or developing their dominance require some level of measurement and performance analysis due to the complexity of their nature.

This paper aims at identifying the factors which add value and enhance the cluster's performance and proposes a robust framework for measuring the attractiveness of a maritime cluster with the use of a Performance Index. Modern clusters are being observed as supranational phenomena needing new strategies and aspects of policy in both emerging and developing economies (Bialic-Davendra and Pavelkova, 2010). Similarly, works focusing on clusters like Silicon Valley have shown that policy-making combined with a cluster-oriented view can achieve performance optimisation (Delgado *et al.*, 2014). Moreover, several works have also shown that clustering has a positive impact on firm performance due to the fact that it improves access to skilled workforce and specialised suppliers (Du *et al.*, 2008).

A Maritime Performance Index will support the ability to identify the strengths and weaknesses of a maritime cluster, helping researchers and policymakers to adjust policies and strategies. The proposed performance index consists of a group of performance indicators weighted and categorised in five groups (institutional, financial, infrastructure, manpower and governance), leading to a Performance Index similar to World Bank's Logistics Performance Index. The development of such models increases the understanding of the beneficial role of clustering such as positive externalities, firm performance improvement and innovation capabilities. In the case of the maritime industry, this can lead to a better overall cluster performance such as container management improvement, loading and unloading time reduction, seamless flow of bureaucratic processes and more.

The rest of the paper is arranged as follows. Section 2 reviews the literature, Section 3 discusses the methodology and the design of the index, Section 4 presents the case of the port of Piraeus in Greece and Section 5 concludes the study.

2. Literature review

2.1 Cluster definition

Various cluster definitions exist, such as "a spatially concentrated group of firms competing in the same or related industries that are linked through vertical (buyer/supplier) and horizontal relationships (alliances, collaborations, resource sharing etc.)" (Porter, 1990). Porter did not pay much attention to geographical concentration in his early work on clusters but gradually recognised the importance of geographical proximity.

A cluster is a population, not as an entity. People cluster because of the presence of a large labour pool inside the cluster. The presence of such a labour pool reduces the cost for talent acquisition. Furthermore, such a labour pool allows for the existence of specific training and education programmes, which upgrade the quality of the labour force. This aspect is important as it implies that the internal heterogeneity of clusters has to be taken into account. The notion of a cluster population also implies that cluster population can change. Indeed, entry and exit are important mechanisms for the transformation of the cluster.

In addition, a cluster enables the geographical concentration of like-minded businesses. Firms cluster together due to the presence of suppliers and customers in a cluster. Proximity to suppliers and customers provides cost advantage due to low transportation costs, along with closer monitoring and frequent face-to-face interaction. Even though the geographical aspect is widely acknowledged, the delimitation of the relevant cluster region can be

problematic. No matter how a cluster is geographically defined, firms in the cluster will be strongly linked with firms outside the relevant cluster region.

Finally, a cluster consists of related business units, associations and public-private organisations. Firms cluster together because of the presence of “knowledge spill-overs”, which take place in clusters. Knowledge disseminates due to the frequent interaction among cluster participants and the fact that developments can be detected locally faster (de Langen, 2010). Business units participate in the cluster if they have relatively strong economic links with one or more other business units in the cluster. Associations are included in the cluster if the majority of their members are active and public-private organisations when they are strongly linked to firms in the cluster (de Langen, 2004). Because linkages are vital in the definition of clusters, these are composed of firms that can be competing or acting in a complementary way.

2.2 Cluster theory evolution

Cluster theory has been applied to the maritime sector over the past 10 years. Benito *et al.* (2003) analysed the maritime sector in Norway using Porter’s framework. They quantified the characteristics of the Norwegian maritime cluster and discussed its advantages and disadvantages. De Langen (2004) analysed the collective activities of Rotterdam’s port cluster and reviewed the roles of four sectors in cluster governance. Cluster analysis has become an important component for many port authorities (i.e. MIC, 2003) emphasising on the competitive advantages induced by geographic concentration. However, cluster theory does not provide insights in relation to the reasons a specific location is preferred against another for the creation of a specific cluster.

Clustering management and policy methods have been under investigation for the past three decades. However, maritime clustering has gained little academic attention in recent years. Clustering policies in agglomerating economies plays a significant role in industry development. Creative industry cluster approach is embedded, according to Chan and Zheng and Chan (2014), in two theoretical sources: cultural approach and local – regional – development. Existing literature emphasises on spatial cluster analysis and functional clustering policies. The former refers to the co-existence of firms linked together due to the regional connection, while the latter focuses on the cluster as a whole, consisting of interconnected parts (firms, associations, etc.) cooperating together in promoting development (Hall, 2000). Thus, the latter analysis appears to be more valuable, assisting policymakers in developing clustering policies. Lai *et al.* (2014) analysed the clustering effect in terms of innovation. Innovation is one of the most important factors, making clustering research necessary for regional and individual firm development (Giuliani, 2005; Chang, 2011).

