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DEPARTMENT OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

Laboratory of Maritime Transport

**DEVELOPMENT OF PERFORMANCE INDICATORS FOR MARITIME
CLUSTERS**

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DEVELOPMENT OF PERFORMANCE INDICATORS FOR MARITIME CLUSTERS

PAVLOS KAMPOURIDIS

1. Introduction

Regional clusters have been the in the focus of economists, academics, and national governments in the last couple of decades. Even though several clusters have been thriving for a very long time, generally in more traditional industries and were well established in the world market, it was only during the early 1990s that the importance of clusters was more widely recognized and accepted in promoting innovation, productivity and creation of new business in the region. Michael E. Porter's papers on industrial clusters (Porter 1990) initially, and on regional clusters (Porter 1998a) later on, alerted the economic world on the relationship between the mechanisms of regional clusters and regional or national competitiveness in the global economy. Porter linked the local concentration of highly specialized firms with specialized knowledge and skills, fierce rivals, demanding customers and local institutions within a regional cluster, with the existence of sustained advantages in global competition. His theory on clusters has since been regarded to be the most representative of industrial development in various regions and has been extensively used to design state or regional policies worldwide.

This increased focus on clusters by the scholars and their perceived importance on a national level due to their capability for innovation and competitiveness has led several individual countries and even the European Union to conduct official research (European Commission 2002) on the subject of clusters. Some governments have even proceeded to adopt new policies to support the establishment of regional clusters across all industrial sectors but focused mainly around the high technology industry.

Maritime clusters have been in the focus of many countries, mostly in northern Europe, which traditionally had strong presence in the maritime industry, as well as the European Union in the last few years. Several national studies have been conducted and several maritime cluster organizations have been established with regional or even national focus. These organizations have been industry led (bottom-up) efforts, or government led (top-down) (Policy Research Corporation 2008) and usually have the aim to improve cluster competitiveness and innovation, and boost the maritime clusters image.

Maritime cluster researchers have found it very difficult however to accurately gauge the effectiveness of maritime clusters. The main concerns stem from the literature on clusters in itself, and the lack of precise and exact definition of the concept of clusters. The imprecise geographical boundaries applied to clusters by various scholars as well as policy makers can lead to overestimation of their true importance for the region. Furthermore the general underestimation of local geographical factors, cultural factors and the general move of the economy towards globalization aided by the latest communications and information technologies, can lead to overestimation of the importance of regional clusters which are based on agglomeration. The problem is further enhanced by the different perspectives that are prevalent with regard to the maritime cluster's scope and many different definitions of the maritime sectors that are being used by different researchers. Finally the lack of concrete data on maritime clusters hampers most attempts to accurately gauge the maritime clusters performance and strength.

In this paper an effort has been made to develop a common set of cluster performance indicators in order to benchmark the maritime cluster performance and strength, and a comparison of four leading maritime clusters, the United Kingdom maritime cluster, the Netherlands maritime cluster, the Greek maritime cluster and the Singapore maritime cluster has been attempted.

2. Methodology

2.1 Literature and data

In order to achieve the aims of this study a wide range of literature, information and data was collected. This data was divided into four main categories.

- Basic theories regarding the clustering concept and related theories
- Maritime cluster studies and research material.
- General industrial cluster studies and data.
- Maritime cluster organization information and data.

The literature on basic cluster theory and all related theories were collected and studied in order to achieve a better understanding of the concept of clusters in general and clearly identify its differentiation to related economic theories and in particular the agglomeration theory, the network theory and the economic geography theory.

The maritime cluster studies provided an insight of the European maritime clusters, the identification and categorization of the maritime cluster sectors, and the performance indicators which have been used by scholars and researchers for benchmarking the maritime cluster strength and performance.

Studies and data of general industrial clusters were utilized in order to gain a better insight of the established industrial cluster organization's operation practices and the performance indicators used to gauge the performance of industrial clusters. These were then used for comparisons with similar studies on maritime clusters and influenced the formulation of suitable, measurable performance indicators for the maritime clusters.

Information and data on the maritime clusters and the established maritime cluster organizations were used to benchmark a number of established maritime clusters based on existing and newly proposed performance indicators.

2.2 Cluster Benchmarking

After the list of existing and proposed cluster performance indicators was completed the relevant data on leading maritime clusters were collected from various sources including the maritime cluster's websites, the research and studies conducted by the maritime clusters, and several studies conducted by the European Commission and the European Union. This data collected on the maritime clusters were then normalized so that the cluster with the highest number on each indicator received a score of 100

The performance indicators were initially grouped into three categories based on their importance.

In the initial step of the benchmarking all the performance indicators were equally weighted (weight 1.0) and the total score of each cluster and their ranking was recorded.

In the second step, the three different groups received different weights (1.5 , 1, 0,5) in descending level of importance and the total scores of each cluster and their ranking were recorded and compared with the results of the initial step.

3. Theory about clusters

Various theories have been suggested throughout the 20th century in order to try to explain the industrialization, economic growth, progress or economic expansion of certain regions in relation to others. Scholars and economists alike have proposed theories of industrial districts, agglomeration, economic networks, spatial economics and economic geography among others in their quest to understand and explain the various market mechanisms that have existed for thousands of years

3.1. Agglomeration theory

In recent years the importance of agglomeration in the economics analysis of big economic centers is greatly emphasized. The concept of agglomeration however is hardly new. It has been first attributed to English economist Alfred Marshall who in his “Principles of Economics” (1890), wrote about “manufacturing towns or thickly peopled industrial districts” with further mention of the theory in later years by economists such as Hoover (1948). Yet Marshall concentrates mainly on the aspect of knowledge spillover as the main benefit of agglomeration by writing “When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighborhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously, Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits properly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas”. Further economic benefits of proximity have been clearly identified (Johansson-Quigley, 2004) further to the work of Fujita (1988) and can be summarized as follows:

The size of an agglomeration can secure the necessary demand to allow individual firms to develop and produce individual, differentiated products while still maintaining scale economies

Individual firms have the benefit of the option to buy these differentiated, more specialized, products at lower costs within the agglomeration, and thus produce their own specialized end products and price them more competitively (Johansson, 2004).

Firms can benefit from information spillovers within an agglomeration thus reducing development costs for products and easily producing more specialized or differentiated end products.

Transportation costs for inputs are minimized within an agglomeration, making the end product cheaper and more appealing.

The first two benefits are symmetrical for suppliers and customers inside an agglomeration while the next two are relevant to all the firms which are located within the agglomeration

More specifically end products are dependent on “raw materials” or inputs, and the specialized labor required to turn them into the end product. Inside an agglomeration, suppliers of “raw materials” or inputs can develop and produce special inputs that would otherwise be uneconomic to produce, at far lower cost because of the existing scale economies involved, and offer them to co-locating end-product producers at very competitive prices. This has the effect of increased business opportunities for input producers and increased market share compared to competitors outside the agglomeration. The larger the size of the agglomeration, the biggest the variety of specialized inputs available. Since the end product depends on the number and differentiation of the inputs, this has the effect that the larger agglomeration will have more diverse and differentiated end products at more competitive prices, and in the end the agglomeration will be more productive as a whole. In a similar fashion, specialized services from specialized firms can be purchased more economically inside an agglomeration, for instance in a maritime agglomeration chartering, maritime banking services or maritime legal

services. A similar effect can also be claimed for the specialized labor. Inside an agglomeration specialized labor which is required for the production of specialized end product, is in greater supply than outside the agglomeration thus containing the labor costs involved.

One of the main externalities that have positive benefits for agglomerations according to Romer (1990), is that of knowledge spillover. Knowledge gained by one firm is soon transmitted to others and leads to the evolvement of other firms within the agglomeration. The knowledge spillovers that result from the contact between firms, the cooperation between firms, the joint ventures and the contacts with outside institutions such as universities, have influence on productivity and innovation but also lead to more pronounced changes in management and organization of the firms within the agglomeration (Kuha ,2002) which can have effects on growth.

Further to the lower input costs (raw materials) for firms located within agglomerations, there are benefits gained by the relatively lower transaction and delivery costs for these inputs due to the close proximity with the suppliers. The same also applies for the supply of labor. Furthermore these lower transaction and delivery costs apply for the delivery of the firms' end products to consumers or other firms within the agglomeration. This backward and forward externalities that arise due the the firms location within the agglomeration in the end can make its products more attractive than those of competitors from outside the agglomeration and can contribute to a firms growth.

In order to summarize, an agglomeration can provide three types of benefits for its members: First the products that are produced within the agglomeration can have a bigger degree of differentiation in relation to competitors due to the availability of differentiated inputs and specialized skill available within the agglomeration, which are sustained by the greater scale economies available, second the skills and practices that are developed within the agglomeration in time become common knowledge which benefits the agglomeration as a whole , and third the transportation costs within the agglomeration are lower,

making the products that are produced within the agglomeration more economic than outsourcing the same products from outside the region.

3.2. Network theory

The theory of networks was first suggested by Ronald Coase (1937) as an alternative to a normal organization. Depending on a set of criteria, it is more efficient to decompose an entity into subunits that interact through the market instead of operating as a whole. These subunits may then be regarded as nodes and their interactions can be regarded as links thus forming a network. This theory however can mostly be applied to firms whose products have transaction costs that are relatively low or negligible, while generally proves unsatisfactory for products that are price sensitive or have inherently high transaction costs. Networks of economic entities can be spatially disconnected but still achieve similar benefits to an agglomeration and can ultimately become a substitute for one.

The interacting parties of a network, suppliers and buyers, when involved in repetitive transactions, have a mutual interest to minimize transaction costs by organizing the procedures of the transaction and ultimately creating a link between them (Johansson, 2004). Buyer and seller are the respective nodes of the link. What differentiates the links of a network from the general market interactions is that in a network interactions are usually repetitive, such as those among factories and their suppliers, wholesale producers and their distributors, component manufacturers and assembly factories. These types of interaction usually involve considerable set up costs and capital investment initially, and have been designed from the outset to mitigate the initial set up cost and be profitable in the long run by regular repetition of the transaction. This can, however, also become a disadvantage as it can negatively affect the flexibility of the parties involved due to the capitals invested and can lead to rigidity in transactions.

Economic advantages that can be gained by networks can be summarized as follows:

Firms (nodes of economic networks) can achieve low input prices, similar or even lower to those that can be achieved inside an agglomeration.

Economic networks can demolish the boundaries between remote regions, and allow businesses to locate in regions where location would otherwise be uneconomical and unsustainable

The formulation of networks can generate knowledge spillovers similar to those achieved inside an agglomeration

Networks can enhance input and product differentiation and create economic advantages for the firms involved.

It has been determined that one of the benefits of agglomeration is the ability of firms to acquire differentiated inputs at a relatively low price. However when there is need for standardized inputs which are not greatly affected by transportation costs, similar or even greater benefits can be gained by a firm through outsourcing these inputs through a network. Standardized inputs can be mass produced outside the region with great scale economies and distributed to buyers at lower prices than are available within the region if the transportation costs per item are minimal.

Similarly the network can allow a firm to set up in a location outside the region, in an area which has other economic benefits, like low land rent, or where some of its important inputs are located and rely on transportation for the remaining inputs and the resulting end products to be delivered to buyers. If the transportation cost is relatively low and do not greatly affect the price of its end product, the firm can rely on scale economies and other gained benefits to make the product price competitive and ultimately successful.

One advantage that is normally attributed to agglomerations is knowledge spillover. This advantage however can also be achieved through the regular transactions between the firms interlinked through a network. New technical

solutions to problems and updated product characteristics are normally communicated between business partners. Most of the modern age networks are designed in such a fashion as to promote knowledge distribution and diffusion between firms which transact regularly in order to promote further innovation and new knowledge creation. Technical meetings are usually the norm between collaborating firms, universities and organizations in a network in order for new products, new solutions and new ideas to be communicated and discussed to all involved. This comes in sharp contrast to knowledge spillover within agglomerations which usually is more empirical, has a more informal character and is more dependent to the proximity between the firms. In this respect a network might become a substitute for the agglomeration.

It can be argued that networks can also vastly enhance the differentiation of inputs available to firm as well as end products available to the end consumers. It has already been established that because of agglomeration a selection of differentiated inputs is available to firms within the region, and subsequently these differentiated inputs can be transformed into differentiated end products. However similar the products between two different agglomerations, they can never be exactly the same. The existence of networks has the effect that similar but differentiated inputs and end products are traded between different regions (Armington 1969). This trading of inputs and end products between different agglomerations and regions has the end effect of even greater selection of inputs available to firms and end products available to end customers.

3.3 Cluster Theory

Cluster theory was initially presented by Michael Porter in *The competitive Advantage of Nations* (1990). He defined clusters as “geographic concentrations of interconnected companies specialized suppliers, service providers, firms in related industries, and associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also cooperate”.

As per Porter's definition the cluster although variable in form and size depending on its sophistication and extent, usually includes suppliers of specialized inputs, suppliers of services, end producers, financial institutions, technical support centers such as universities, government agencies as well as some firms in related industries, and its geographic extent can vary from a small district to even neighboring countries. The boundaries of a cluster include all the relative firms, industries and institutions whose linkages and spillovers can affect innovation and productivity, and can extend beyond the standard classification systems of industries. In this sense competitive advantage can be achieved by exploiting the complementarities, knowledge and technology spillovers, different skills and linkages between different industries.

Influence of Location-Porter's Diamond

Traditional views on the influence of location on competition, where closed economies rely on cost minimization are dismissed, as they don't promote improvement and innovation, but rather rely on minimization of factors like labor and capital costs of production. In recent times, globalization generally devalues these factors, as supplies grow and markets are expanding, so the relative advantage of a location is lost.

The influence of a cluster location comes from the effect it has on local productivity. This effect is directly related to the underlying factors in a location which can influence the quality of the business environment, and the prosperity of a region. These factors were modeled by Porter in *The Competitive Advantage of Nations* (1990) and graphically depicted in the form of a Porter's Diamond (fig.1). The four attributes which must be present for a cluster to succeed are depicted as the four corners of the diamond. These attributes are Factor conditions, Demand conditions, Related and supporting industries and Firm strategy and Rivalry. Later two external influences were added to the model, Government and Chance.

Factor conditions in Porter's Diamond include natural resources, human resources, capital resources, physical infrastructure, administrative

infrastructure, information infrastructure, scientific and technological infrastructure. Improvement in quality, efficiency and

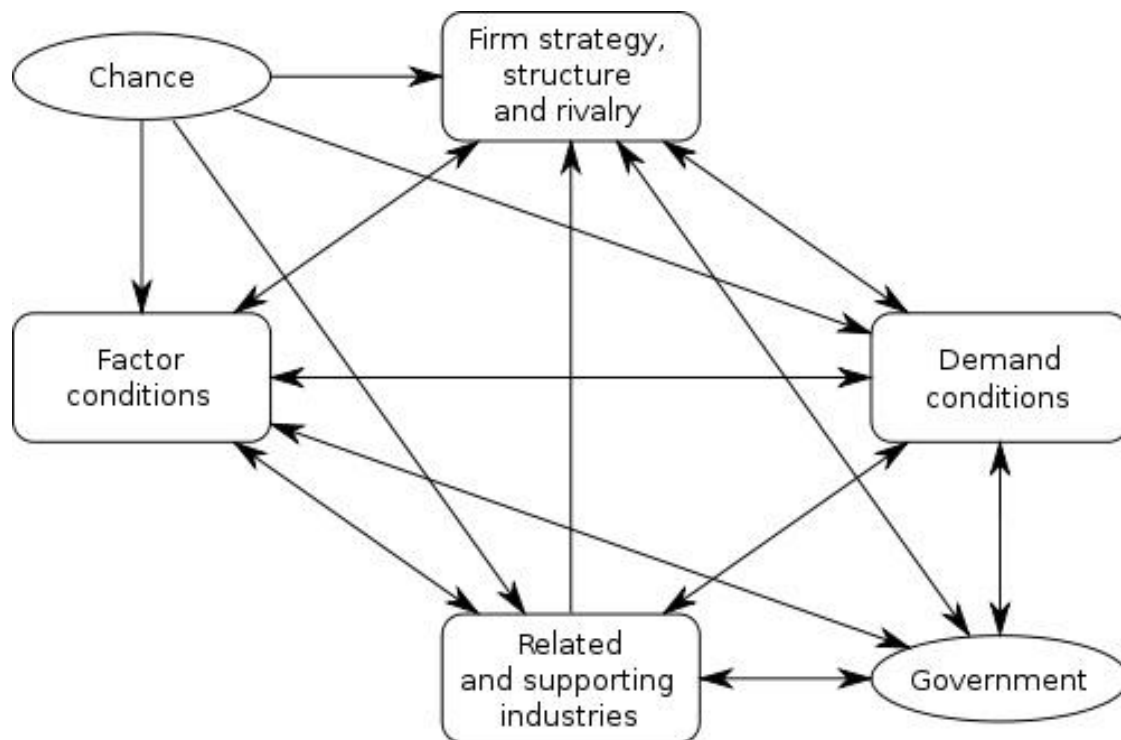


Figure 1: Porter's Diamond

Source: Wikipedia

specialization of these factors can directly influence the level of productivity and competitiveness of a cluster and can provide sustainable advantage as they cannot be readily reproduced or imitated. Porter's factor conditions come in sharp contrast to classical economic theory which considered factors of production, such as natural resources or labor as the determinants for economic success. Instead cluster theory considers the effectiveness with which factors of production are created and used to be of paramount importance. Furthermore sustained, heavy and specialized investment rather than affluence in basic factors –which can nowadays be cheaply outsourced- constitutes a serious advantage in modern knowledge intensive business. Disadvantages in some of the factor conditions can be overcome and turned into future advantages through determination of the cluster participants and if the remaining sectors of the diamond are robust.

Firm strategy, structure and rivalry in Porters Diamond refer to the underlying business conditions within the cluster. The climate towards investment, the macroeconomic stability and the microeconomic policies of the region as well as the intensity of local rivalry, can greatly affect productivity within a cluster. Local taxation, labor laws and regulations, bureaucracy, state corruption and unionism have a definite impact on investment, whether local or foreign. On the other hand productivity, innovation and efficiency are enhanced and intensified by local rivalry, strict antitrust laws, and openness to trade. The notion of government protectionism and “National champions” of old, who enjoyed advantages like economies of scale but tended to be too cumbersome to be innovative and stay competitive in a global market, have been proven wrong by recent developments, with many of those “national champions” across all industries filing for bankruptcies.