Cluster analysis has also become an important tool for regional development policies. In relation to maritime policy development, Othman *et al.* (2011) examined the factors linked to the performance of the cluster. They identified that a maritime cluster consists of three main sectors, namely, shipping, shipbuilding, ports and terminals. They recommend that the factors for success for a maritime cluster are location, competition, network and governance. Moreover, a factor playing significant role in a cluster’s performance and liable function is the information spill-over among the co-localised firms and institutions (de Langen, 2010). De Langen (2010) also set an analytic cluster performance framework separating cluster structure and cluster governance. Based on his work, the most important factors for cluster performance are the level of agglomeration in the cluster, internal competition among firms, entry-exit barriers and heterogeneity of population. Agglomeration has three distinct drivers (Alfred, 1920), namely, linkages, labour pool and information/knowledge spill-overs.

Internal competition has been also examined in the case of intra-port competition, indicating that ports (and maritime clusters in general) could promote innovation under specific circumstances such as multiple production models and many port service providers (Pallis and de Langen, 2006).

In terms of governance, the presence of a leader firm seems to contribute to the performance of the cluster, as leader firms further and protect the interests of the entire cluster (Albino *et al.*, 1999). Such firms could be a terminal operator of a supply chain management provider (i.e. Maersk), creating multiplier effects and information spill-overs (de Langen, 2010). Information spill-overs among cluster members is of significant importance as they can improve and enhance innovation on firm strategies. Knowledge spill-overs are present in the cluster-making infrastructure to support innovation capabilities. Knowledge inputs may come from suppliers, customers, maritime services providers, universities and other research institutions. This provides extra weight in the significance of the geographic proximity and co-location of cluster members (Baptista and Swann, 1998). This argument is highly supported by Breschi's (1999) work, who suggests that high concentration of industries is a supporting factor for innovators to gain market power.

Systematic studies on port choice have been conducted for more than five decades. Murphy and Daley (1994) surveyed five groups, namely, port operators, shipping lines, freight forwarders, large and small shippers, with the results showing statistically significant differences in port selection criteria. Subsequent works have identified the influencing factors of port competitiveness for respective port users.

From a shipper's perspective, a number of surveys have been conducted to identify the factors influencing port selection (Tongzon and Sawant, 2007; de Langen, 2007). The common key determinants identified by the studies are location, terminal infrastructure, port efficiency and frequency of service. In addition, Nir, Lin and Liang (2003) used a multinomial logit model to analyse the shipper's choice behaviour among Taiwan's three ports, with selected variables being cost, travel time, shipping route and frequency of service.

In reference to shipping lines, both regional surveys and factor analyses have been conducted to capture the significant factors in port selection (Tongzon and Sawant, 2007; Chang *et al.*, 2008; Yeo *et al.*, 2008). Port charges and port services have long been considered as determinant factors for port selection. Moreover, both studies emphasised that hinterland cargo volume and connectivity are important factors in deciding port attractiveness.

From the perspective of port competition ability, Lirn *et al.* (2004) used the analytic hierarchy process (AHP) to reveal the port selection process of global carriers. Yang *et al.* (2005) applied an AHP model to analyse non-quantifiable factors and develop an index system to evaluate container port competition. In addition, there have been studies measuring the attractiveness of ports in terms of port-hinterland connectivity, aiming at identifying the factors shippers use when evaluating a port (Veldman and Buckman, 2003; Malchow and Kanafani, 2004; Malchow and Kanafani, 2001; Garcia-Alonso and Sanchez-Soriano, 2009).

Veldman and Buckman (2003) studied the problem of port competition from a shippers' perspective based on the routing decision. Factors affecting cargo routing, such as transportation cost, transit time, frequency of service and service quality, were quantified. Similar work has been conducted by Garcia-Alonso and Sanchez-Soriano (2009), who analysed the actual inter-port distribution of traffic to examine the port selection process.

However, there are two major limitations in the so far works. The first limitation identified by [Tongzon \(2009\)](#) is that there is an inconsistency between the stated preference and the revealed preference of shipping lines. Second, supply chain services are ignored. As port attractiveness is only one component for port choice, door-to-door multimodal transportation should be given more attention.

Ports have been in the centre of the attention in more recent studies examining maritime clusters. Characteristic is the study of [Zhang and Lam \(2017\)](#), who examined the role of ports in maritime cluster development, using the cases of London and Hong Kong. Similar works focusing on different aspects of cluster on different locations around the globe are present such as, Panama ([Pagano et al., 2016](#)), Canada ([Doloreux et al., 2015](#)), Malaysia ([Othman et al., 2011](#)) and Japan ([Shinohara, 2010](#)).

Innovation is another dimension for clusters which is considered to be a function of key variables such as, interaction with business markets, product development and human resources ([Lendel and Varmus, 2014](#)). For a maritime cluster, innovation could be identified as the provision of effective services at low cost. Such services could be terminal management with better container handling, which eliminates delays. Empirical research such as the one by [Brett and Roe \(2010\)](#), where Delphi method was used to study the Great Dublin maritime transport cluster, revealed the lack of promotion strategies, the existence of strong internal competition, strong exit barriers and significant access to cluster knowledge, but with low trust levels present among cluster stakeholders. As presented in [Figure 1](#), based on THM (Triple Helix Model), these stakeholders are ([Leydesdorff and Etzkowitz, 1996](#)):

- institutions (universities, research institutes);
- firms and enterprises (in this case shipping oriented); and
- central, regional and local government to facilitate clusters' processes.

This model is a regional development model, which describes the interactions among the different stakeholders of the cluster.