Demand conditions in the Diamond refer to the clusters local market which can help cluster companies gain competitive advantage. A demanding and sophisticated home market will force the local firms to invest in research and development and create more advanced and innovative products than those of competitors. It will also influence greater differentiation and improvement of product sophistication and quality. A sophisticated clientele will also bring valuable feedback and insight to cluster by communicating future trends and needs faster than foreign markets, or even by shaping them. In this respect the character of the local market is of great importance and the level of innovation and productivity and in the end the competitive advantage of the whole cluster can be greatly influenced by it.

Related and supporting industries in the Diamond are the suppliers of inputs or services to the cluster. Their influence to the cluster’s innovation and productivity can be very important. Close proximity to the cluster, provides direct flow of information and eases the direct exchange of ideas regarding the development of new and innovative inputs that can create advantages for the cluster. Furthermore if the suppliers themselves are also competing outside the cluster, the cluster will gain further advantages by the backflow of information from foreign competitors as well as the scale economies that are created. Related industries will also provide advantages for a cluster as they

are likely to communicate further technical solutions to similar problems, and thus increase the rate of innovation.

Even though Government and Chance are not considered factors as such in the cluster theory per se, they can influence the competitiveness of a cluster. Government policies and interventions can affect all four corners of the diamond, while Chance events can create situations where some stand to gain competitive advantages while others lose already established advantages.

The Government's Role in Clusters

The Government wasn't identified initially as a factor in Porter's diamond model, its role however was acknowledged in his theory, and has been subsequently added as a determinant. Government can influence economy in general by achieving political and macroeconomic stability, by focusing on the quality and efficiency of the general business inputs such as infrastructure and education in order to boost the microeconomics, by efficiently governing and regulating the local competition to encourage innovation and productivity, by promoting the development and the upgrading of clusters by means of appropriate incentives and by developing a long term policy to organize and motivate the constant upgrading of the business environment and cluster evolution.

The government can play a significant role on the cluster level:

- By supporting all the clusters in the region irrespective of their size or orientation. All the clusters, even the traditional (low tech) ones help to raise the regions productivity and through their existence support other regional clusters as well. Therefore one complete cluster policy that includes all clusters is to the benefit of all regional economy, in contrast to selective intervention usually towards more high tech clusters. Furthermore government support of all clusters helps to avoid economic specialization of the region which can prove unhealthy and disastrous in case of future technological discontinuities.
- By focusing on emerging or established, market driven clusters rather than trying to invent new ones. Businesses and clusters especially

those involving high-technology or heavy industry cannot be built from scratch and usually require some foundations in existing activities. Furthermore the effort and funds spent on implementing a cluster policy are better directed in clusters that are somewhat market tested.

By investigating the regional clusters' areas of specialization and differentiation with regard to foreign competing clusters, and building on these areas of uniqueness where that is possible in order to strengthen the regional clusters' competitive advantage.

- By attracting Foreign Direct Investment for the regional clusters. The government's building of location advantages such as investment on modern high quality infrastructure, the existence of a high level educational system that promotes specialization, the easing of business regulations and the maintenance of long term economic stability will aid to attract Foreign Investment in the regions clusters and reinforce their development.
- By constantly monitoring and evaluating all the clusters and concentrating or removing government-created obstacles and eliminating inefficiencies that impede their growth. Government rules and regulations that affect cluster growth without compensating to society in any meaningful way should be revisited, revised or altogether eliminated. New infrastructure needs and educational or training policies must be identified and addressed in time to allow cluster upgrading.
- By concentrating government initiatives and investments towards the improvement of business environment in the whole cluster, which includes firms, suppliers, related industry, service providers, institutions, will have the benefit of upgrading the cluster without affecting competition. Aiming government investments towards specific industries, or at the broad economy, can create market distortions and affect competition and private investment. A constructive dialogue between the government and the cluster participants can address the common problems and focus on the common constrains rather than

downgrading to lobbying or gravitating towards market protectionism or subsidies as usually happens in government-industry dialogues.

The government can influence the cluster upgrading by organizing its agencies internally to better align themselves with local clusters, and with continued and ongoing cluster assessment through the collection and compilation of cluster-specific information, identify deficiencies and concentrate on simplifying regulations that impede cluster upgrading.

Competitive Advantage

The main advantages that can be achieved through a cluster are increased productivity, the promotion of innovation and the stimulation of new business creation.

Productivity can be increased within a cluster by the easier and more cost effective procurement within a cluster of both specialized inputs as well as better qualified and more specialized employees, by the existence of a specialized pool of knowledge and information, by the access the cluster can achieve to various government institutions and public goods, and the incentives the cluster creates among its members for benchmarking.

Inputs that are sourced from competitive local suppliers as well as other cluster participants will have inherently lower transaction costs than outsourced inputs, and can be cheaper than if they were produced through a firm's vertical integration. Furthermore when inputs are sourced locally, delays are minimized and more efficient supply patterns can be used. Support and after sales servicing is also easier and more cost effective than if they were supplied by firms outside the cluster. Even in the case of distant outsourcing of inputs or even services, the presence of a cluster can present advantages for the cluster participants, as distant suppliers will price their products competitively in order to gain access to the cluster, in the hope of repeated business.

A Cluster will increase the supply of employees, which limits the costs for training and also recruiting for the cluster participants. The existence of the other hand of a booming cluster might in the end limit the availability of specialized employees and increase the wages in the region, but usually the overall advantages gained outweigh the penalties. In the case that local supply of specialized input, services or personnel is unavailable, the existence of the cluster will create incentives for outside players to enter the region in order to fill the market voids, by relocating or creating alliances, which in the end strengthen the cluster.

A pool of specialized knowledge and information forms within a cluster, which is better accessed from within the cluster, which can greatly enhance productivity in the region. This kind of specialized knowledge and information can only be gained by costly research and development otherwise. As Porter very wisely describes it “Proximity, supply and technological linkages, and the existence of repeated, personal relationships and community ties fostering trust facilitate the information flow within clusters”

The high level of complementarities that can be achieved by the products and the activities of the cluster participants make the overall cluster output very desirable. The coordination and internal pressure within the cluster to improve the level of services, quality, and design of cluster products all across the board increase the overall productivity of the cluster. The presence of a formal cluster organization that can put creative pressure on the cluster participants, market the cluster products and enhance the cluster’s reputation in itself through initiatives like trade fairs, or cluster publications can also have significant benefits for local productivity.

The cluster’s access to public or quasi-public goods and institutions such as universities, local training programs, infrastructure at relatively low cost can severely cut the cost of research and internal training for cluster participants as well as substantially increase the level of specialization within the cluster with obvious benefits in productivity and competitive advantage for the cluster.

One of the benefits of clusters is the fact that it creates substantial incentives in cluster participants for self-benchmarking of their performance. The

proximity of the participants, the similarity of their functions and the relative availability of information on other participant's performance, eases the task of measurement of each firm's performance as well as those of its suppliers and creates pressures for improvement in order to increase competitiveness. This function has positive benefits on the whole cluster's productivity.

Innovation can be greatly enhanced by the clusters inherent characteristics. The concentration of many firms with relationships to a wide market of buyers, eases the communication of new trends and emerging buyer needs to the cluster participants. New technologies and new inputs can easily spread throughout a cluster by firms' direct relationships and direct observation. Furthermore there is greater flexibility in experimenting with new technologies to further develop existing products or create future products based on communicated buyer needs. The competitive pressures between cluster participants reinforce all the other advantages and promote innovation in the region.

Economic Geography

Clusters are usually regional or even national, they can however cross national borders when a number of factors such as the language, the legal system are similar and the trade barriers are minimal.

Clusters can be categorized as local or outward oriented by the main scope of their business. Local clusters such as the housing market, entertainment and restaurant markets rarely compete with other regions and due to their nature are inherently limited in their growth, as they are confined to the regional or national borders. The outward oriented clusters however which are also the main drivers of outward economic activities, don't share the same limits with the local clusters and can greatly outgrow the local market. These clusters are the ones which in the long run sustain the economic growth and prosperity of the region.

The formation and growth of clusters is more common in advanced economies, whereas in developing economies the clusters usually amount to

foreign owned subsidiaries which either serve the local markets or exploit cheap resources and labor costs. Cluster formation in developing economies can be hampered by government restrictions, protectionism and educational systems that fail to adapt to modern needs.

Birth, Evolution and Decline of Clusters

The formation of clusters can usually be attributed to:

The existence of early companies that capitalized on the existence in a particular area or region of pools of factors, such as skilled labor, accumulated expertise, appropriate high quality infrastructure.

Very intense and unusual local demand for a particular product or service

The pre-existence of a related cluster which has spawned related industries, attracted suppliers, and has lead to the accumulation of related expertise

The existence of one or two innovative firms that generate substantial growth for other firms

Chance events that create factor or demand conditions and lead to the formation of companies in particular areas.

After the formation of clusters, their development, although not guaranteed, is often like a chain reaction and is dependent mainly on the intensity of local firm competition, the local economic and political climate towards entrepreneurship and the existence of organizational mechanisms that can bring all the cluster participants together.

A cluster which includes critical mass firms attracts specialized input suppliers, influences local institutions to develop specialized research facilities and cater for specific new educational needs, and through this process new information and knowledge is accumulated. Market opportunities spawn new business; new companies and existing company spinoffs emerge, which in

turn attract new specialized suppliers. Although this process boosts cluster status and recognition, it can take up to a decade for the cluster to fully develop and achieve competitive advantage (Porter). The cluster can further develop where it intersects with other clusters and technology, information and skills from different sectors and fields merge and create new innovation and new product niches. Foreign investment also contributes to the acceleration of cluster development by introducing new companies or subsidiaries to the cluster. Clusters also attract skilled people both entrepreneurs and labor by offering opportunities for growth, and these people in turn reinforce the clusters development. The internationalization of the cluster participants which can be achieved either by marketing their products internationally, or internationalizing part of their production to achieve cost reduction and gain access to foreign markets, helps the cluster gain access to foreign knowledge pools, promotes the innovation process, generates growth and helps cluster development.

Although successful clusters can remain competitive for decades or in some cases even centuries, there are endogenous or exogenous causes that can lead to cluster uncompetitiveness and ultimate decline.

Endogenous causes, which are usually related to elements of the cluster's diamond, can reduce the clusters innovation capacity and its productivity. These can include extensive government regulations, unionization, cartels and mutual understandings that limit local competition, or even the onset of groupthink among cluster participants which hampers innovation. Usually endogenous causes tend to surface when the government intervenes in competition either through subsidies or lack of reinforcement of a proper anti-trust policy. These problems and local rigidities can be somewhat averted if firm competition remains strong, through globalization, outsourcing and out-locating of production facilities, but this in the end will lead to the loss of the clusters competitive advantage and subsequent decline.

Exogenous causes are mostly caused by technological discontinuities or a shift in buyers needs and preferences, which can have catastrophic consequences to a cluster, as they automatically render technical knowledge

and expertise as well as the accumulated skill and supplier bases useless. If the new skills and technical knowledge can be found locally or the needed inputs can be outsourced and product development moved elsewhere until the necessary skills are developed, the cluster can compensate for discontinuities of this kind but unless over time a critical mass of new innovation is not achieved in the cluster and the buyers needs are not met, the cluster will face competitive loss and decline.

Role of trade associations

The trade or cluster association has a multi faceted role according to cluster theory:

It is responsible for achieving the recognition of the cluster by the national government and its various institutions, and interface the local and national government on behalf of the cluster. Based on the fact that the cluster association represents all or at least most cluster members, it can achieve significantly greater influence than individual trade or industry associations. Furthermore due to its nature and the fact that it represents all the firms, the service providers, the suppliers and related industry, the cluster association avoids issues of government lobbying, and can focus on addressing issues related to education, training and infrastructure in which other trade associations are ineffective.

The trade association also carries the role of institutionalizing the cluster linkages and providing a common and neutral forum where its member common problems, needs and constraints can be identified. The association can then proceed to find ways to address the identified problems by implementing specific initiatives, by establishing appropriate contacts with government or educational institutions to create specific training programs, by organizing regional or national trade fairs, by organizing delegations to representing the cluster in foreign functions and by managing purchasing consortia.

4. Concept of the Maritime Cluster

The maritime business is especially suited to the concept of clusters. This can be evidenced in the numerous government (top-down) or industry-driven (bottom-up) initiatives (Policy Research, 2008), started in the last 15 years, in establishing regional or national maritime cluster organizations mainly within Europe.

There were certain benefits, such as increased government awareness of the considerable economic significance of the maritime clusters, which lead to introduction of pioneering policies like the introduction of tonnage tax in several European countries in order to compete with open registries, as well as increased intra-cluster synergies which promoted innovation and cluster growth (Wijnolst, 2003). Furthermore, the foundation of The European network of maritime clusters was a pioneering initiative by the maritime cluster organizations of 9 European Union Countries (Denmark, Finland, France, Germany, Italy, the Netherlands, Poland, Spain, Sweden, United Kingdom) and Norway with the objective of strengthening the maritime cluster of Europe.

Several studies of individual countries maritime clusters like the Netherlands, Norway, Denmark, Sweden and Italy have been completed, revealing part of the structure and some quantitative data of their maritime clusters. There have also been studies conducted on behalf of the European Commission into the maritime clusters across the whole European Union. However there is still little systematic information and data on the degree of interaction between sectors of the maritime clusters. Furthermore the statistical data that are gathered for these studies lack consistency, which makes cluster benchmarking very difficult.

One of the reasons for this situation is the fact that the exact scope of maritime clusters is still the subject of debate, mainly triggered by the differences that can be witnessed between the maritime clusters of different countries with regard to the scope and specialization of their sectors.

Furthermore uncertainty still exists regarding the maritime clusters geographic extent, which has led to many studies concentrating on regional clusters, while in others the geographic scope is expanded to national or international level.

Traditional Shipping Sectors (European Commission Report 2008)	Dutch Maritime Cluster	European network of maritime clusters
Shipping Marine Equipment Shipbuilding Seaports Navy Recreational Boating Offshore supply Maritime Services Maritime Works Inland Navigation Marine Aggregates	Shipping Marine Equipment Shipbuilding Ports The Royal Navy Yachting Offshore Maritime Services Dredging Inland navigation Fishing	Shipping Marine Equipment Shipbuilding Seaports Yachtbuilding Offshore Services Maritime Services Fishing
		Optional Maritime Sectors Navy and Coastguard Inland Waterways Dredging and Waterworks

Table 1: Traditional maritime sectors definition

Sources: European Commission Report 2008, Dutch Maritime Cluster 2010, European Network of Maritime Clusters 2006.

This situation is clearly evident by the different definitions of the traditional maritime sectors that are included in a maritime cluster that have been given in the study of the Policy Research Corporation conducted for the European Commission (2008), the Dutch Maritime Cluster and the European Network of Maritime Clusters shown in table 1.

The traditional sectors of the maritime cluster according to the European Commission's definition can be briefly summarized as follows:

Shipping

The shipping sector of the maritime cluster is considered to be the core of the maritime industry. It includes ship owners and ship-managers as well as charterers. Activities of this sector includes open sea shipping, short sea shipping as well as ferry services.

In recent years the increased maritime trade due to the manufacturing boom of the Far East which greatly increased freight rates and subsequently shipping profits has lured many investors from outside the shipping sector to become ship owners. Commercial management and sometimes technical management of vessels can be outsourced from established operations and technical managers as they can offer great economies of scale by managing large fleets as well as having great expertise. Ship managers, operations and technical are involved in all the operating and technical aspects of the ships, such as trading, dealing with charterers, shipbrokers, bunkering, crewing, vessel supplies and vessel agents as well as monitoring of vessels performance, maintenance, supply of spares and coordination and monitoring of repairs and dry dockings. Technical managers are also responsible for the compliance of the vessel to flag and class regulations.

Marine equipment

This sector includes all the manufacturers of maritime equipment for all maritime industry, including main and auxiliary engines for ships, deck equipment such as hatch covers, mooring equipment, cargo and ballast pumps, safety equipment. A large part of this industry is import and wholesale trade of such equipment, and this is included in this sector.

Shipbuilding

This sector involves all the industries involved in the construction of commercial ships, naval ships, inland going vessels such as riverboats and fishing boats. Only the construction of recreational boats over 24 meters (mega yachts) is included in this sector while that of smaller yachts is included in the recreational boating sector. Ship repair and ship scrapping of the above mentioned vessels as well as construction of floating docks and dry docks are considered to belong in the shipbuilding sector.

Seaports

This sector of the maritime cluster includes port authorities, port management as well as tug and port pilot services and all the industries involved in cargo handling, including maritime logistics firms, storage facilities of cargo, the stevedore industry, maritime forwarding companies as well as port agencies. Other industries which are related like the road transportation industry are not included in this sector as they belong to a different cluster system.

Navy and coastguard

This sector includes national navies and coastguards, including all administration, management, operations, engineering, training and education

Recreational boating

This sector includes the industries involved designing, and building recreational boats under 24meters. The industry involved in wholesale and retail sales, brokering and financing as well as the sector specialized in servicing, spares and repairs is included. The sector also includes the firms involved in renting and chartering as well as marinas and supporting services.

Offshore supply

This sector includes all firms engaged in the seismic research required for the exploration of underwater resources on or under the seabed, all firms

engaged in offshore drilling, all firms involved in the design, engineering, construction and installation of offshore platforms, all firms involved in transportation and supply to offshore installations and firms related to offshore installation, operation and maintenance. Firms involved in the installation and operation of offshore wind turbines for the production of electricity are also included in this sector.

Maritime services

This sector includes maritime brokerage, cargo brokerage, classification societies, marine surveyors, cargo inspectors, maritime financing institutions, maritime law firms, maritime insurance institutions, bunker agencies, crewing/manning agencies, industry associations, maritime education and training services and institutions, maritime consultants, research and development institutions and services, as well as diving companies, ship suppliers and maritime related government services.

The scope of this sector is to provide specialist services for ship owners and charterers.