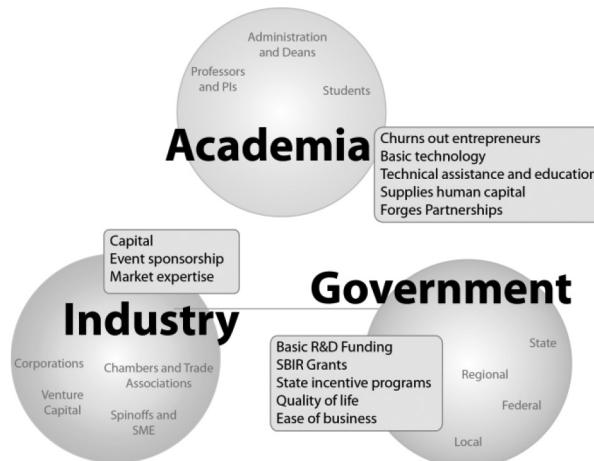


Figure 1.
The triple helix model

Source: Authors

Therefore, an index similar to Leydesdorff and Etzkwitz (1996) is developed to assess the attractiveness of a maritime cluster, using the Port of Piraeus in Greece as a case study.

3. Methodology

The proposed framework enables cluster stakeholders to evaluate the weaknesses and strengths of a cluster, especially in highly competitive cases as is the maritime cluster, where according to [Leonard and Swap \(2000\)](#), skills such as management and knowledge techniques are necessary for the cluster to support its activities.

3.1 Attractiveness index

An attractiveness index includes four key categories:

- (1) *Policy and regulatory framework*: Within this, the cluster exists and operates. Without a supportive and complementary policy and regulatory framework, the full potential of the cluster for high-end services will be constrained. The factors also include the environmental, sustainability and cultural elements, which encourage maritime-related firms and their workforce to operate.
- (2) *Institutional structure*: This reflects the structural form of the cluster comprising of both public and private organisations. An institutional structure that lacks awareness, communication and collaboration is unable to maximise the economies of scope, which are inherently part of a successful cluster of high-end maritime services.
- (3) *Manpower*: This represents the availability of skills and resources to meet the current and future needs of the maritime cluster to further develop unconstrained and create innovation and entrepreneurship.
- (4) *Tax and financial tools*: These encourage membership, growth, resourcing and innovation within the maritime cluster.

Common goals in a cluster are set through joint activities of members (cluster actors). They are being accomplished in various areas within (i.e. common projects, research, production, services etc.), having both short-term and long-term perspective. Based on existing research, cluster activities can be found in the areas of networking, human resources, research and innovation, business cooperation and promotion, investment financing, governmental and political activities and supporting activities.

As far as the performance of a maritime cluster is concerned, several works have taken place in recent years for identifying the key sectors of the cluster. These sectors can be, ports, shipping lines, agencies, shipbuilding and repair, offshore, marine equipment, bunkering, ship chandlery, ship broking and chartering, classification societies, ship management, logistics, legal services, insurance, finance, education and training, research and development and information technology ([Cullinane et al., 2007](#)).

3.2 Conceptual model

The performance index created here is composed of several weighted sub-indexes, which are measurable components-indicators of cluster parts, following the philosophy of World Bank's Logistics Performance Index. A multi-attribute utility theory (MAUT) approach is applied for the purposes of this work. Multivariate techniques are considered to be more advanced and more complicated as they allow the researcher to study the behaviour of more than two variables simultaneously. Compared to other decision analysis tools, MAUT's superiority is its high level of robustness, that is its ability to analyse and formulate

problems with a level of imprecision, which is not feasible when using other methodologies (Dyer *et al.*, 1992). Using six factors presented in Table I, MAUT is preferred to other methods such as AHP, structural equation modelling (SEM) and regression analysis (Lagoudis *et al.*, 2006).

According to Von Winterfeldt and Edwards (1986), there are three main models of aggregation weights and single-attribute utilities as presented in Table II.

For this study, the additive model has been selected as it is suited to the purposes of the research. The total index value is calculated based on the following equation:

$$\begin{aligned} \text{MCAI} = & (\text{Infrastructure Category Value}) \times W_1 + (\text{Finance Category Value}) \times W_2 \\ & + (\text{Governance Category Value}) \times W_3 + (\text{Manpower Category Value}) \times W_4 \\ & + (\text{Institution/Legislation Category Value}) \times W_5 \end{aligned}$$

where W_i = the weight of each Category. The weight W_i is given by the following formula based on Eckenrode (1965):

Factor	MAUT	A.H.P.	S.E.M.	Regression
Easy to comprehend	●	●	●	●
No need of special software	●	○	○	○
Easy to apply	●	○	●	○
Easy questionnaire design	●	○	●	●
No sampling restrictions	●	●	○	●
Comparison of more than two factors	●	●	●	○

Notes: ● Yes; ○ No
Source: Lagoudis, Lalwani and Naim (2006)

Table I.
Comparison of methodologies

Model	Formula
Additive with linear value function	$u(x) = w_1x_1 + w_2x_2 + w_3x_3$
Additive	$u(x) = w_1u_1(x_1) + w_2u_2(x_2) + w_3u_3(x_3)$
Multiplicative (extended)	$u(x) = w_1u_1(x_1) + w_2u_2(x_2) + w_3u_3(x_3) + ww_1w_2u_1(x_1)u_2(x_2) + ww_1w_3u_1(x_1)u_3(x_3) + ww_2w_3u_2(x_2)u_3(x_3) + w_2w_1w_2w_3u_1(x_1)u_2(x_2)u_3(x_3)$
Multiplicative (compact)	$1 + wu(x) = [1 + ww_1u_1(x_1)][1 + ww_2u_2(x_2)][1 + ww_3u_3(x_3)]$
Multi-linear	$u(x) = w_1u_1(x_1) + w_2u_2(x_2) + ww_3u_3(x_3) + w_1,2u_1(x_1)u_2(x_2) + w_1,3u_1(x_1)u_3(x_3) + w_2,3u_2(x_2)u_3(x_3) + w_1,2,3u_1(x_1)u_2(x_2)u_3(x_3)$

Table II.
MAUT Aggregation models ($n = 3$)

Notes: u: Overall value function; x: Evaluation object; xi: Measurement (level, degree) of x on attribute i; ui: Single-attribute value function; wi: Weight of attribute i
Source: Von Winterfeldt and Edwards (1986)

$$W_i = R_c / \text{Sum}(R_c)$$

where:

R_c = sum of converted ranks across judges for each criterion;

$$R_c = \text{Sum}(R_{cj})$$

in which

R_{cj} = converted rank assigned by judge j to criterion c .

To make clear the processes involved in weight estimations, a framework table is presented based on the set of attributes in Table III. Column 1 refers to the name of the variable, and in the second column (Normal rank), the score each variable achieves is depicted. This score is the sum of the opinions of all participants for each individual attribute. In the third column the reciprocal of normal rank is calculated. The most important variable takes the value 1 and the rest are adjusted to this variable. The last column is a rank weight based on the third column.

Based on literature, the factors that affect the performance of a maritime cluster fall in the following five categories: infrastructure, financing, governance, manpower and institution/legislation. The evaluation of each factor is based on the mean of each attribute in relevance to the overall sub-mean value of each category (Figure 2). The value for each attribute is collected via questionnaires using a Likert scale from 1 to 5. Each group of questions was consisted of a question measuring the performance and another question measuring the importance of each factor. For performance questions, 1 is for very low performance and 5 for very high. Respectively, for importance questions 1 stands for “not important at all” and 5 stands for “extremely important”. For example, each indicator A_i will gain a score based on the respondents’ answers. Each indicator of the Category will score a mean value and the whole Category will have a total score of P_i . Overall, category scores will be weighted according to the significance each category has on the performance index.

The performance indicators, which compose the overall Cluster Performance Index, were selected based on the frequency present in the literature. Depending on the frequency of appearance, they are categorised in four groups: above ten times, seven to nine times, five and six times and one to four times. Table IV shows the performance indicators based on frequency of appearance. As seen, the cluster performance mostly depends on “soft” factors

(1)	(2)	(3)	(4)
Attribute/Indicator	Normal rank	Reciprocal of normal rank = (most imp. score)/ Y_i	Rank reciprocal weight = $\text{Sum}(3)/(3)$
X1 (indicator 1)	(Most Important Factor Score)	1	0,.....
X2	Y2	0,.....
X3	Y3	0,.....
.....	0,.....
X_N	Y_n	0,.....
TOTAL	SUM(2)	SUM(3)	1

Table III.
Ranking of
performance
indicators

Source: Eckenrode (1965)

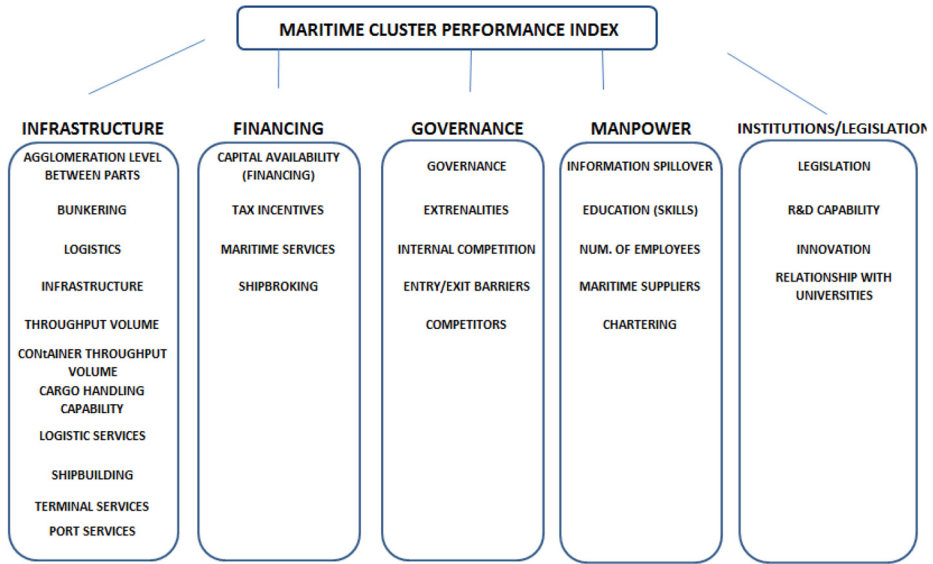


Figure 2.
Value tree of
Maritime Cluster
Performance Index

Source: Authors

	Appearance Level			
	>10	7-9	5 and 6	1-4
	Agglomeration between cluster members	Capital availability	Core technology	Bunkering
	Education-skills Governance-policy methods	Logistics Maritime services (general)	Externalities Infrastructure	Cargo handling Chartering
	Information spillover Innovation capability Maritime suppliers services	Social Interaction Shipbuilding capability Relationship with Universities	Internal competition Number of Employees	Throughput volume Entry/exit barriers Co-location
	R&D capability			Legislation Market share Tax incentives Supply Chain Management Terminals