Shipbrokers (Cargo brokers) bring cargo interests, shippers or charterers, usually big commodities companies, mines, oil companies, into contact with ship-owners for agreement on a contract, known as charterparty, for the chartering of a ship. Chartering of a ship can involve the fixing of a ship either for a single trip on the spot market or for a period of time through a time-charter. Vessel chartering is almost exclusively completed through shipbrokers and traditionally, ship-owners and charterers use different shipbrokers. Shipbrokers usually have a big pool of knowledge on different cargo interests and ship-owners. Brokers also provide post-fixture services after the successful fixing of a ship in order to facilitate and ensure the level of transaction.

Ship brokers specializing in ship-sales bring ship-owners and shipyards into contact and mediate for the ordering of new-building vessels. They also broker the sales of second hand vessels between their owners. Brokers usually receive payment for their services as a percentage of the sale price.

They also perform similar services for big ship-repairs and dry-docking of vessels.

Marine Insurers include hull underwriters who insure the vessel in itself in case of sinking, cargo underwriters who perform the same task for the vessels cargo, and P&I Clubs who insure the vessel with respect to third party liabilities that could arise through ownership or operation of the ship. Clubs are mutual insurance non-profit associations between vessel ship-owners.

Financial services institutions are mainly used for the funding of the purchase of vessels, both new-buildings as well as on the second hand market. Usually this includes mortgaging on the vessel, bonds or structured products. In some cases financial institutions become ship-owners by default, in which circumstance management companies are employed for the vessels operation until they are sold on.

Maritime consultants usually include ship surveyors and cargo surveyors employed by ship-owners and cargo interests. Many charterers and ship-owners use technical consultants during normal operation of vessels, usually for exact determination of loaded cargo, or exact determination of vessel's bunker quantities. Consultants are also employed by classification societies or flag state administrations as outside surveyors to conduct sea-worthiness surveys on vessels.

Maritime law firms are usually employed in disputes and claims between ship-owners and cargo-interests over operational aspects of the maritime business. Claims are usually dealt by arbitration or mediation. Traditionally provision is made in charterparties for English Law and jurisdiction for the governing of claims and disputes due to the increased specialization and expertise of English courts in maritime law. Maritime law firms are also advised on the subjects of vessels sale and purchase as well as on contractual and financing matters.

Crewing or manning agencies are used in order to supply seafarers to ship owners for the manning of their vessels. Usually they retain a great pool of labor in order to ensure flexibility.

Industry Associations are national and/or international representatives of various maritime sectors or subsectors as well as trade and worker unions

University departments specializing in the maritime sector such as naval architecture, shipping or logistics, as well as marine training academies are also included in the maritime services sector of the maritime cluster.

The IT industry that specializes in maritime software, maritime communication and ship related internet technologies is a part of the maritime services sector. Also included are the firms which specialize in maritime logistics software creation.

Companies specializing in maritime publications are also a part of the maritime services sector of the maritime cluster.

Maritime works

This sector of the maritime industry includes companies involved in dredging the sea bed for the construction of new ports as well as the maintenance of existing ports, the construction and maintenance of canals and dykes and maintenance of rivers by removal of sand and sediments and the supporting industry. It also includes the industry involved in the transport of the resulting sand. The industry involved in the laying of nautical cable and the construction and maintenance of underwater pipelines is included in this sector

Inland navigation

The sector of inland navigation includes ship-owners, managers and charterers of river boats. River boats include bulk carriers, tankers as well as tanker vessels. Other type of inland shipping such as cruising and ferrying is also included in this sector. This sector also includes the harbor and river towing companies operating in rivers.

Marine aggregates

Companies engaged in seabed exploration using seismic, acoustic and seabed sampling techniques and subsequent exploitation of marine aggregates, are included in this sector.

Fishing

A special mention has to be made on the fishing sector, which includes coastal fishing, fisheries and offshore fishing. Its inclusion in the maritime cluster's sectors is the matter of much debate, with several of the maritime cluster organizations [dutch maritime network, italian], listing fishing in their maritime sectors, while in others [Danish, united kingdom] it is excluded. Furthermore, fishing is not included in the list of traditional maritime cluster sectors by the European Commission [].

In sharp contrast, the European Cluster Observatory's definition of the Maritime Cluster and its sectors, shown in table 2, does not include most of the traditional maritime sectors, and focuses mainly on fishing related sectors and activities, while categorizing some of the traditional maritime cluster sectors like shipbuilding under the Maritime Technology Cluster .

European Cluster Observatory
Hunting, trapping and related service activities
Marine fishing
Freshwater fishing
Marine aquaculture
Freshwater aquaculture
Processing and preserving of fish, crustaceans and molluscs
Manufacture of cordage, rope, twine and netting
Manufacture of other tanks, reservoirs and containers of metal
Building of pleasure and sporting boats
Retail sale of fish, crustaceans and molluscs in specialised stores

Table 2: Sectors of the Maritime Cluster , European Cluster Observatory

Source: ECO 2010

5. Research on Maritime Clusters

The increased interest on the concept of clustering that was created among scholars, economists as well as the industry itself by Michael Porter's cluster theory led to the initialization of a great amount of research on the subject. The maritime industry was no exception, particularly due to the fact that the cluster theory seems ideally suited to describe and explain the localization of the maritime industry in many regions.

The maritime industry and some maritime associations especially in northern Europe were particularly interested in the benefits that could be gained by this new concept. This led to a large amount of research on maritime clusters being conducted in the last few years mainly in the European Union.

A brief overview of the more significant research on maritime clusters conducted in Europe can be seen below in chronological order.

5.1. London Maritime services cluster

One of the first studies on the subject of maritime clusters by Prof. Grammenos (1992) was focused on the maritime services sector of London. The study gave an insight on the interconnection of sectors of the shipping industry, concluding with a model in which the core of the industry was constituted of a triangle whose corners were the ship-owners, the charterers, and the brokers. Around these three sectors revolved all the ancillary sectors, with interconnection between them as well as with the central triangle.

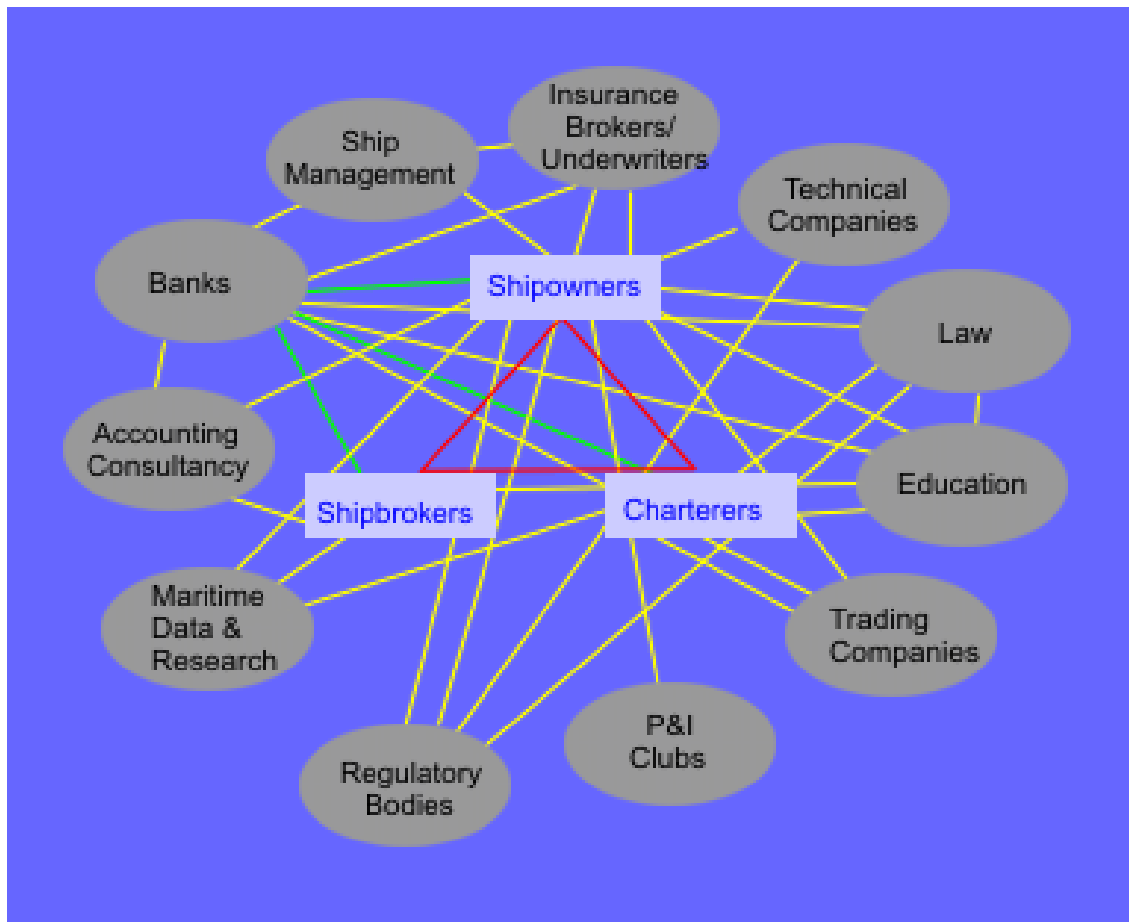


Figure 2: Maritime services cluster

Source: Grammenos 2005

It was thus argued that the central triangle represented the maritime clusters critical mass, and the driver for the existence, economic growth and prosperity of the whole cluster. The ship owners represent the supply side of the industry (available tonnage), the charterers represent the demand side and the brokers are bringing the supply and demand side in contact. These three sectors employ the rest of the maritime clusters sectors for the supply of maritime services, legal services, bank services, ship managers etc. The size and growth of the central triangle of critical mass companies will also directly affect the demand for services from the remaining maritime sectors. In this respect the whole clusters existence and growth is solely dependent on the state of the central triangle.

5.2. Dutch Maritime Cluster

The Dutch maritime cluster was the first to initiate maritime cluster studies in the mid-1990s which clearly showed (Wijnolst et al, 2003) that the value generated by the shipping companies shore activities far exceeded the one created on board the vessels flying Netherlands' national flag. This new insight prompted significant policy changes in the country and prompted the state to focus on creating a level playing field for ship-owners rather than supporting the national flag. A further amount of studies since, commissioned by the Dutch Maritime Network, have broadened the understanding of the mechanisms and qualitative characteristics of maritime clusters and given further insight on their importance.

The initial study of 1999 attempted to define Netherlands' maritime cluster, and proceeded to identify its main sectors as: Shipping, Shipbuilding, Marine Equipment Supplies, Offshore, Inland Shipping, Dredging, Ports, Maritime Services, Fishing, The Royal Netherlands Navy and Yacht Building Industry.

The research attempted to establish the economic significance of the Dutch maritime cluster. In the studies published in 1999, 2003 and 2006 the maritime clusters direct added value was calculated at €7,8 billion (2.5% of GDP) , €9,5 billion (2.2% of GDP) and €10 billion (2% of GDP) respectively. The total value added over the same periods was €20.3 billion, €25 billion, €29.9 billion respectively.

In the same years however, the studies showed a decrease in employment in the Dutch maritime cluster from 137,000 initially to 133,250 although this was partly blamed in the fall of employment in the Dutch Navy, increased productivity in the other sectors of the cluster, and the expansion of many cluster participants abroad.

Throughout this period the most important sectors for the cluster in terms of added value were shipping, offshore and the ports, contributing about 50% of the whole cluster production in terms of GDP.

Furthermore the research attempted to define a set of enablers that would aid the upgrading of the cluster and ensure its sustainability and future growth. A set of seven enablers were identified:

1. Definition of the cluster, establishment of its significance and subsequent promotion of its visibility:

Definition of the cluster sectors and establishment of the key economic indicators will motivate the government, and the industry itself to seek the development of specific cluster policy. The creation of concrete statistical data is imperative for a specific industry to make its economic impact identifiable and noteworthy.

2 Definition of an industrial policy

Upon the successful identification of the maritime cluster and the understanding of the internal mechanisms and inter-relations between sectors and sub-sectors of the cluster, an appropriate long term policy should be created by the government in order to a competitive environment

3 Strengthening of the pull sectors of the cluster.

Demand pull sectors, like shipping, are the driving force of the cluster, and use the capital services of other sectors. In order for maritime clusters to remain strong and viable, the existence of strong and internationally oriented demand pull sectors is a prerequisite. The supply push sectors, like shipbuilding and marine equipment manufacturers are more affected by competition from low cost Far East markets, whereas the demand pull sectors, like shipping, can outsource their needs for capital equipment from the lowest cost supplier. Therefore, government policies should be focused on them in order to ensure the sustainability of the maritime cluster.

4 Monitoring and maintaining a level playing field

Big sectors of the maritime cluster, such as shipbuilding and dredging, are faced with unfair competition internationally. Governments and even the EU have to continuously monitor the competition and intervene when necessary

in order to maintain a level playing field for all companies in order to ensure the competitiveness and growth of the maritime cluster.

5 Promotion of exports and internationalization

The industry must be export oriented in order to be viable, especially in countries with limited home markets. When a certain level of exports is exceeded firms should revert to internationalization of their business in order to maintain their own competitiveness and the competitiveness of the whole cluster.

6 Promotion of R&D and Innovation.

Exports can only be maintained in the long run by constant upgrading of products, and revamping of services. In order to achieve this policies are required that stimulate innovation. Leader firms are required to set high standards of innovation, triggering their suppliers and the rest of the cluster to follow their lead. The cluster's role is to monitor and invite leader firms to fill this role.

7 Promotion of education for labor

Highly educated and skilled people are essential for the maritime cluster. They can promote innovation, and promote better management and modern operation. Therefore educational infrastructure of a high level and sufficient career and growth prospects are a prerequisite in attracting the highly skilled labor that is needed. It is the cluster's role to influence the strengthening of the educational infrastructure and in creating a positive image of the cluster.

5.3. European Commission 2001

The European Commission's pioneering study (European Commission, 2001) on the Economic Impact of Maritime Industries in Europe, published in 2001, carried out for the total EU-15 member states and Norway, found that the maritime industry as a whole, employed roughly 1.5 million people and a direct added value of about €70 billion. That was close to 1% of the total

European Unions and Norway's GDP. The indirect economic impact, estimated at roughly €41 billion (0.6% of GDP). The largest sector of the maritime cluster was shipping, by quite a margin, followed by ports with about €30 billion in total added value and €20 billion respectively. Furthermore the study showed that the largest part of the added value or about 83% was spent inside the European Union, thus creating further economic benefits.

5.4. Italian Maritime Cluster

Federazione del Mare, the Italian maritime cluster organization published as The Second Maritime Economy Report: The Economic and Employment Impact of the Italian Maritime Cluster in 2002. The report (Censis, 2002) focused on five traditional maritime sectors, merchant shipping, shipbuilding, recreational boating, fishing and the navy. It found the economic contribution of these core maritime sectors to amount to 2,1% of GDP for the year 2000, with the complete maritime cluster contributing roughly 2.3%. It was also estimated that the maritime sector employed about 176,000 people. Again in this study the shipping sector was found to be predominant with by contributing almost 50% of the whole clusters value and almost 75% of its exports.

5.5. Norwegian Maritime Cluster

A 2003 study (Jakobsen et al, 2003) on the Norwegian maritime cluster, which was part of The European Benchmarking Project, found that the value created by the Norwegian cluster employed was about €4 billion in 2000. That amounted to 8% of total Norwegian value creation. Furthermore the cluster, which employed roughly 70000 people in 2000, demonstrated tremendous amount of growth rates, and accounted for one half of the total export service exports. Even though the Norwegian maritime cluster often has been referred to by experts to be the most complete, several studies have shown that a rather high percentage of the cluster participants are involved in the shipping

sector which accounts for almost 80% of the complete clusters gross created value. Furthermore the Norwegian maritime cluster was found to be quite fragmented into several smaller regional clusters with a small degree of interconnection and a small amount of synergies and agglomeration.

5.6. Finnish maritime cluster

The 2003 study on the Finnish maritime cluster by the Center of Maritime Studies in Turku University (Viitanen et al 2003) found that the maritime clusters turnover in 2001 was about €11.4 billion. The most fascinating finding of the study however came from the conclusion that the largest part of the maritime cluster's turnover did not come from the shipping sector (€2.1 billion), but from the marine equipment sector (€2.7 billion). This can be attributed to the fact that several leader firms are members of Finland's marine equipment sector (firms like Wartsila, Abb Azipod, McGregor, Mariof etc) which have internationalized and quite export driven, as well as the fact that the Finnish shipping sector is mainly focused on handling the Finnish import and export commerce.

The study further found that the maritime cluster directly provided employment to 47,000 people, though it was calculated that the maritime sector companies provided indirect employment to a further 250,000 people.

A further interesting finding was the fact that a significant number of maritime cluster members were involved in several sectors of the cluster, thus proving the theory of cluster interconnections and synergies within the cluster. It was also determined that the business created within the cluster sectors was extremely significant as the Finnish shipping sector of the cluster accounted for more than 60% of the total €3 billion in sales of the shipbuilding and marine equipment sectors.

The authors were further concerned with the maintenance of a level playing field as it was determined from the study that rival Swedish shipping companies were receiving significant subsidies from the Swedish government.

5.7. Belgian Maritime Cluster

The report “A Durable Belgian Maritime Policy”, which was produced by the Policy Research Corporation on the Belgian Maritime cluster (Policy Research Corporation, 2002) , showcased the great importance of national legislation on the maritime cluster. Even though the maritime cluster provided direct employment to 6,750 people, the report noticed that the complete Belgian merchant shipping had flagged-out of the national register in the last 15 years, seeking refuge in the nearby Luxemburg open-register and other flags-of-convenience. This was a direct effect of the antiquated shipping laws still current then in Belgium that had the effect of no single merchant vessel flying the Belgian flag. The report suggested that unless the highly unfavorable policy on shipping was changed and a focus was placed on ensuring a level playing field for the shipping sector, the preservation of the whole maritime cluster would be at risk. It was further suggested that when the shipping sector of the cluster relocates, other sectors of the cluster become unviable and tend to relocate as well.