Table IV.
Attributes in terms of
importance

Source: Authors

such as people, structure and policies (Checkland, 1989). These systems allow policymakers to make use of existing infrastructure improving the overall performance.

In addition, the most important factors deal with “soft” issues capable to improving regional performance. The first group is composed of the most valuable ones, based on literature. Agglomeration between firms and cluster members relate to the maturity of the cluster and its growth capability. Governance methods and information spill-over have positive effects

on the services offered, whereas R&D capabilities act as enablers for innovation to a region or a cluster. This is one of the basic reasons for some clusters to excel and others to lag behind. Conclusively, education is referred as of extreme importance, enabling multiplying effects on the overall attractiveness of a cluster.

3.2.1 Infrastructure. Infrastructure and services encapsulate the “soft” factors like quality of services in a maritime cluster. This implies that performance is strongly dependent on the quality of these services in combination with the technical infrastructure in the cluster. Indicative factors are:

- *Agglomeration:* It promotes spatial concentration.
- *Bunkering:* It measures bunkering efficiency in the port.
- *Logistics services:* It refers to the quality of services such as warehousing and 3PL services.
- *Throughput:* It refers to the volumes of cargo in and out of the port.
- *Shipbuilding:* It refers to the shipbuilding capability of a maritime cluster.
- *Information spill-over and cooperation:* Experts indicate that co-operation within the cluster is important. This result is important as it provides evidence against the argument that local cooperation is not relevant, given the international nature of port related activities. Thus, a diverse local set of firms and resources is important for the performance of the cluster.

3.2.2 Finance. Finance contains the economic factors that enable firms in the cluster to operate in full efficiency. These factors provide capital and tax support to firms in the cluster. Firm leverage is strongly connected with these indicators. Among the finance factors are:

- *Capital availability:* It describes access to capital for a firm.
- *Tax incentives:* It refers to the taxation and support to firms.
- *Maritime financial services:* It refers to transaction and other costs among the firms of the cluster.

3.2.3 Governance. Governance in a cluster influences the structure of the cluster. Cluster governance variables are incorporated in the framework. The performance of clusters is also affected by changes in the business environment of a cluster. For instance, the development of a new energy-related technology might deeply affect the development of a chemical cluster (de Langen, 2004). Some of the most important indicators are:

- *Externalities:* The presence of externalities in a cluster can affect negatively the overall cluster performance.
- *Internal competition:* Firm competition in a cluster boosts firms’ productivity level. The importance of internal competition depends on the level of external competition. When external competition is significant, the absence of internal competition does not affect the performance of the cluster. Porter’s cluster research emphasises the fact that the effect of internal competition is among the strongest empirical findings (Porter, 1990).
- *Entry/exit barriers prevent the entry of new firms:* Legal entry barriers exist in the majority of ports, especially in the cargo handling and port services industries. In general, entry barriers are relatively high in the maritime industry due to legal or financial constraints.

- *Presence of a leader firm*: This increases the performance of a cluster, as such firms further the interests of the cluster as a whole (Albino *et al.*, 1999). The whole cluster benefits from the presence of leader firms, due to the “multiplier effects” and “knowledge spill-overs”.

3.2.4 Manpower. This category contains all the factors related to human-resource skills and education level of the workforce in the cluster. More specifically, factors such as education, number of employees, number of maritime service providers and suppliers and business culture are critical to cluster performance.

3.2.5 Institution and legislation. This category contains all the factors related to academic institutions and other institutions conducting research in cooperation with maritime firms. Among the factors within this category are the cooperation between firms and universities, willingness to innovate and R&D capabilities. The visual presentation of cluster performance can be expressed in a spider diagram as illustrated in Figure 3.

4. Case study

4.1 Sample profile

The case study took place in the city of Piraeus in Greece. In total, 70 questionnaires were distributed to maritime related industries such as ship management companies, shipowners, shipbrokers, research institutes, maritime equipment providers and media. The criteria based on which the responding companies have been selected are:

- minimum of 10 years of presence in the Piraeus cluster; and
- to be registered in the Maritime Hellas platform. (www.maritimehellas.org).

The questionnaires were addressed to the Managing Directors or CEOs of the sampled companies assuring one response per company. The person answering the questionnaire varied depending on the policy of each company. Similar data collection approaches are present in the literature (Richardson *et al.*, 2012; Manrai *et al.*, 2001). The total number of responses were 30, achieving a response rate of 42 per cent. Table V shows the companies, which took part in this study, with some of the respondents keeping their anonymity. The participation of academic institutions has been limited as there are less than a handful present.

Table VI presents the profile of the respondents. As seen, the majority of the respondents hold middle or executive level positions (43 per cent), with top executives representing 40 per

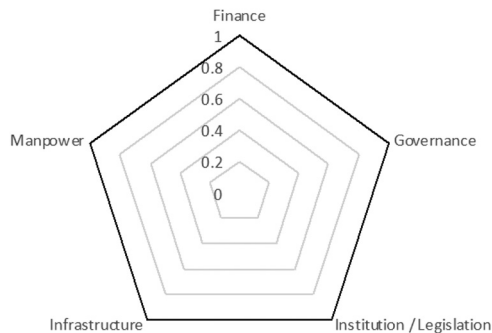


Figure 3.
Cluster performance depiction

Source: Authors

cent of the sample. Junior executives represent 17 per cent of the respondents. The average years of working experience is above 10 years of working experience in the maritime sector with 67 per cent holding a master's degree, while only 20 per cent being graduates. A small percentage (3 per cent) hold business certifications such as CFA, Chartering certification etc.

4.2 Analysis of survey results

4.2.1 *Finance*. Respondents were asked to evaluate both the performance and importance of the finance-related attributes; accessibility to capital, tax incentives, access to stock markets, cooperation with banks, government support for businesses, firm taxation, inflation, salary, insurance costs, information costs and firm expenses.

Table VII presents both the ranking among the factors and the performance of each factor based to the assigned weights. As seen, the most important factor according to the respondents is *cooperation with banks*, with a normal rank of importance of 130 points. This factor has also the highest performance score of 4.6 out of 5. In terms of performance, the lowest score is assigned to *government support* with a score of 3.13 out of 5. This result indicates that government and companies lack consistent and efficient cooperation. The second lowest score is assigned to *inflation*, which reveals that the industry pays little attention to that factor. Finally, the overall score for this category is 3.9834.

4.2.2 *Governance*. Firm governance in a cluster influences the structure of the cluster and vice versa. For the purposes of this research Governance is composed of the following attributes; presence of leader firms in the cluster, entry/exit barriers, trust between cluster members, internal competition, governmental support for international exposure, presence of intermediaries, power of competitors and collective action regimes.

As presented in Table VIII, the most important factor according to the respondents is *trust between firms*, obtaining 122 points, followed by *governmental support for*

University of the Aegean	Costamare	ELVIK S.A.
Gratia Publications	Pacific & Atlantic	Aegean Motorway SA
Overseas Agency Ltd	GLOBUS Shipmanagement Corp	Lloyd's Register
Arcadia Shipmanagement	Trefin Tankers Ltd	Piraeus University
Chartworld Shipping Corporation	EVIA PETROL	GasLog
Stealth Gas	UPMARITIME LONDON	Vergos Marine Management S.A.
DYNACOM TMLTD	Psycotherm	IASON HELLENIC SHIPPING
SELMA	Pireus Bank	MaranGas
Aluminox	HEMEXPO	

Table V.
Summary of
respondents

Source: Authors

Position	(%)	Years of experience	(%)	Education	(%)
Senior	40	0-2	20	Bachelor's	20
Middle level	43	3-5	23	Master's	67
Junior	17	6-10	10	PhD	10
		>10	47	Business qualifications	3

Table VI.
Sample profile

Source: Authors

Attribute/indicator	Normal rank	Reciprocal of normal rank	Rank reciprocal weight	Mean value (based on performance)	Weight x value (4) × (5)
Accessibility to capital	128	0.9846	0.1036	4.00	0.4146
Tax incentives and tax benefits	125	0.9615	0.1012	3.83	0.3877
Access to stock markets	102	0.7846	0.0826	3.87	0.3196
<i>Cooperation with banks</i>	<i>130</i>	<i>1.0000</i>	<i>0.1053</i>	<i>4.60</i>	<i>0.4842</i>
Governmental support for businesses	122	0.9385	0.0988	3.13	0.3092
Firm taxation	115	0.8846	0.0931	3.80	0.3538
Inflation	103	0.7923	0.0834	3.63	0.3027
Salary	104	0.8000	0.0842	4.37	0.3680
insurance costs	103	0.7923	0.0834	4.20	0.3503
Information costs	103	0.7923	0.0834	4.07	0.3394
Firm expenses	100	0.7692	0.0810	4.37	0.3538
SUM	SUM	9.5000		SUM	3.9834

Table VII.

Finance attributes

Source: Authors

Attribute/indicator	Normal rank	Reciprocal of normal rank	Rank reciprocal weight	Mean value (based on performance)	Weight x mean value (4) × (5)
Presence of leader firms	121	0.9918	0.136	3.80	0.5178
Internal Competition	111	0.9098	0.125	3.33	0.4163
Entry/exit barriers	104	0.8525	0.117	3.23	0.3783
<i>Trust between firms</i>	<i>122</i>	<i>1.0000</i>	<i>0.137</i>	<i>3.17</i>	<i>0.4355</i>
Governmental support for international exposure	120	0.9836	0.135	2.10	0.2838
Power of competitors	109	0.8934	0.123	3.30	0.4051
Presence of intermediaries	98	0.8033	0.110	3.07	0.3388
Collective action regimes	103	0.8443	0.116	2.90	0.3364
SUM	SUM	7.2787		SUM	3.1119

Table VIII.