5.8. Danish Maritime Cluster

The study (Sornn-Friese, H. 2003) of the Danish maritime cluster, Navigating Blue Denmark: Structural Dynamics and the Evolution of the Danish Maritime Cluster (2003) demonstrated that the maritime cluster of Denmark contributed more than 6% of the Danish economy in 1998 .Of this amount, the direct added value was roughly 45 billion DKK, or about 4.5% of GDP. The biggest sectors of the cluster were shipping and water transport which contributed to roughly 70% of the total cluster output. Furthermore the maritime cluster employed 81,000 people or 3% of total employment, while indirectly employing 119,000 people or 4.4% of total employment. A further study by the Danish Maritime Authority, entitled The Danish Maritime Cluster – An Agenda for Growth, verified the shipping sector as the largest contributor in production value, and its increased contribution to Denmark’s vital economic data

5.9. European Commission 2006

The study “Employment Trends in All Sectors Related to the Sea or Using Sea Resources” which was conducted for the European Commission in 2006, attempted to provide a complete overview of employment in European maritime clusters. All activities were categorized per sector and country. It was found that 5 million people were employed in sea related activities in 2005, although this number was grossly overestimated as it included those employed in coastal tourism as well as national navies, whose inclusion in the maritime cluster is still the subject of debate. Traditional maritime sectors were found to employ 1,9 million people. The study demonstrated however significant downward trends in employment on the shipbuilding sector which can be attributed to Europe’s decreasing share in shipbuilding, but also on the shipping sector which is caused by increased cost of European seafarers against those from developing nations and the decreasing attractiveness of the maritime profession for Europeans. Particular growth has been noticed in the offshore and coastal energy sector and in coastal tourism across Europe. The highest employment is observed in Germany, France, the United Kingdom, Italy, Greece Poland, Denmark.

5.10. European Commission Report 2008

The European Commission’s 2008 report titled “The Role of Maritime Clusters to Enhance the Strength and Development in European Maritime Sectors”, identified the maritime clusters of the 27 member states of the European Union and Norway and proceeded with their evaluation. The report attempted to stress the economic importance of the European Maritime clusters to the European economy by calculating their production value at €450 billion of which €186.8 billion was estimated to be the direct added value, of the clusters. This figure amounted to an average contribution of 1.65% of the average GDP in the European Union and Norway. Furthermore the maritime

clusters were estimated to provide total direct employment to nearly 4.8 million people. That amounts to nearly 2.25% of total European employment.

The report proceeded to identify the maritime clusters to a regional level and attempted to evaluate the strength of the individual clusters, while also investigating the maritime cluster organizations. The research showed that the countries with the 10 most important clusters namely the Netherlands, Germany, Poland, France, Denmark, Italy, Greece, Belgium, Norway and Spain provided 88% of the total added value of all the maritime clusters in Europe. Furthermore it showed that they accounted for 83% of all maritime employment in Europe.

As with previous reports, once again it became evident that the shipping sector and the ports were the main export drivers and the biggest contributors to total value and direct added value as a percentage of GDP. For some of the smaller economies this added value was a substantial percentage of national GDP. Furthermore the report showed the continued shrinking of the shipbuilding sector in Europe, as well as the shrinking of the maritime profession across Europe.

5.11. United Kingdom Maritime Cluster

A report on the United Kingdom's maritime cluster published under the name The Economic Impact of Ports and the Shipping Industry on the UK Economy in 2007 and based on two earlier reports by Oxford Economics demonstrated that the cluster's direct economic contribution amounted to £11.4 billion, while the indirect effects were estimated at £23.4 billion (1.7% of GDP). The cluster provided employment to 490,000 people or an estimated 1.7% of total UK employment. The direct employment constitutes was 221,000 jobs. The major contributors to the cluster were the ports which provided employment to 132,000 people while contributing £7.7 billion to the GDP. In contrast the shipping industry contributed £4.7 billion to the GDP. This can be attributed to the fact that, nearly all of UK trade is moved through the ports, thus greatly increasing their importance and economic significance to the maritime cluster

in comparison to other European countries. The study also demonstrated the significance of the tonnage-tax regime to the UK's maritime cluster by analyzing different scenarios. It was calculated that without the existence of tonnage tax the shipping industry would be 80% smaller.

5.12. European Cluster Observatory

The European cluster observatory, an initiative financed by the European Commission under the Europe INNOVA initiative, which is based in the Center for Strategy and Competitiveness (CSC) at the Stockholm School of Economics, is an online platform that provides information and analysis of all the clusters in Europe, including the maritime clusters.

The Observatory which was launched in 2007, is aimed mainly on informing regional and national government policymakers and officials, researchers and academics as well as the cluster organization's managers, on European clusters, cluster policies and cluster initiatives. This study mainly differs from all other previous research in that it provides data and quantitative analysis on European clusters based on a consistent and fully comparable methodology. The observatory's data sources come from the national statistical institutes of the European Union countries as well as Eurostat.

The Observatory provides a wide array of tools for policy makers and researchers which range from the cluster mapping tool, the cluster calendar, and cluster library to cluster classroom.

The observatory's mapping tool provides statistical mapping of the clusters in Europe, including measuring the effects of spillovers and linkages, based mainly on analysis of national statistical data on employment for the 2000 clusters that have been identified within the European Union as well as Norway, Iceland, Switzerland, Israel and Turkey. The mapping tool also includes data on the geographic concentration of industries and indicators on economic performance as well as information on the framework conditions that affect regional competitiveness compiled from a broad range of sources.

The cluster calendar which is updated by the observatory as well as cluster organization managers provides information and promotion concerning cluster events such as seminars, workshops and conferences.

The Cluster Classroom offers diversified educational material on the subject of clusters, such as videos, which serve as an introduction to clusters and cluster policies.

The Cluster Library acts as a European repository for many different cluster-related documents. Available types of documents include regional cluster reports, sectoral cluster reports and cluster policy reports. Documents are added by the European Cluster Observatory but can also be contributed to the library by the cluster management. The library also incorporates a subscription system to facilitate notifications to users on relevant documents and events.

The Cluster Wiki pages which are updated by the users, usually cluster policy officers, contain information on clusters, cluster sectors, cluster organizations and networks as well as the relevant regions. These can also be linked to relevant research material and data, as well as notifications and promotional material for upcoming events.

6. Cluster Indicators

Porter's cluster theory has attracted increased interest from economic and industry circles as well as from policy makers in the last two decades. Its implications led many academics and industry associations to revisit some of the traditional sectors of industry and business in order to gain new insight on centuries old business activities. The new economic theory seemed particularly suited to the maritime industry, which led to the initiation of a large amount of studies and completion of several reports on the subject of maritime clusters. Initial reports were mostly focused on determining the economic value created by the maritime cluster for the regional or national economies. A further interest to investigate the competitive advantages of maritime clusters and attempt to benchmark them against the competition has led to some attempts to develop a common set of indicators of cluster performance. The extent and complexity of maritime clusters as well as the different structures witnessed between different clusters makes this a very difficult proposition.

6.1. Performance Indicators formulated by the Dutch Maritime Cluster

In his research for the Dutch Maritime Cluster professor Wijnolst (2003) formulated a set of nine groups of performance indicators which he deemed to be crucial for the benchmarking of maritime clusters.

- 1) Structural indicators
- 2) Economic indicators
- 3) Internationalization
- 4) Critical mass and leader firms
- 5) Level playing field
- 6) Innovation

7) Institutional framework and business networks

8) Labor market and education

9) Image and communication

1) Structural indicators:

Structural indicators of a maritime cluster include the number of maritime sectors it is comprised of, as well as the type of these sectors, the balance between its demand pull and supply push sectors and, the clusters geographical concentration.

A cluster's strength and the potential that is created for innovation and synergies are directly dependent on the number of sectors the cluster is comprised of. Completeness greatly adds to the strength and value of the maritime cluster.

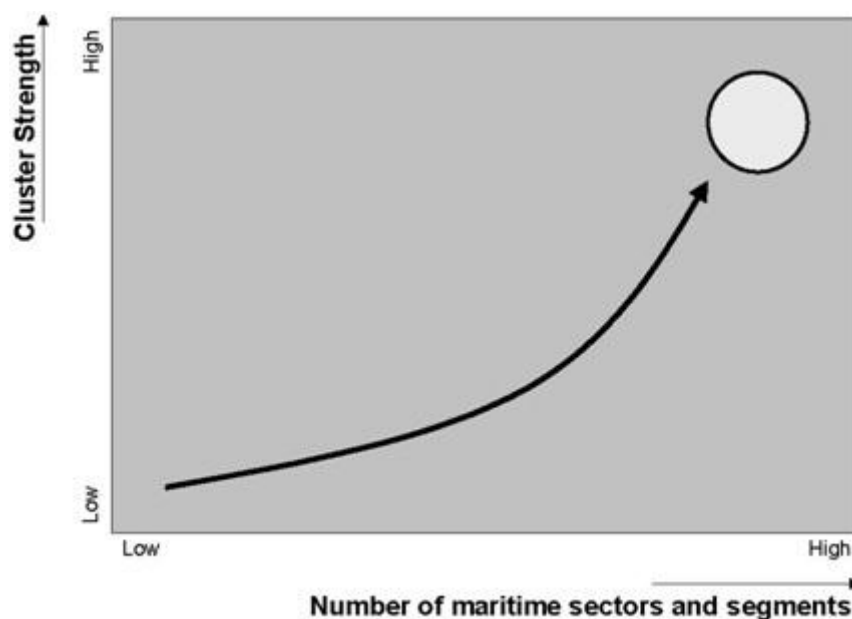


Figure 3: Cluster strength with relation to cluster sectors

Source: Wijnolst 2003

Not all the sectors of the cluster carry the same importance. Demand drivers such as the shipping sector, or the naval forces who make new investments in

equipment and services can determine the cluster dynamics in a far greater degree than the supply sectors of the cluster like maritime services and shipbuilding. Thus the strength of the cluster is greater, and it's long term prospects better when the cluster is complete, but lacking completeness, the demand pull sectors are of greater importance for the future viability of the cluster than the supply push sectors, which would depend on foreign customers to generate sales.

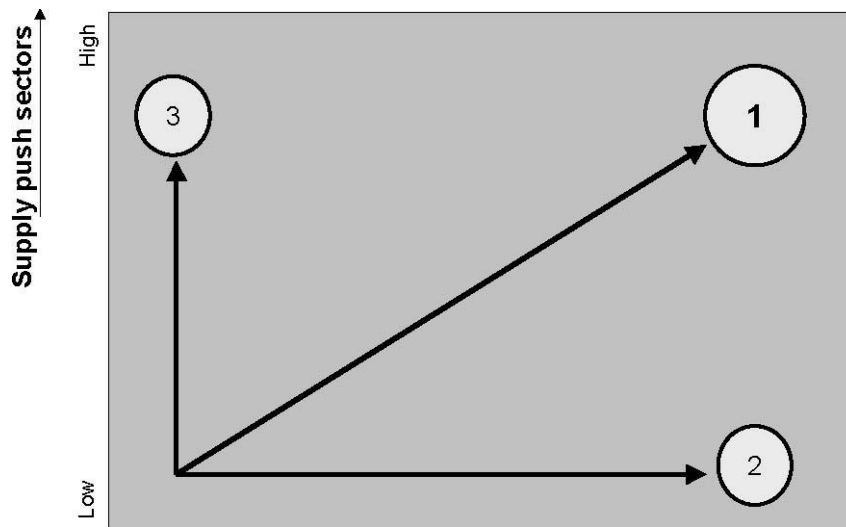


Figure 4: Cluster strength with relation to supply and demand sectors

Source: *Wijnolst 2003*

The geographical concentration of the cluster and its sectors is also an important aspect as it can affect the interaction between the various sectors of the cluster as well as the synergies and agglomeration that can be achieved between cluster participants. If the distances are high cluster participants cannot achieve substantial agglomeration benefits and interaction becomes more difficult thus diminishing some of the effects of the cluster

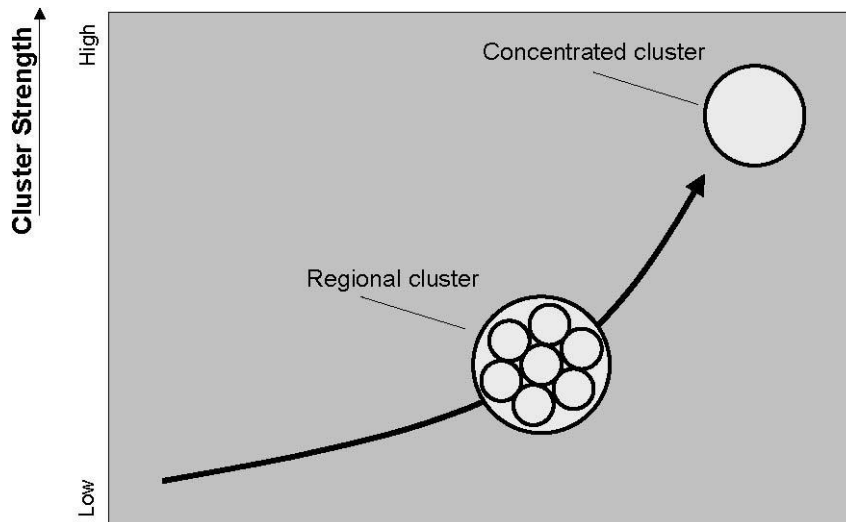


Figure 5: Cluster strength with relation to geographical concentration

Source: Wijnolst 2003

2) Economic indicators

Economic performance indicators used for describing the economic impact of the maritime cluster are value creation of the cluster as direct and indirect value added, the cluster's value creation share in GNP, the clusters growth rate, cluster employment, the cluster's export quote and share of the balance of payments, domestic investment as well as foreign direct investment. Important performance indicators are the demand-supply relationship between the (maritime) sectors as these express the interrelatedness, and the multiplier of each sector in relation to the other sectors and the economy as a whole. The higher, the stronger the cluster counts for all these indicators.

	Economic performance indicators
1	Direct value added
2	Indirect value added
3	Share in GNP
4	Growth rate

5	Multiplier (within cluster and national)
6	Employment
7	Export and balance of payments
8	Domestic investment
9	Foreign direct investment

Table 3: Cluster Economic Performance Indicators

Table 3: Cluster Economic Performance Indicators

Source: Wijnolst (2003)

Direct value added is the sum of the profit generated by the maritime cluster, the total personnel expenditure (wages and social security) plus the cost of depreciation of the clusters capital.

The maritime clusters total expenditure of supplies and services within the country, excluding the cost of imports is the indirect value added.

The ratio of the indirect value added to the direct value added is the multiplier.

Gross National Product (GNP) is the value of all the goods and services produced by labor and capital of a country's residents, and is supposed to reflect the average income of a country's citizens.

Growth rate is used to describe the growth of the maritime cluster's revenue over a period of time, usually per annum.

A county's balance of payments is comprised of two elements: the current account and the capital account. The current account shows the sum of the

balance of trade, factor income and cash transfers and the capital account shows a country's ownership of foreign assets.

Domestic investment of the maritime cluster is the sum of the expenditures by cluster participants in machinery, tools, and facilities and is an indicator of the future productive capacity of the cluster. It includes replacement purchases as well as net additions to capital assets plus investments in inventories and is usually calculated as a percentage of GDP.

Foreign direct investment refers to long term investment in the cluster by foreign capital. This could involve opening of foreign-owned businesses within the cluster, joint-ventures with cluster participants, participation in management, transfer of technology and expertise through licensing.

3) Internationalization

A maritime cluster's ability to generate exports is an indication that the cluster participants are international or global competitors. A high export quote however can only be achieved through innovation. For the long term maintenance of a strong export position against low cost economies such as Far East economies, a high level of internationalization and foreign production is essential. Therefore internationalization and foreign investment is an important indicator of the maritime cluster's dynamic in the future.

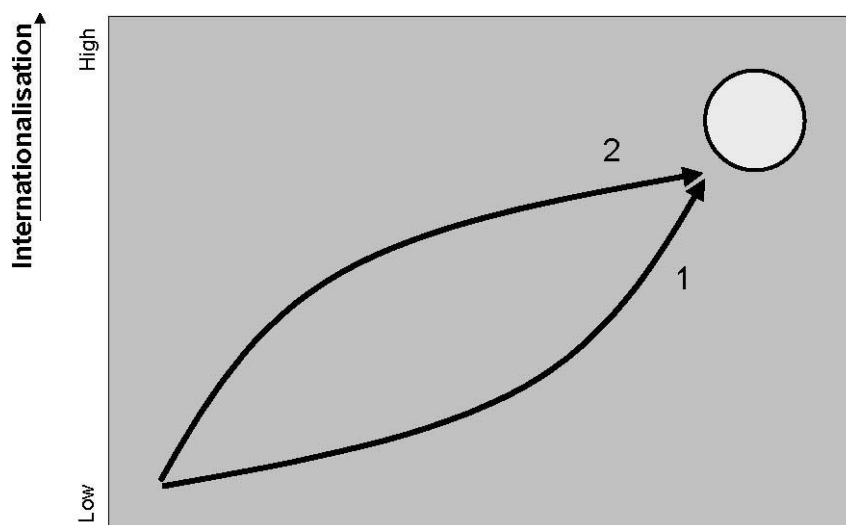


Figure 6: Cluster strength with relation to exports and internationalization

Source: Wijnolst 2003

4) Critical mass and leader firms

Companies that are market leaders in their segments, in terms of production and added value and have the necessary capital for research and development which can result in innovation are important for the dynamic of the cluster. When leader firms reach the critical mass necessary to sustain growth, they can upgrade the cluster as a whole as they will push other cluster participants to modernize, innovate and export. Leader firms, which can be the result of integration, mergers or takeovers can achieve greater economies of scale through increased production and operational efficiency and also increased diversification, and can more easily compete against foreign multinational companies. The number of leader firms within a country's maritime cluster is in direct relation with the cluster's strength.

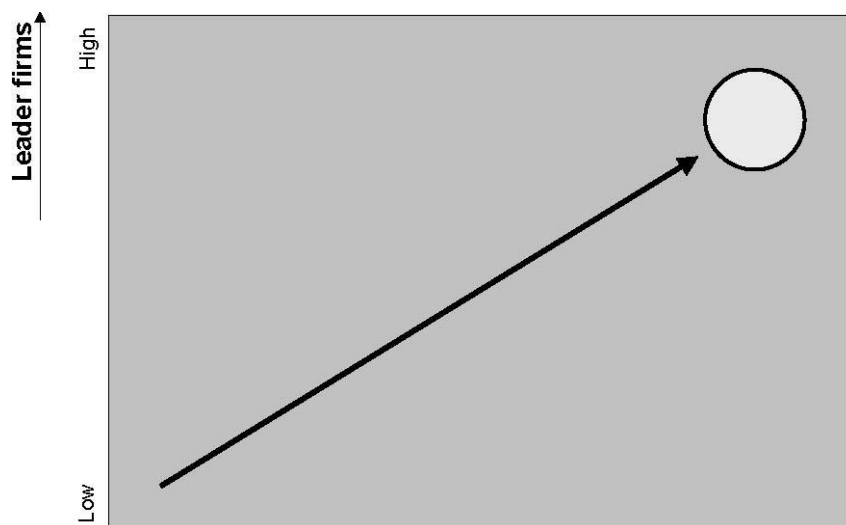


Figure 7: Cluster strength with relation to critical mass and leader firms

Source: Wijnolst 2003

5) Level playing field

Government policy to create a level playing field for all the firms can result in greater investments and innovation by the cluster participants. The absence of a level playing field, subsidization, increased regulation and the lack of real

competition will ultimately result in distortion and weakening and ultimate perish of the market. Protectionism has the usual result of decreased investments, lack of upgrading and innovation and will render the firms uncompetitive on the international level and decreased exports. It will further weaken the industry as many companies will seek to relocate. In this respect the cluster's strength is in direct relation to the existence of a level playing field.

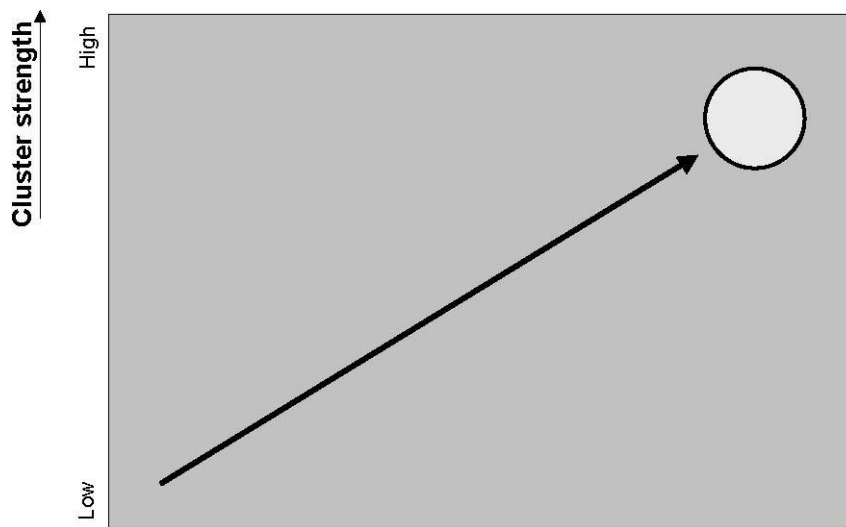


Figure 8: Cluster strength with relation to level playing field

Source: *Wijnolst 2003*

6) Innovation

The marine equipment sector of the maritime cluster is very important for the innovative forces of the cluster, as it is the sector which is most involved in research and development of new products within the cluster, but also communicates, adapts and diffuses new information and processes between the other cluster participants therefore acting as a crucial intermediary. Research and development of new and innovative products is translated in increased sales both domestic and foreign, which in turn produce the necessary profits to allow for further innovation. As it is easily understood innovation by the cluster participants strengthens the whole cluster.

The drivers behind cluster innovation are usually the leader firms, which should therefore be the focus of government R&D policies.

Innovation can be the result of two different paths. Most governments try to influence cluster firms to research and development-led innovation which will in turn leads to sales and increased exports. This however necessitates investments in infrastructure, education which are seldom available. Traditionally, it is increased exports will lead to demand for innovation.

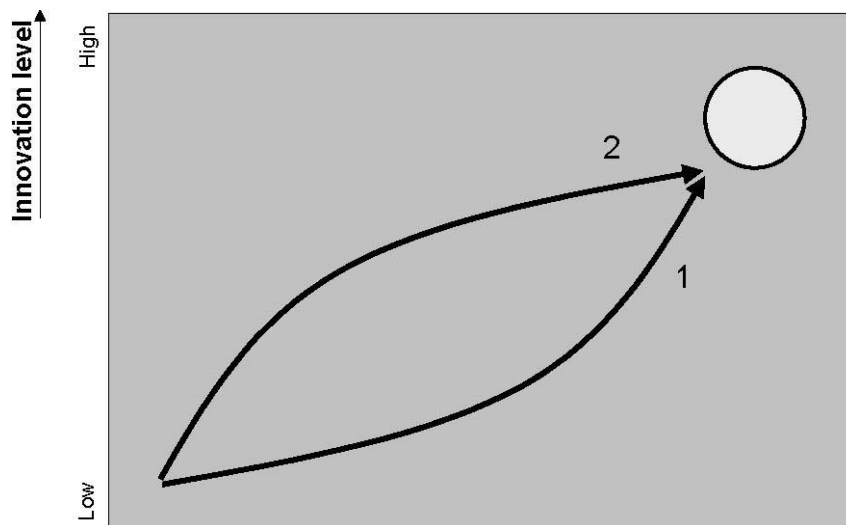


Figure 9: Cluster strength with relation to innovation and exports

Source: Wijnolst (2003)

7) Institutional framework and business networks

The strength of the maritime cluster is directly related to the number of cluster participants, as well as their quality. Furthermore the various trade associations and their interrelation with the cluster organization, their interaction with the government and the policymakers also play an important role to the cluster's position and strength. The policies that are put in place regarding the promotion of entrepreneurship, the attraction of foreign investment, the stimulation of innovation and exports, are dependent on the influence of the trade associations and the maritime cluster on the government, which intern must be committed to a progressive industrial policy and ensure a level playing field that supports the maritime cluster.

8) Labor market and education

The attraction of talented people to a maritime career increases the strength of the cluster. Most sectors of the maritime cluster require similarly educated and trained personnel. This increases employment opportunities and makes the choice of a maritime career an attractive proposition

A high quality and specialized maritime education which can only be achieved through investments in educational infrastructure will help to promote the innovativeness of the maritime cluster and maintain its high level.

9) Image and communication

The cluster's positive image and constant communication with its participants, the maritime trade associations and government in order to maintain its dynamic. Furthermore the advertisement of the clusters strength and dynamism to the public will help upgrade the status of a maritime career and serve to attract the best talent to the maritime industry.

As is quite evident the indicators groups that were formulated by Wijnolst cover a big area of the maritime cluster activities, they are however mostly qualitative in nature and not easily measurable. This fact, combined with the relative lack of concrete statistical data available for most maritime clusters makes the task of gauging a maritime clusters competitiveness and strength a very difficult task.

6.2 European Cluster Observatory

The European cluster observatory initiative is using a common set of cluster indicators to gauge all the clusters in the European Union. Out of this set of indicators 7 are cluster specific indicators and 10 are region specific indicators

Cluster Specific Indicators

1) Cluster Employees

This indicator represents the total number of employees who are working in a particular cluster in a specific region and serves to show the clusters strength.

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2) Cluster employee growth

This indicator represents the growth of employment in a particular cluster in a specific region as the compound annual growth rate calculated over the period of the last three years for which statistical data is available, and serves to be a measure of cluster growth.

3) Cluster employees per firm

This indicator represents the average number of employees per cluster firm as a ratio of cluster employees to cluster firms, and serves to be a measure of cluster strength.

4) Cluster Firms

This indicator represents the number of cluster firms in a region in a specific cluster and serves to be a measure of cluster strength.

5) Firm growth

This indicator represents the growth of the number of firms in a particular cluster in a specific region as the compound annual growth rate calculated over the period of the last three years for which statistical data is available, and serves as a measure of cluster growth.

6) Cluster employee wages

This indicator represents the average wages of cluster employees in a particular cluster, and serves as an indicator of the clusters strength and competitiveness.

7) Stars

This indicator represents the clusters capacity for spillovers, based in the perceived amount of specialized knowledge available within the cluster. The knowledge available is dependent on the clusters size, specialization and the regional focus on the specific cluster. A cluster's ability to generate positive spill-overs and linkages between its members is thus judged upon these three factors.

Each cluster is assigned with zero, one, two or three stars depending on the criteria that it meets .

- Size:

When the cluster is in the top 10 percent of all the European clusters in the same category with regards to the number of the cluster employees, then it receives a star. It is argued that when a clusters employment is a sufficiently large share of total European employment in the same sector, this signifies that the cluster also presents significant economic effects to the region.

- Specialization (Location Quotient):

When a certain region's cluster is more specialized than competing clusters in other regions, firms and labor will be attracted to the cluster, thus strengthening the cluster's capacity for increased spill-overs and linkages between its members.

Specialization is measured by comparing the proportion of a cluster's employment within a region over the total regional, to the proportion of the employment of all similar European clusters, over total European employment. When a cluster receives a specialization quotient of two or more it receives a star.

- Focus:

It is argued that when the employment that is generated by a cluster is a significant portion of total regional employment, spill-overs and linkages are more likely to appear. Therefore this is an indicator of the regional economy's focus on the specific type of industry which is included in the cluster, and is measured the proportion of cluster employment over regional employment. A star is awarded to the top 10% of clusters with the largest proportion of employment in their region.

According to the Observatory's policy no stars are awarded to clusters employing less than 1,000 persons in order to avoid small insignificant clusters.

The Region Specific Indicators that are employed by the European Cluster Observatory are:

1)RIS

RIS, which stands for Regional Innovation Scoreboard is a measure of regional innovativeness and depends on the educational level of the workforce, the number of high tech sectors in the region, the patents that are registered in the region and the degree of lifelong re-education

2) Region Population

This indicator represents the number of people living in a region.

3) Regional population density

This indicator represents the number of people/ per square kilometer living in a region.

4) Gross Domestic Product (GDP) per capita

This indicator represents the gross domestic product that is produced per every person in a region

5) Growth of Gross Domestic Product (GDP) per capita

This indicator represents the growth of the gross domestic product per person in a specific region as the compound annual growth rate calculated over the period of the last three years for which statistical data is available, and serves to be a measure of cluster growth.

6) Rate of Employment

This indicator represents the growth of share of the employed people over the total workforce in the region

7) Share of part-time employment

This indicator represents the share of part-time employment in the region over total regional employment

8) Private Research and Development as a share of GDP

This indicator represents the amount of capital spent by private businesses for Research and Development as a percentage of the total Gross Domestic Product (GDP) in a region

9) Public Research and Development share of GDP

This indicator represents the amount of capital spent by public companies or the government for Research and Development as a percentage of the total Gross Domestic Product (GDP) in a region.

10) Internet use

This indicator represents the percentage of people who use the internet to order goods or services over the total population.

6.3. Proposed indicators for maritime clusters

1) Cluster organization

As has been evidenced before through the various studies on maritime clusters, the role of the maritime cluster organization is multifaceted:

The first and foremost role of a maritime cluster organization or association is to assess and convey the maritime cluster's economic significance to the government and the general public. As it has been evidenced by the various researches on maritime clusters that were conducted in Europe in the past decade, simply understanding the extent of the various sectors of the cluster and accurately mapping their interconnections and synergies and assessing the whole clusters economic activity and impact on national economy can be a very daunting task due to the great extent of the cluster, which encompasses a wide array of activities. This can be further evidenced by the fact that most national governments rely on national statistical data on the direct income from the shipping sector alone when they are referring to the economic impact of maritime clusters and that the only national statistics on maritime labor readily available, are the ones on mariners at sea and sometimes shipbuilding and fisheries. Thus the labor employed in land based maritime professions, such as shipping, maritime equipment, maritime services is largely ignored. As a result the complete economic impact of the maritime cluster on local economy has not been measured and cannot be easily recognized. As national statistical agencies usually cannot afford the time and expense required for collecting and analyzing the necessary data, this important task falls upon the cluster organization which must identify the sectors of the cluster and their boundaries, understand and monitor their inter-relations, gather specialized statistical data about the cluster regarding quantitative as much as qualitative parameters, and finally assess the clusters complete economic impact.

Another equally important role of the maritime cluster organization is in enhancing cluster competitiveness. The maritime cluster organization

institutionalizes the linkages between its members and provides a neutral forum where the common obstacles, inefficiencies and constraints faced by the members can be identified, and their needs and opportunities can be assessed. Furthermore the cluster organization can act as a focal point to address these identified issues of its members by interfacing with the local or national government, by proposing regulatory changes and reforms, by interacting with educational or national institutions for the creation of new training programs, by organizing national or international trade fairs or even by cooperating with universities for the creation of new research and testing facilities.

One very important aspect is that the maritime cluster organization by representing all or at least most of the cluster sectors and participants can achieve far greater influence and command far greater attention when interacting with the government and the policymakers than can be achieved by individual members or some maritime sector associations, therefore achieving greater impact and influencing progressive future policies, which can add to the maritime cluster's competitiveness and strength.

Therefore the existence of a cluster organization, association or collective body that represents all the maritime cluster sectors and participants can be considered to be a substantial indicator of the maritime clusters strength and competitiveness.

2) Gathering of concrete statistical data

All the research that has been conducted over the years on maritime clusters, both by regional cluster organizations and national governments as well as the European Union, have clearly established the vital importance of accurate statistical data that are needed for understanding the qualitative characteristics of maritime clusters, understanding their inner workings assessing their economic effects and benchmarking them.

The maritime clusters, due to their various sectors, some of which are quite different in size, orientation and nature are inherently difficult to define. Their

size, their interrelation, their specialization, their innovative capacity, their interactions with various institutions, their economic impact both direct and indirect, and their effect on exports and labor markets cannot be quantified and accurately assessed without the existence of specialized data on the cluster.

The data which are necessary to understand these inner workings of the maritime cluster are not readily available and can only be gathered by an in-depth analysis of the cluster. Some of these necessary data, which include proprietary information and strategic company secrets of the cluster participants such as R&D expenditure, labor costs, labor re-education expenses, investment data or data on strategic partnerships, economic relations with other cluster participants, foreign investments and capitals spent for internationalization, due to their nature could only be collected by the maritime cluster organization, based on mutual trust, which would guarantee anonymity and proper use of this data.

This statistical data can then be used both by the cluster and the government to gauge cluster trends and accurately design future cluster policies or create specific initiatives aimed towards the promotion of innovation, inter cluster synergies, increase of productivity and creation of high added value products and services

This statistical data would have to be gathered on a continuous and regular basis, in order to provide perspective on the cluster, and its development and be of any particular relevance in designing future cluster policies which would create competitive advantages and strengthen the cluster. In this respect the creation of a mechanism to routinely gather meaningful and informative statistical data on the maritime cluster by a cluster organization can be considered an indicator of forward thinking and future cluster strength.

3) Cluster Communication

The communication of the maritime cluster's existence, economic significance, innovative capacity and business opportunities are an important role of the cluster organization. The clusters public image can be responsible

for attracting new customers for the cluster, creating new business for the cluster participants, attracting new talent to the cluster, attracting considerable Foreign Investment and generally strengthening the cluster.

3a) Maritime Cluster website.

In this new age of information where everything is available at the click of a mouse, it is imperative for maritime clusters to be well represented on the internet.

A dedicated maritime cluster website that is always up to date with the maritime clusters information and relative issues, serves the purpose of indicating the cluster organizations existence. It can easily and inexpensively communicate the clusters various initiatives regarding education, trade, innovation and supported policies as well as proposed legislation, becoming a great advertising tool for the clusters efforts. It can also prove a significant means of providing cluster information to the market as well as the general public, and can greatly enhance the maritime clusters image.

Furthermore it can be a fast and inexpensive means to keep cluster members updated on current affairs and issues concerning the maritime cluster, as much as to inform them on the program and developments of the maritime cluster organization's initiatives.

A maritime cluster website can also be a great platform to promote the maritime profession, and serve to attract new talent.

For these reasons the existence of a maritime cluster's dedicated website is an indicator of the clusters competitiveness and strength.

3b) Complete list of Cluster Participants by maritime sector

A complete web based list of all the maritime cluster sectors and all the firms of each cluster sector can serve multiple purposes.

- Initially it can serve as tool to show the scale of the maritime cluster and further build the image of the cluster, and strengthen its influence to the government, the markets and to the public
- It can communicate and advertise all the individual cluster sectors, as well as all the individual cluster members and their products to the market, and serve to provide new business for the cluster in general.
- It can be used as a tool to promote co-operations and synergies between cluster participants, thus increasing the inter cluster business opportunities and contributing to the cluster growth.
- It can be used as a means to attract and better match available labor to specific cluster sectors and lower the costs of labor recruitment.

All these can add to the cluster competitiveness

3c) Maritime Cluster Initiatives to promote e-commerce.

E-commerce is fast becoming a vital part of maritime company's growth and sustainability in the market. E-commerce generates publicity for maritime companies and also serve to create a positive image. Furthermore electronic stores offer many advantages in comparison to traditional physical stores. They are open 24 hours a day, 365 days a year providing the potential clients of the firm with a constant and intuitive way of browsing through a company's catalogue of products or services, while requiring a very small budget in comparison to a physical store. Companies in maritime clusters greatly benefit by developing and maintaining up-to-date and comprehensive electronic stores, as they increase their revenues and client base with minimal effort, since most if not all of them already track their inventories with elaborate logistics systems, thus making the transition to a web-based store easy to implement and manage. Electronic stores are also a very efficient way of doing business, since the transactions take place immediately, most online stores support many different payment methods and the goods are shipped directly to the client without the need of an actual store front. The efficiency

and speed of service is perhaps of utmost importance, since business transactions take place faster and cheaper.

In this respect a maritime cluster organization's initiative to increase the clusters e-commerce can increase the business opportunities of the cluster members and provide competitive advantage for the maritime cluster.

4) Gauging the cluster's present and future strength

As has been established from various researches and studies the core of a maritime cluster and the source of its strength and prosperity is the shipping sector.