Governance attributes

Source: Authors

international exposure. As observed in the finance category, there is a lack of cooperation between government cluster members. In terms of trust among the different parts of a maritime cluster, it is crucial to refer that it can boost the cluster's exposure and success. The highest score was assigned to *the presence of leader firms*. Based on literature, the presence of leader firms is necessary in a cluster, as they can access markets smaller firms cannot. The presence of leader firms increases the performance of a cluster, as such firms actively further the interests of the cluster as a whole (Albino *et al.*, 1999). In addition, leader firms facilitate investments improving the quality of the labour force, facilitate data exchange infrastructure and increase working standards of suppliers.

Internal competition is also a factor of high importance as it can result in innovation and increase the capability of doing "business" more efficiently. Moreover, with innovation spillovers, firms become more profitable. The overall score for the Governance category is 3.1119.

4.2.3 Institutional legislation and innovation. As illustrated in Table IX, this category encapsulates attributes such as cooperation with Universities and research institutes, R&D capability, willingness to innovate, cooperation with government, information spill-over,

Table IX.

Institution/legislation
attributes

Attribute/indicator	Normal rank	Reciprocal of normal rank	Rank reciprocal weight	Mean value (based on performance)	Weight x mean value (4) × (5)
Cooperation with Universities	113	0.8968	0.1171	2.53	0.2963
Cooperation with research institutes	120	0.9524	0.1244	2.57	0.3196
R&D capability	120	0.9524	0.1244	2.7	0.3358
Willingness to innovate	122	0.9683	0.1264	3.43	0.4336
Cooperation with Government	119	0.9444	0.1233	2.23	0.2750
Information Spill-over in the Cluster	124	0.9841	0.1285	3.03	0.3893
Legislation	126	1.0000	0.1306	3.27	0.4270
Classification society	121	0.9603	0.1254	3.3	0.4138
SUM		7.6587		SUM	2.8903

Source: Authors

legislation and classification societies. *Legislation* is the most important factor based on the results of the survey, as it assists firms to operate within the cluster. Low score is observed for the factors of *cooperation with universities* and *cooperation with research institutes* achieving a score of 2.57 and 2.53, respectively. According to the triple helix model (see Section 2 in literature review), academia is one of the three main pillars for a cluster. The results here indicate that there is a gap among these pillars, which needs to be addressed by closer collaboration between academia and industry. The overall score of this category is 2.8903, which is the lowest among the categories.

4.2.4 *Infrastructure and maritime services.* This category encapsulates the physical infrastructure and the services a cluster provides. For the purposes of this study the Piraeus maritime cluster services are presented in Table IX with the following attributes; Port services, Terminal services, Customs, Logistics services, Cargo handling services, Bunkering services, Shipbuilding/Repair services, Shipbroking services, and Infrastructure in Piraeus.

Based on Table X, the most important attribute is *Shipbuilding/repair services*, obtaining 128 points in terms of importance. Shipbuilding is one of the core businesses in a cluster, and thus these services need to be of high quality. In terms of performance this attribute achieves a score of 3.27 out of 5. However, the highest score is obtained by *Bunkering*

Table X.

Infrastructure and
services attributes

Attribute/Indicator	Normal rank	Reciprocal of normal rank	Rank reciprocal weight	Mean value (based on performance)	Weight x mean value (4) × (5)
Port services	120	0.9375	0.1088	3.00	0.3264
Terminal services	121	0.9453	0.1097	3.24	0.3554
Customs	116	0.9063	0.1052	2.50	0.2629
Logistic services	123	0.9609	0.1115	2.97	0.3312
Cargo handling services	127	0.9922	0.1151	3.23	0.3719
Bunkering services	124	0.9688	0.1124	3.60	0.4047
Shipbuilding/Repair Services	128	1.0000	0.1160	3.27	0.3795
Shipbroking services	116	0.9063	0.1052	3.73	0.3923
Infrastructure in Piraeus	128	1.0000	0.1160	3.10	0.3597
SUM		8.6172		SUM	3.1840

Source: Authors

services with a score of 3.60 out of 5, revealing the Port’s long maritime tradition. Despite the fact that bunkering is not one of the core businesses in a maritime cluster, executives considered this to be of highest performance. Lowest performance was assigned to *customs services*. The overall category score is 3.1840.

4.2.5 Manpower. Manpower refers to factors related to labour abilities and skills. Factors such as quality of education, level of productivity, teamwork ability, employee initiative and business culture are included in this category. Based on responses, the most important factor for this category is *productivity* with 132 points. Furthermore, as seen in [Table XI](#), all factors of this category scored high enough, implying that Greek maritime professionals are highly qualified. More specifically, *quality of education* scored the highest, indicating that the manpower of the Piraeus maritime cluster is of high calibre. The overall category score is the second highest with a score 3.6508.

4.3 Piraeus cluster performance index

As a next step, weights are assigned to each category to estimate the overall Index. Two scenarios are examined for this process. In the first case, equal weights are assigned to each factor, whereas in the second, weights are assigned to each of the five categories composing the index based on the rankings assigned by the respondents.

4.3.1 Index with equal weights. Index with equal weights is quite simple to conduct. There are five main factors; thus, each factor has a weight of 0.2. Then weight is multiplied with the factor value (in this case the overall score of each factor) and the final Index is the sum of these five products. Following this process, [Table XII](#) shows that the Maritime Cluster Performance Index (MCPI) for Piraeus is 3.3641.

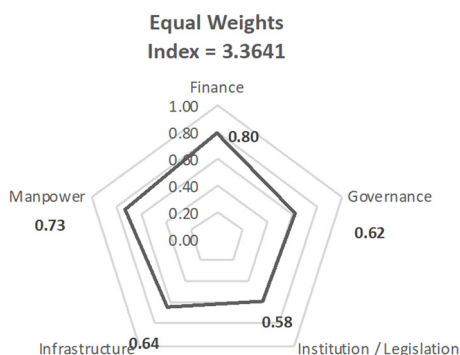
A spider diagram is also used to depict the Index and factor scores ([Figure 4](#)).

Attribute/indicator	Normal rank	Reciprocal of normal rank	Rank reciprocal weight	Mean value (based on Performance)	Weight x mean value (4) × (5)
Quality of education	126	0.9545	0.2000	3.87	0.7740
<i>Productivity Level</i>	132	1.0000	0.2095	3.7	0.7752
Ability to teamwork	126	0.9545	0.2000	3.73	0.7460
Employee Initiative	120	0.9091	0.1905	3.2	0.6095
Business Culture	126	0.9545	0.2000	3.73	0.7460
SUM	SUM	4.7727		SUM	3.6508

Table XI.
Manpower attributes **Source:** Authors

Category	Value	Weight	Value × weight
Finance	3.9834	0.2	0.7966
Governance	3.1119	0.2	0.6223
Institution/Legislation	2.8903	0.2	0.5780
Infrastructure	3.1840	0.2	0.6368
Manpower	3.6508	0.2	0.7301
Index		3.3641	

Table XII.
Index with equal weights **Source:** Authors



Source: Authors

Figure 4. Maritime Cluster Performance Index (equal weights)

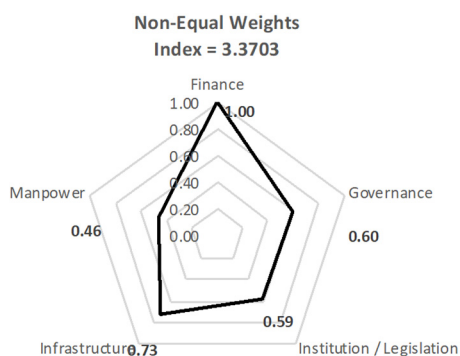
4.3.2 *Index with non-Equal weights.* When non-equal weights are assigned, weights are calculated for each factor based on the estimations of the respondents. As presented in Table XIII, the value of the weight for each factor is the outcome of the reciprocal rank. As seen, the Maritime Cluster Performance Index with non-equal weights for Piraeus is 3.3703.

A spider diagram is also used to depict the Index and factor scores (Figure 5).

Category	Value	Reciprocal rank sum	Weight	Value × weight
Finance	3.9834	9.5000	0.2511	1.0004
Governance	3.1119	7.2787	0.1924	0.5987
Institution/Legislation	2.8903	7.6587	0.2024	0.5851
Infrastructure	3.1840	8.6172	0.2278	0.7253
Manpower	3.6508	4.7727	0.1261	0.4606
SUM		37.8273		3.3703

Table XIII. Index with AHP weights

Source: Authors



Source: Authors

Figure 5. Maritime Cluster Performance Index (non-equal weights)

5. Conclusions

This present study focuses on measuring the attractiveness of a maritime clusters via the creation of a methodological framework. The study has reviewed in depth the methodologies present in the cluster literature, emphasising on maritime clusters, and is proposing a new robust theoretical framework which facilitates the evaluation of the attractiveness of maritime clusters, assisting stakeholders to devise strategies, which will attract companies.

For the analysis of the index, MAUT is used as a tool to evaluate the importance and performance of the different attributes composing the index, namely, infrastructure, financing, governance, manpower and institution/legislation. Among the benefits of the proposed index is that it offers the flexibility and robustness to compare among different maritime clusters globally and can be readily used as a benchmarking policy tool at national, regional and global levels. In addition, its conceptual simplicity in combination with the well tested MAUT methodology, which is used for the analysis of the collected data, makes it a comprehensive tool for both policy and industry stakeholders in evaluating the cluster's performance at any given point in time and attribute dimension. Furthermore, the active participation of the stakeholders via the use of questionnaires provides a collective perception of the cluster's status.

With the use the Piraeus maritime cluster case, the framework has been tested in its robustness and friendliness to the user, providing useful insights to the stakeholders. Among the results has been the importance of the finance, manpower and infrastructure attributes, which appear to promote the cluster's attractiveness. In addition, legislation and institutional partnerships, along with government support, need to take place improve the performance of the cluster.

The fact that the authors had the opportunity to use only one case study to test the methodological framework is among the limitations of the study. Applying and testing the methodological framework in a wider sample of clusters to identify weaknesses and shortfalls will significantly improve the present work. An additional element that can further improve this work is to explore and compare MAUT, which has been justified as the proper tool for data analysis here, with other tools available in the literature (i.e. AHP, SEM and regression) for evaluating and measuring the under-investigation attributes. This comparison will provide further insights for the improvement of the methodology itself.

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