The shipping sector is the main creator of growth, export and added value for the maritime cluster. In the past the shipping sector also used to be the main provider of employment in the maritime cluster, as it provided employment to thousands of sailors, however from the current employment trends this may not be the case in the future, at least in a European level.

The shipping sector is also the main driver behind other significant sectors of the maritime cluster, such as the shipbuilding and the marine equipment as well as the maritime services sectors, such as ship broking, maritime financing, maritime insurance etc. These sectors rely almost solely on the shipping sector for their continued growth and prosperity, as the shipping sector is the main buyer of their services.

Therefore it is a logical conclusion that in order to gauge the strength of a maritime cluster, one has to attempt to gauge the strength of the cluster's shipping sector.

Some alternative indicators of a cluster's shipping sector strength in comparison to competing clusters are:

4a) Number of shipping firms active in the cluster

The number of active shipping firms (ship owners and ship-managers) in cluster can directly affect the additional business created for the clusters other

sectors. A large number of shipping firms active within a cluster, has the effect of more added value to the national economy, a bigger export quotient and of course larger potential for extra business for the shipbuilding sector, the marine equipment sector and the maritime services sector. Therefore the number of shipping firms of a maritime cluster is an indication of the cluster's strength and potential growth.

4b) Size of cluster fleet as a percentage of global DWT

The total size of a maritime clusters fleet is a direct indication of the clusters economic performance. A sizeable fleet generates greater turnover, profits and added value for the regional economy while providing employment for more people on board the vessels as well as in land based professions. The size of the fleet also determines the needs for additional services by the other sectors of the maritime cluster, creating more business for the cluster as a whole. In this respect it is evident that the maritime cluster will be stronger and more competitive when the size of the maritime cluster owned and operated fleet is larger.

4c) Number of vessels in cluster, with further provisions for size and age

A further indicator of the cluster shipping sectors strength is the total number of vessels owned and operated by the clusters shipping sector. A large number of vessels owned by the shipping sector can generate more business for the other sectors of the maritime cluster. Additional maritime services such as insurance, legal, shipbroking services are generated. More dry-dockings and repairs are required so additional business is generated for shipyards as well as marine equipment suppliers.

Larger vessels even though they command bigger initial investments can generate greater scale economies and are usually more profitable for their owners and therefore generate higher added value. In this respect it can be argued that a clusters fleet which is comprised of bigger vessels will have a higher profitability and generate higher added value to the cluster as a whole.

Furthermore a vessels age is an indication of its tradability, as newer vessels are able to navigate in areas where older vessels are not allowed to by

regulations, e.g. double hull tankers versus single hull tankers, or are not preferred by charterers (for instance oil majors). As a result a newer vessel's turnaround can be substantially higher than that of an older vessel of comparable size and type.

Therefore a compound indicator that takes into account these three parameters, the number of vessels owned by the clusters shipping sector, their size and their age can give a clear view of the clusters current and future strength and competitiveness.

5) Labor and education

The constant technological leaps evidenced in the last couple of decades especially in the information technologies have also affected the maritime business. These technological advances render old skills obsolete both on board ocean going vessels as well as in land based professions. Therefore the constant upgrading of the maritime educational system and the maritime cluster labor re-education is vital in order to maintain the maritime clusters competitive advantage. A high quality, specialized maritime education which can only be achieved through investments in educational infrastructure and research that can keep up to date with developments, will help to promote the innovativeness of the maritime cluster and maintain its high level and will also help to attract the most talented labor to the maritime profession.

5a) Maritime cluster investment on educational infrastructure and cluster employee training and life-long education.

Investment by the maritime cluster in the constant upgrading of the educational system and its facilities as well as the Research and Development laboratories of educational institutions can have a very positive effect in the amount of innovative technological solutions that are created within the cluster, as well as the creation and honing of new skills for the cluster labor and can provide a measurable and sustainable advantage for the maritime cluster members.

Furthermore the funding of the maritime cluster's labor continuous training and re-education in modern technologies helps to increase the cluster

productivity by making full use of all current technological solutions as well as increases the cluster's capacity for innovation. In this respect, the maritime cluster's investment on education can be an indicator of the clusters competitiveness and future innovative capacity.

5b) Maritime Cluster ties with Educational Institutions

The existence of formal, structured, ongoing initiatives to communicate the developing requirements and needs of the maritime cluster to educational institutions helps to continually update and upgrade the educational curriculum and plan new training programs for existing maritime cluster labor. This process results in a better educated, trained and more specialized labor for all the maritime sectors which will have greater capacity for innovation. In this respect the maritime clusters ongoing cooperation with relevant educational institutions can be an indicator of the clusters competitiveness and future innovative capacity .

6) Maritime Clusters environmental focus

The increasing public focus on the environment and the climatic change that has been evidenced in the last two decades has also affected the maritime cluster. Rules and regulations on marine and air pollution are constantly becoming more stringent and increasing amounts of investments are required to keep the maritime sector updated on these developments.

6a) Median age of clusters vessels

The median age of the vessels owned by the maritime cluster's shipping sector is directly related to the maritime clusters economic indicators. Older vessels which do not comply with updated or current regulations are not allowed to navigate freely the same waters that new vessels can as for instance was the case with single hull tankers in the last few years. Furthermore older vessels require extensive and expensive upgrading of their equipment in order to comply with regulations, as is the case with air-

conditioning systems due to the banning of certain CFCs, fire extinguishing systems due to the banning of halon, and the extensive upgrading of vessels propulsion and power generating systems that will be required by the ever stringent emissions regulations coming into effect worldwide. All these developments will have a direct effect in older vessels tradability and profitability in the future, and will greatly affect the maritime clusters turnover and profits. In this respect the median age of a maritime clusters vessel fleet can be an indicator of clusters future economic strength.

6b) CO2 emissions per ton-mile

The public focus on air pollution has already affected major industries such as the automobile industry and the power industry. Regulations on sulfur emissions from ocean going vessels have already been put in place in the last few years and lately there have been increasing demands for similar regulation of CO2 emissions from ocean going vessels. These future regulations could take the form of emission charges or an overall requirement for the lowering of emissions. In both cases the effect on shipping will be substantial and will likely affect the sea trade and the profits of the shipping sector which in turn will affect the maritime clusters turnover and profits. However the maritime cluster's fleet fuel efficiency will be the most deciding factor, as vessels with lower emissions per ton mile are less likely to be affected by future regulations, whereas energy absorbing vessels with greater CO2 emissions by ton mile (such as passenger ships or containerships) are more likely to be affected by future regulations

6c) Cluster investment in Eco-friendly R&D

Investment by a maritime cluster in Research and Development in Eco-friendly technology either conducted in house by cluster members or in associate Research Centers such as those operating in Educational Institutes has the effect of keeping the maritime cluster updated with developments in environmental issues, promotes experimentation with new technological solutions that are beneficial to the environment and aids innovation within the cluster. Furthermore a maritime cluster involved in eco-friendly R&D is more likely to be an early adopter of Eco-Friendly technologies that anticipate future

regulations and can provide competitive advantages for the cluster members and the cluster as a whole. As a result maritime cluster funding of Eco-Tech R&D is a indicator of the clusters future innovativeness and competitive advantage.

7. Benchmarking of Major Maritime Clusters

After the formulation of the proposed maritime cluster performance indicators, an extensive research was conducted in order to gather quantifiable data on all the available performance indicators for four major maritime clusters, the United Kingdom Maritime Cluster, the Dutch Maritime cluster, the Greek Maritime Cluster and the Singapore Maritime Cluster. The lack of available and verifiable data on some indicators led to their elimination from the final list of performance indicators in order to maintain the reliability of the result.

The final list of 14 performance indicators used for the benchmarking can be found in table 4.

Maritime Cluster Performance Indicators
Maritime Cluster Organization
Maritime Cluster Sectors
Maritime Cluster Shipping Companies
Maritime Cluster Fleet Global Share (DWT)
Maritime Cluster Fleet Size
Direct Added Value
Maritime Cluster Companies
Maritime Cluster Employment
Average Employment per Cluster Company
Maritime Cluster Statistical Data
Maritime Cluster Educational initiatives
Maritime Cluster Organization Website
Maritime Cluster Investment on Education
Maritime Cluster Share in GDP

Table 4: Benchmarking Performance Indicators

7.1. United Kingdom Maritime Cluster

The performance indicators for the United Kingdom Maritime Cluster can be found in table 5

Maritime Cluster Performance Indicators	United Kingdom
Maritime Cluster Organization	1
Maritime Cluster Sectors	9
Maritime Cluster Shipping Companies	130
Maritime Cluster Fleet Global Share (DWT)	3,87
Maritime Cluster Fleet Size	674
Direct Added Value	20,2
Maritime Cluster Companies	10000
Maritime Cluster Employment	253600
Average Employment per Cluster Company	25,3
Maritime Cluster Statistical Data	0,5
Maritime Cluster Educational initiatives	1
Maritime Cluster Organization Website	1
Maritime Cluster Investment on Education	0
Maritime Cluster Share in GDP	2,9

Table 5: United Kingdom Maritime Cluster Performance Indicators

Sources: Policy Research Corporation 2008, Clarksons 2006, Sea Vision UK 2010 Maritime UK 2010, British Shipowners Association 2010

7.2. The Dutch Maritime Cluster

The performance indicators for the Dutch Maritime Cluster can be found in table 6

Maritime Cluster Performance Indicators	Holland
Maritime Cluster Organization	1
Maritime Cluster Sectors	10
Maritime Cluster Shipping Companies	144
Maritime Cluster Fleet Global Share (DWT)	0,78
Maritime Cluster Fleet Size	545
Direct Added Value	10,3
Maritime Cluster Companies	11500
Maritime Cluster Employment	133250
Average Employment per Cluster Company	11,58
Maritime Cluster Statistical Data	1
Maritime Cluster Educational initiatives	1
Maritime Cluster Organization Website	1
Maritime Cluster Investment on Education	0
Maritime Cluster Share in GDP	3

Table 6: Dutch Maritime Cluster Performance Indicators

Sources: *Wijnolst 2003, Clarksons 2006, ISL 2002, Holland Trade 2010, Dutch Maritime Network 2010*

7.3. The Greek Maritime Cluster

The performance indicators for the Greek Maritime Cluster can be found in table 7.

Maritime Cluster Performance Indicators	Greece
Maritime Cluster Organization	0
Maritime Cluster Sectors	7
Maritime Cluster Shipping Companies	907
Maritime Cluster Fleet Global Share (DWT)	17,68
Maritime Cluster Fleet Size	3.996
Direct Added Value	3,4
Maritime Cluster Companies	3337
Maritime Cluster Employment	76000
Average Employment per Cluster Company	23
Maritime Cluster Statistical Data	0,5
Maritime Cluster Educational initiatives	1
Maritime Cluster Organization Website	0
Maritime Cluster Investment on Education	0
Maritime Cluster Share in GDP	6,9

Table 7: Greek Maritime Cluster Performance Indicators

Sources: Policy Research 2008, Clarksons 2006, Hellenic Chamber of Shipping 2010, Zagas and Lyridis 2009, European Commission 2008

7.4. Singapore Maritime Cluster

The performance indicators for the Singapore Maritime Cluster can be found in table 8.

Maritime Cluster Performance Indicators	Singapore
Maritime Cluster Organization	1
Maritime Cluster Sectors	5
Maritime Cluster Shipping Companies	145
Maritime Cluster Fleet Global Share (DWT)	4,27
Maritime Cluster Fleet Size	790
Direct Added Value	10,3
Maritime Cluster Companies	5000
Maritime Cluster Employment	96000
Average Employment per Cluster Company	30
Maritime Cluster Statistical Data	0,5
Maritime Cluster Educational initiatives	1
Maritime Cluster Organization Website	1
Maritime Cluster Investment on Education	1
Maritime Cluster Share in GDP	7

Table 8: Singapore Maritime Cluster Performance Indicators

Sources: *Maritime and Port Authority of Singapore (MPA) 2010, Clarksons 2006, Kuchiki 2009*

7.5. Comparison

A comparison of the maritime cluster performance indicators can be seen in table 9.

Maritime Cluster Performance Indicators	United Kingdom	Holland	Greece	Singapore
Maritime Cluster Organization	1	1	0	1
Maritime Cluster Sectors	9	10	7	5
Maritime Cluster Shipping Companies	130	144	907	145
Maritime Cluster Fleet Global Share (DWT)	3,87	0,78	17,68	4,27
Maritime Cluster Fleet Size	674	545	3.996	790
Direct Added Value	20,2	10,3	3,4	10,3
Maritime Cluster Companies	10000	11500	3337	5000
Maritime Cluster Employment	253600	133250	76000	96000
Average Employment per Cluster Company	25,3	11,58	23	30
Maritime Cluster Statistical Data	0,5	1	0,5	0,5
Maritime Cluster Educational initiatives	1	1	1	1
Maritime Cluster Organization Website	1	1	0	1
Maritime Cluster Investment on Education	0	0	0	1
Maritime Cluster Share in GDP	2,9	3	6,9	7

Table 9: Major Maritime Cluster Performance Indicators

Sources: Policy Research Corporation 2008, Clarksons 2006, Sea Vision UK 2010 Maritime UK 2010, British Shipowners Association 2010, Wijnolst 2003, ISL 2002, Holland Trade 2010, Dutch Maritime Network 2010, Hellenic Chamber of Shipping 2010, Zagas and Lyridis 2009, European Commission 2008, Maritime and Port Authority of Singapore (MPA) 2010, Kuchiki 2009

A graphical comparison of the performance indicators of the four Maritime Clusters is shown in Figures 10 -23

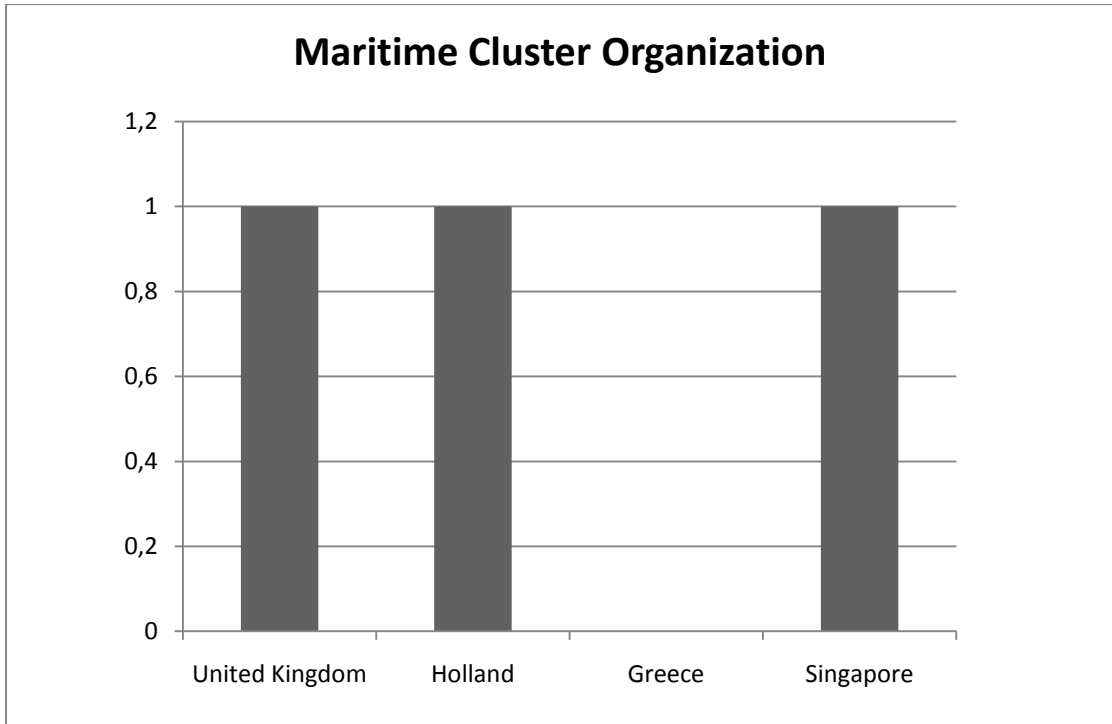


Figure 10: Performance Indicator 1: Maritime cluster Organization

Sources: *Maritime UK 2010, Dutch Maritime Network 2010, MPA 2010*

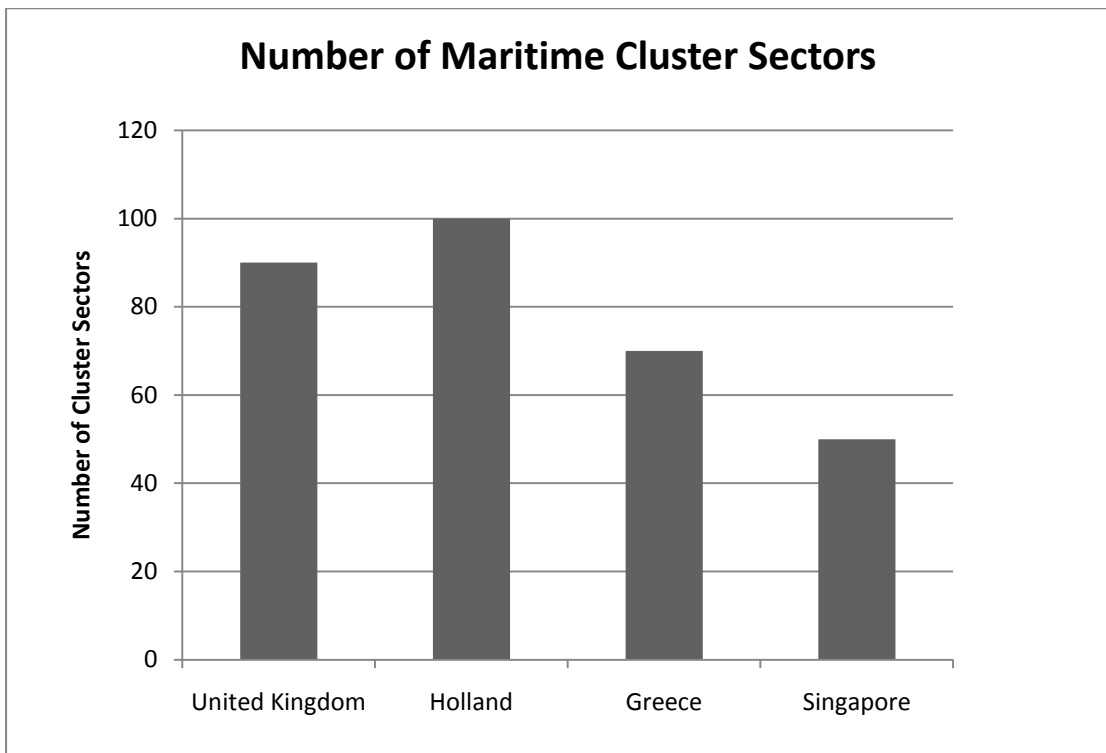


Figure 11: Performance Indicator 2: Maritime Cluster Sectors

Sources: *Maritime UK 2010, Dutch Maritime Network 2010, MPA 2010*

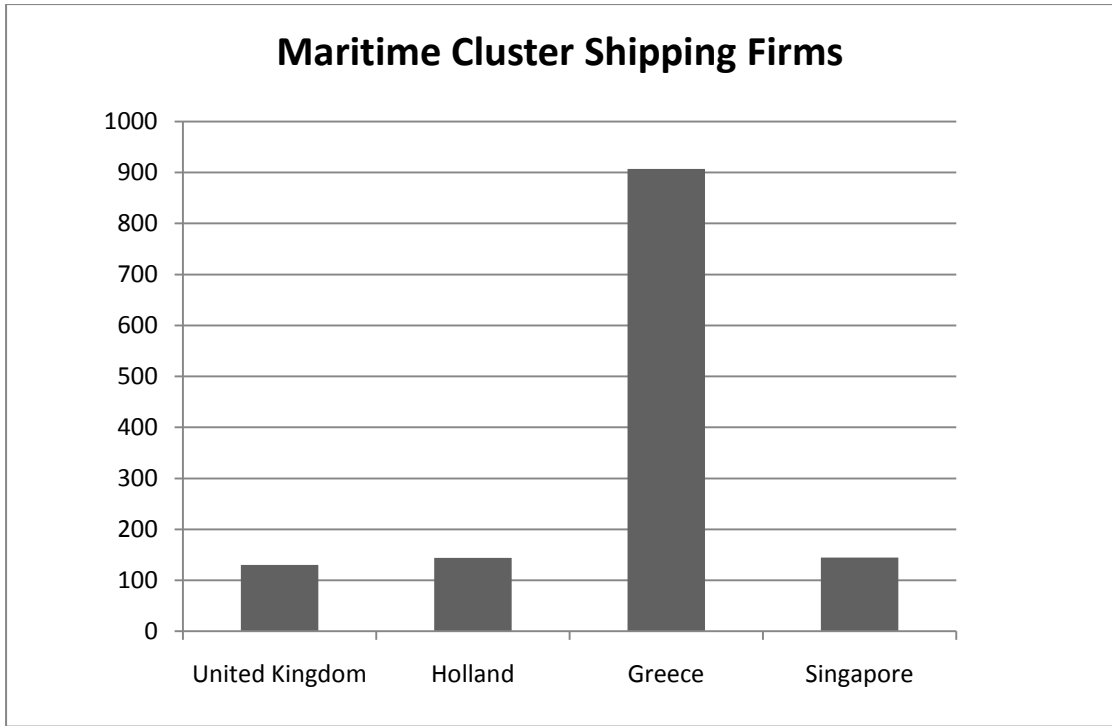


Figure 12: Performance Indicator 3: Shipping Firms active in the Maritime Cluster

Sources: *British Shipowners Association 2010, Zagas and Lyridis 2009, Singapore Shipowners Association 2010, Wijnotst 2003*

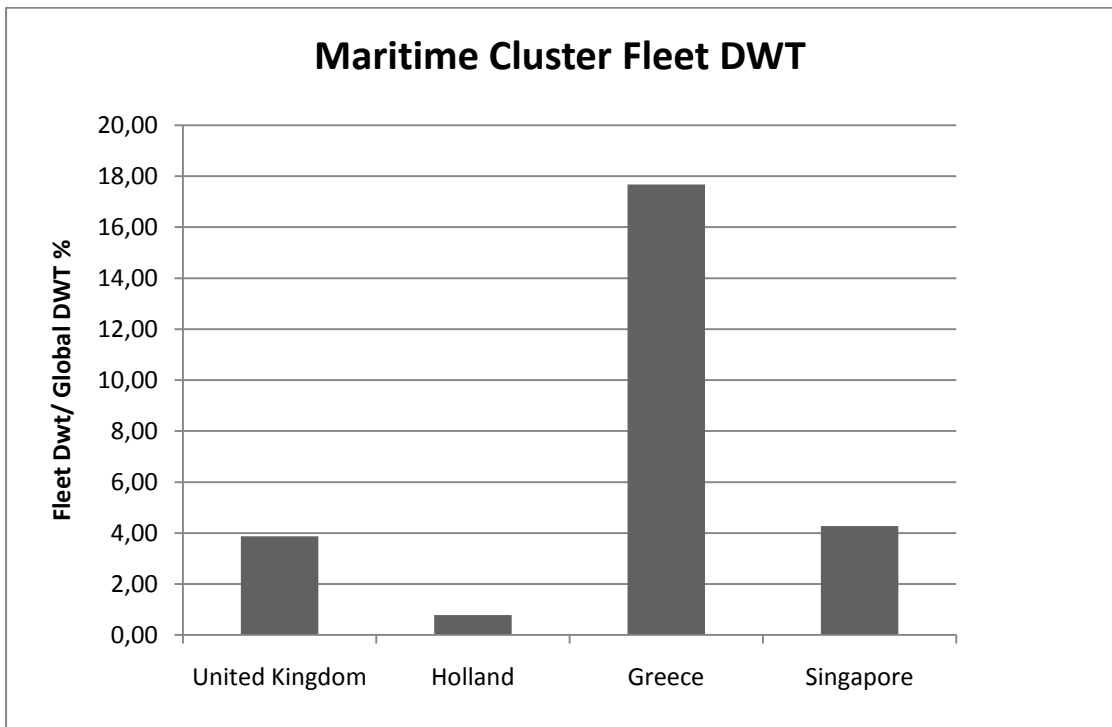


Figure 13: Performance Indicator 4: Cluster Fleet as percentage of global DWT

Sources: *Clarksons 2006, ISL 2002*

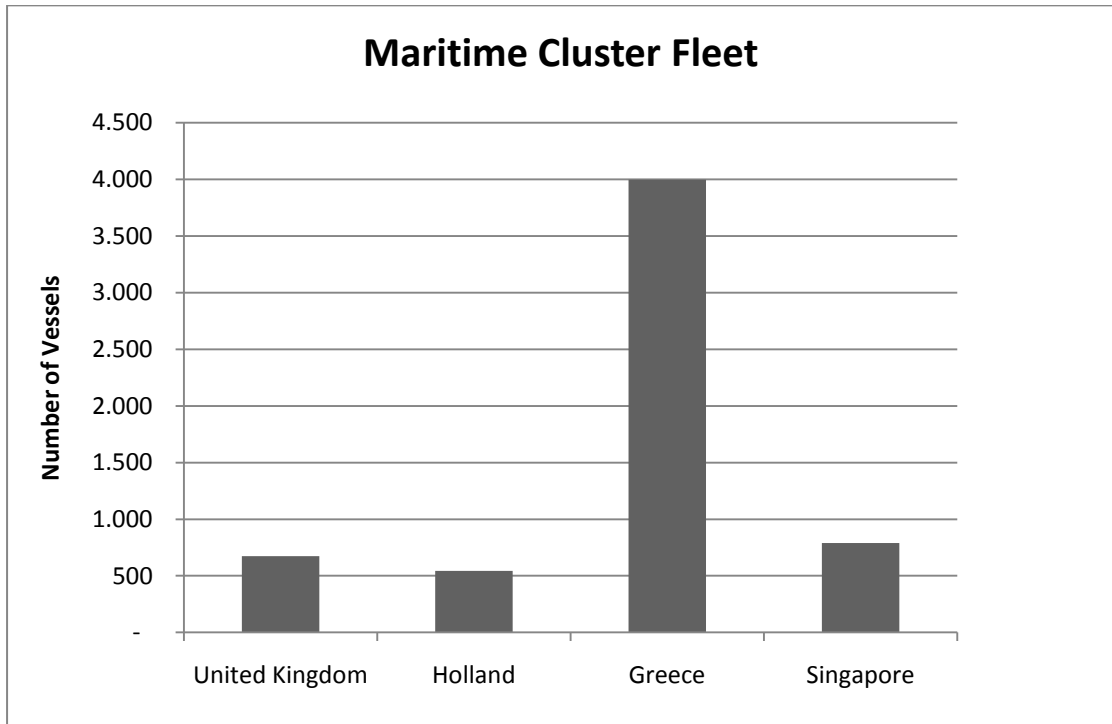


Figure 14: Performance Indicator 5: Cluster Fleet in number of Vessels

Sources: *Clarksons 2006, Hellenic Chamber of Shipping 2010*

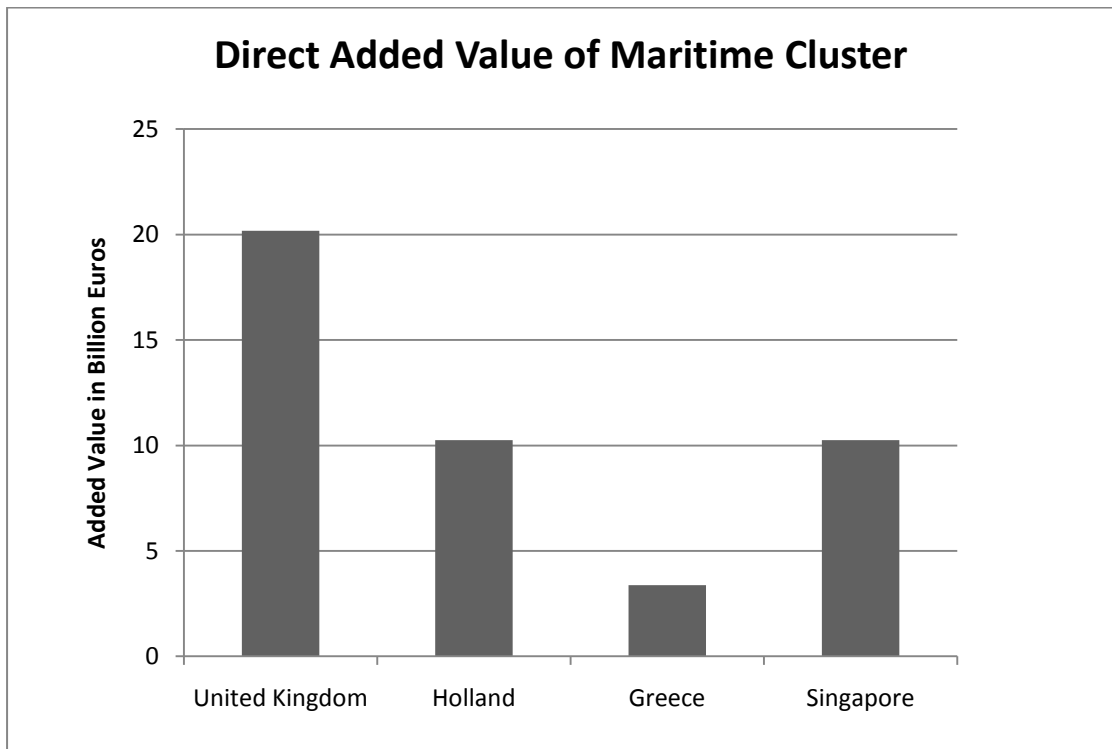


Figure 15: Performance Indicator 6: Direct added Value of the Maritime Cluster in billions of Euro

Sources: Policy Research Corporation 2008, Holland Trade 2010, Kuchiki 2009

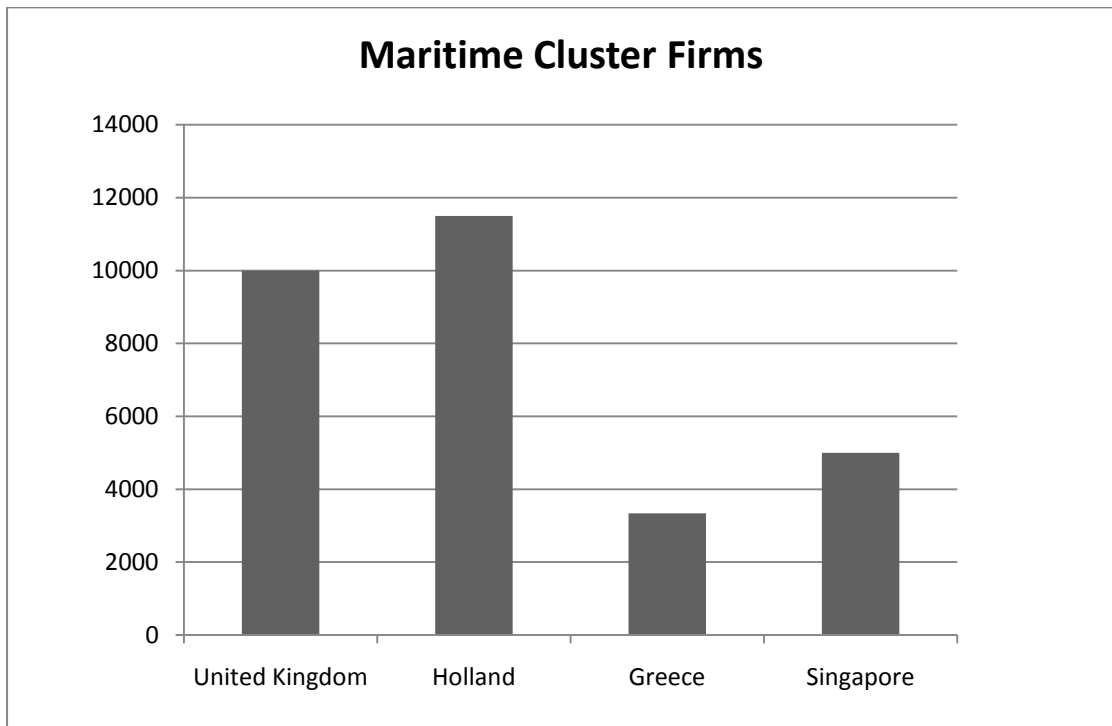


Figure 16: Performance Indicator 7: Maritime Cluster Firms

Sources: Holland Trade 2010, Zagas and Lyridis 2009, MPA 2010

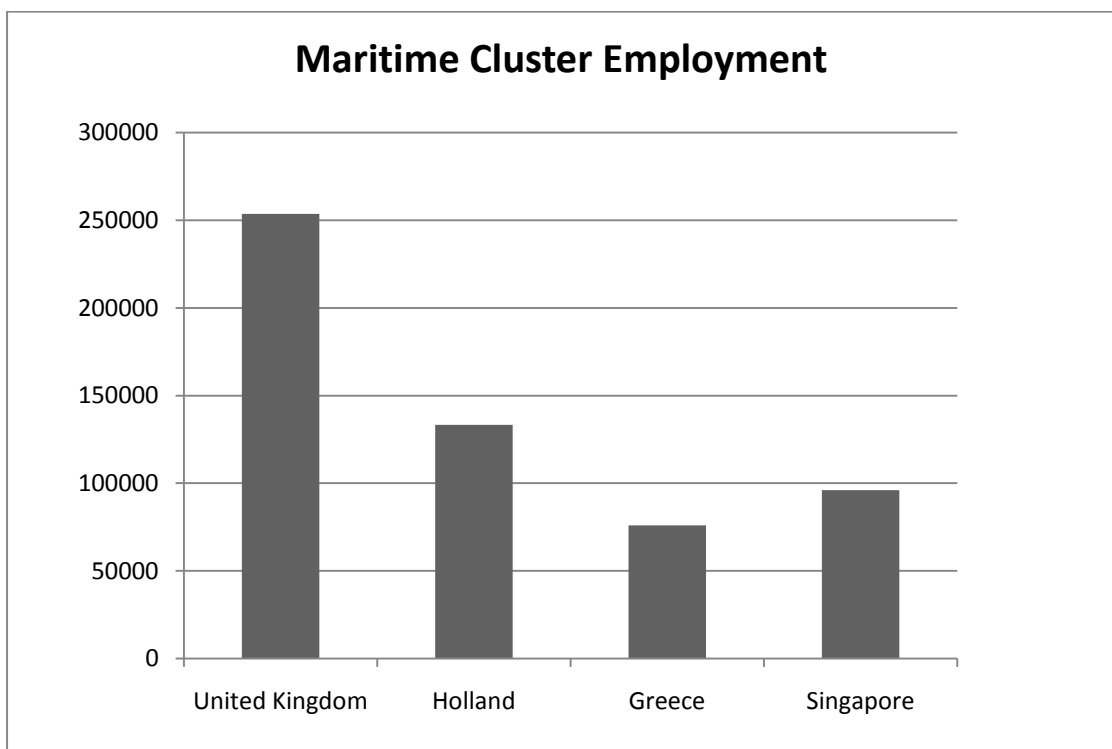


Figure 17: Performance Indicator 8: Maritime Cluster Employment

Sources: Policy Research Corporation 2008, Holland Trade 2010, MPA 2010

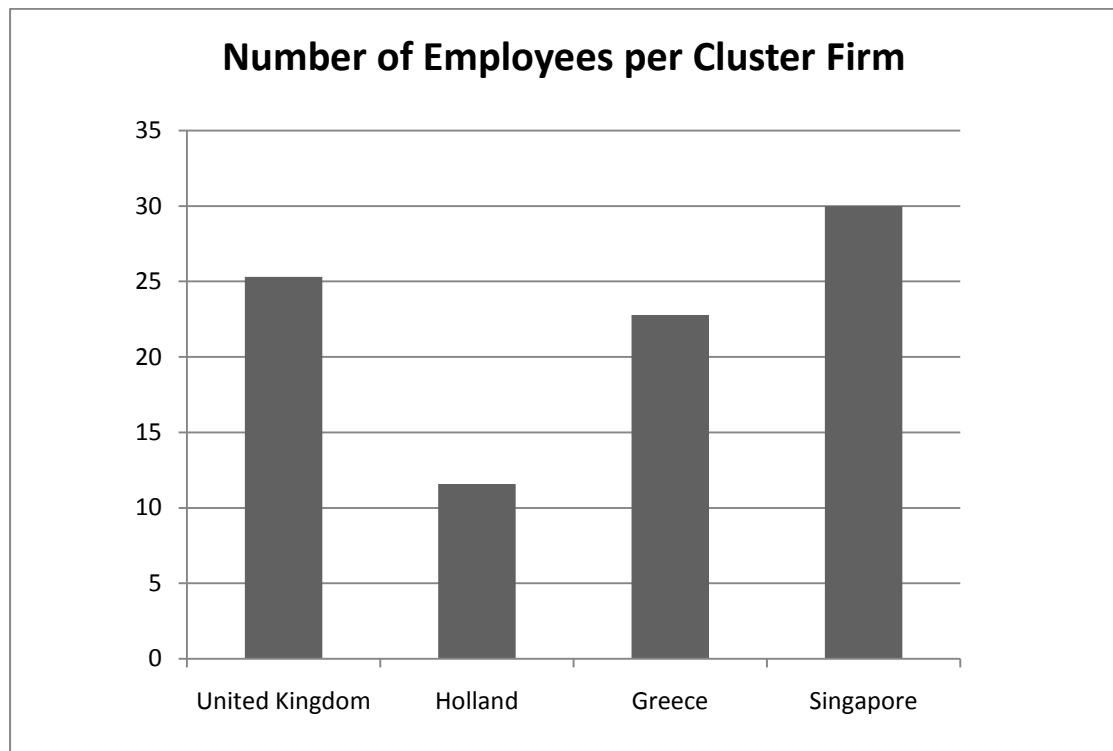


Figure 18: Performance Indicator 9: Average Maritime Firm Employment

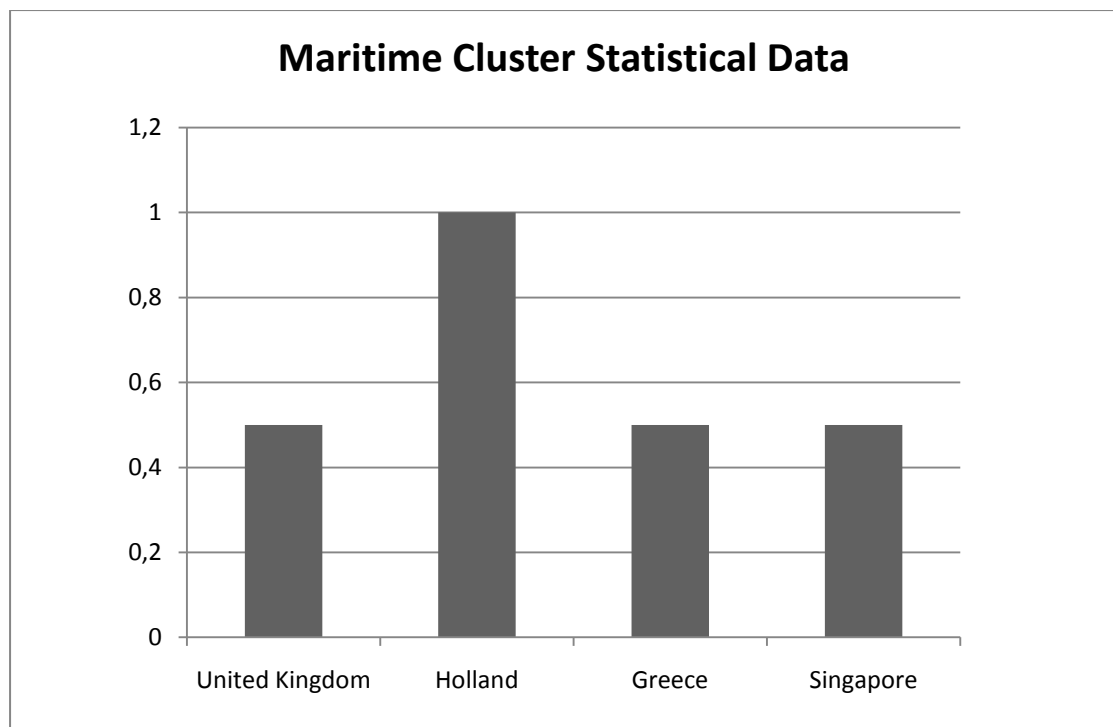


Figure 19: Performance Indicator 10: Maritime Cluster Statistical Data

Sources: Maritime UK 2010, British Shipowners Association 2010, Dutch Maritime Network 2010, Holland Trade 2010, Hellenic Chamber of Shipping 2010, MPA 2010

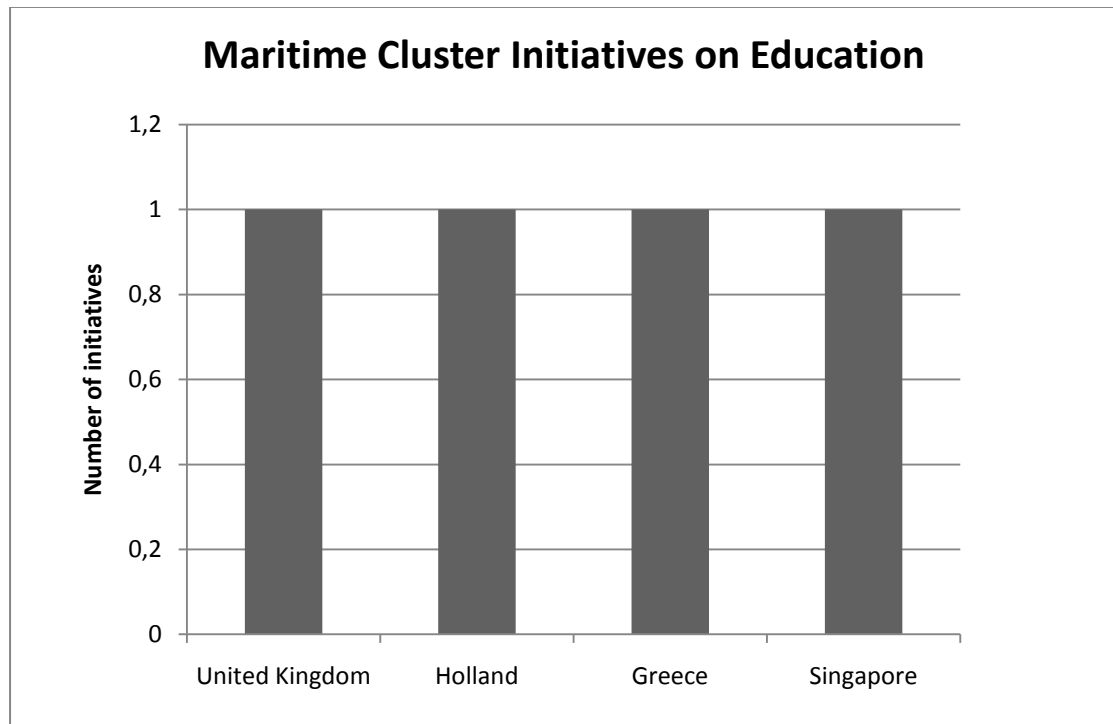


Figure 20: Performance Indicator 11: Maritime Cluster initiatives on Education

Sources: Maritime UK 2010, British Shipowners Association 2010, Dutch Maritime Network 2010, Holland Trade 2010, Hellenic Chamber of Shipping 2010, MPA 2010

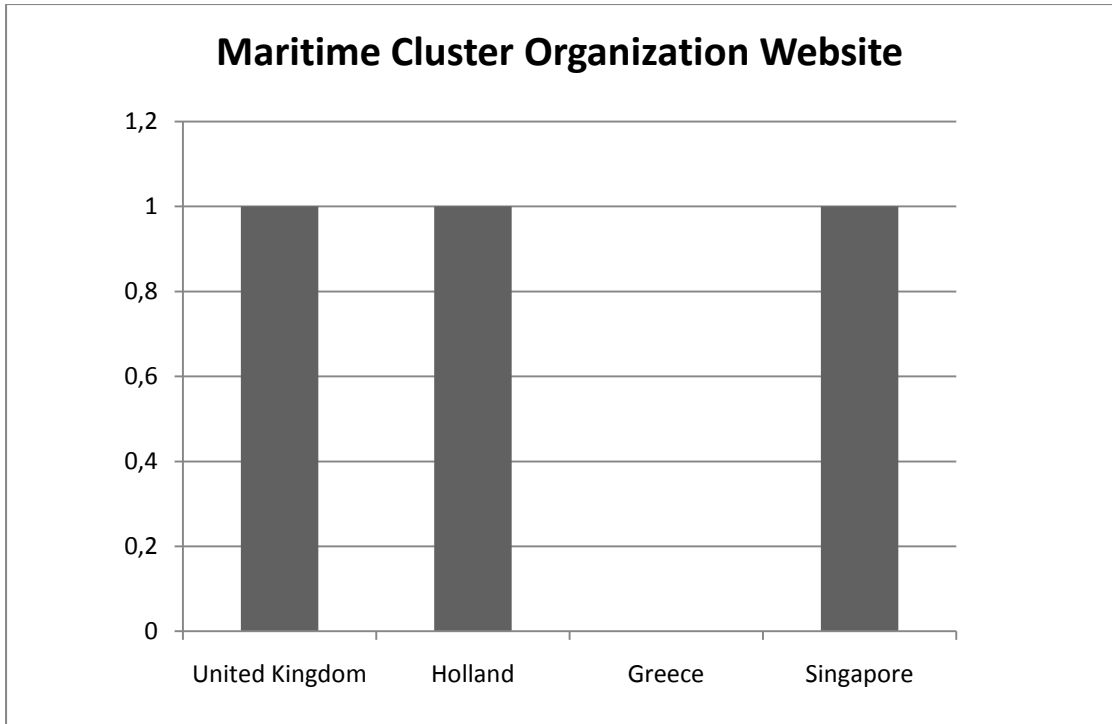


Figure 21: Performance Indicator 12: Maritime Cluster Organization Website

Sources: *Maritime UK 2010, Dutch Maritime Network 2010, MPA 2010*

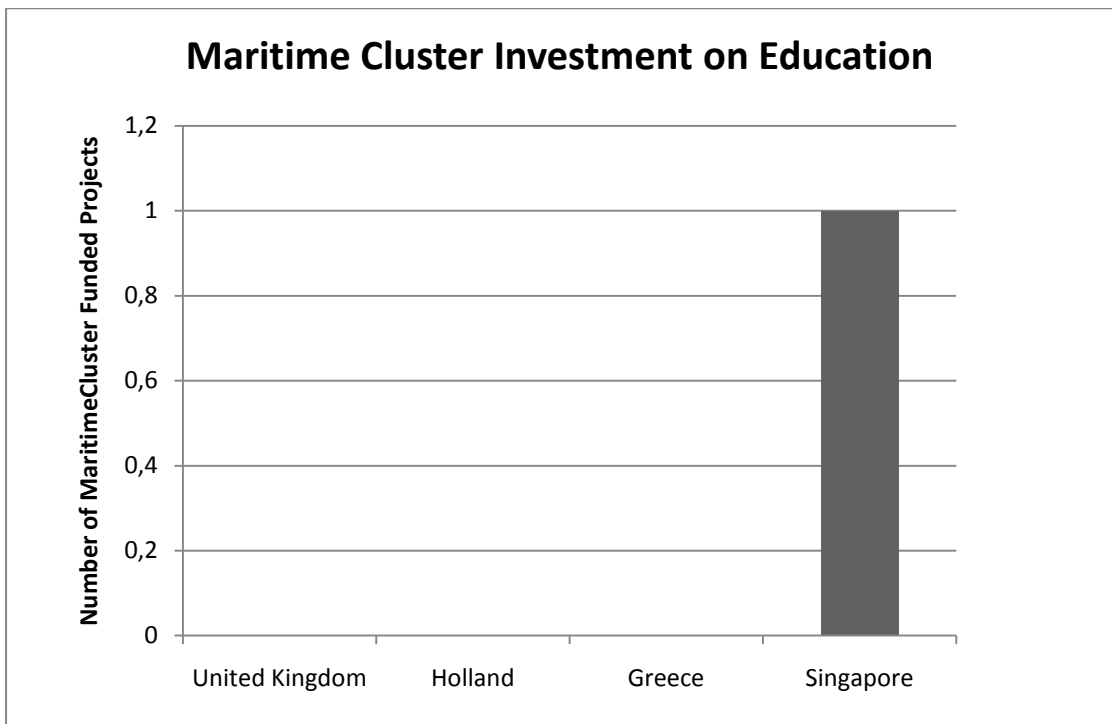


Figure 22: Performance Indicator 13: Maritime Cluster Organization Investment on Education

Sources: *Maritime UK 2010, Dutch Maritime Network 2010, MPA 2010*

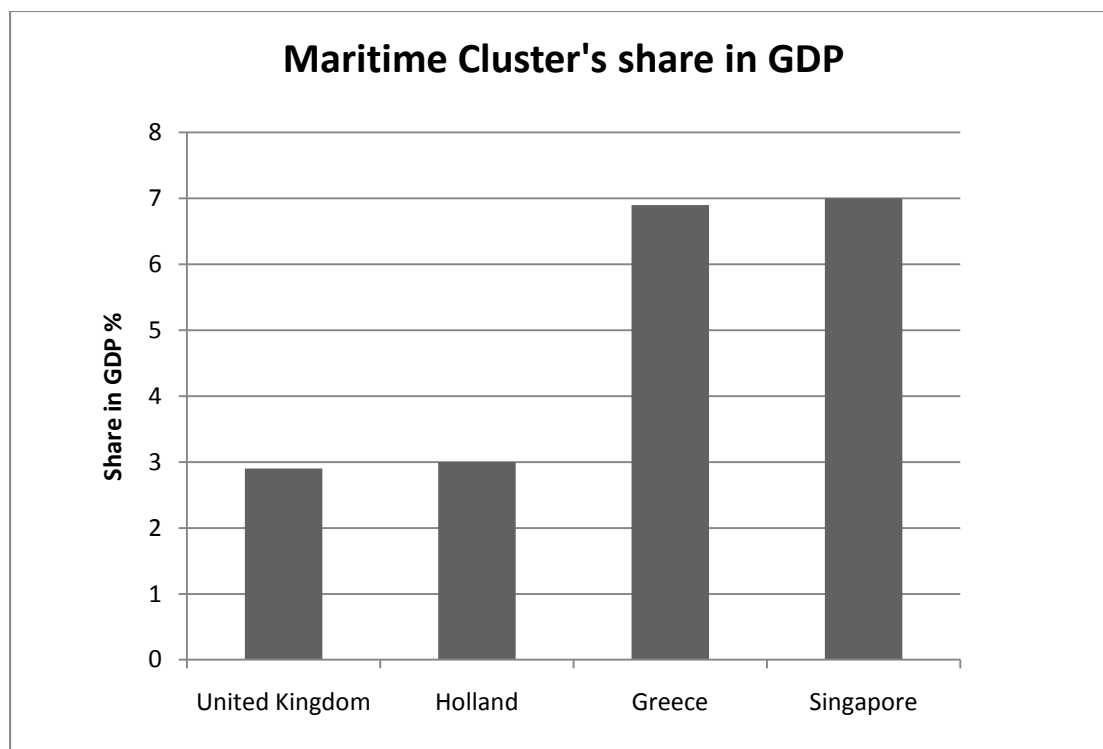


Figure 23: Performance Indicator 14: Maritime Cluster Organization Share in national GDP

Sources: Maritime UK 2010, Wijnolst 2003, Holland Trade 2010, National Statistical Service of Greece 2010, MPA 2010

Maritime Cluster Performance Indicators	United Kingdom	Holland	Greece	Singapore
Maritime Cluster Organization	100	100	0	100
Maritime Cluster Sectors	90	100	70	50
Maritime Cluster Shipping Companies	14	16	100	16
Maritime Cluster Fleet Global Share (DWT)	22	4	100	24
Maritime Cluster Fleet Size	17	14	100	20
Direct Added Value	100	51	17	51
Maritime Cluster Companies	87	100	29	43
Maritime Cluster Employment	100	53	30	38
Average Employment per Cluster Company	84	39	76	100
Maritime Cluster Statistical Data	50	100	50	50
Maritime Cluster Educational initiatives	100	100	100	100
Maritime Cluster Organization Website	100	100	0	100
Maritime Cluster Investment on Education	0	0	0	100
Maritime Cluster Share in GDP	41	43	99	100
TOTAL	906	819	770	892

Table 10: Normalised Maritime Cluster Performance Indicators

The performance indicators of table 9 were normalized so that the cluster with the top score on each performance indicator receives 100 points (table 10).

As it is evident the UK maritime cluster receives the top score overall in this comparison. It is interesting to note that the UK maritime cluster has scored top points in five indicators while the Dutch and Singapore clusters have received top points in six performance indicators. The indicators that set the UK cluster apart are the Direct Added Value and Cluster Employment

Another interesting fact is that the Singapore Cluster has a score in every cluster performance indicator, while the Greek Maritime Cluster has scored zero points in three indicators mostly because it is the only cluster in this comparison that still doesn't have a Maritime Cluster Organization.

In the second step the performance indicators were grouped into three categories based on their importance and the three different groups received different weights (1.5 , 1, 0,5) in descending level of importance and the total scores of each cluster and their ranking were recorded and compared with the results of the initial step.

The first group consists of the following indicators and received a weight of 1,5

- Maritime Cluster Organization
- Maritime Cluster Sectors
- Maritime Cluster Shipping Companies
- Maritime Cluster Fleet Global Share (DWT)
- Maritime Cluster Fleet Size

The next group consists of the following indicators and received a weight of 1,0

- Direct Added value
- Maritime Cluster Companies

- Maritime Cluster Employees
- Average employment per cluster company
- Maritime cluster statistical Data
- Maritime Cluster Educational Initiatives

The final group consists of the following indicators and received a weight of 0,5

- Maritime Cluster Website
- Maritime Cluster Investment on Education
- Maritime Cluster Share in GDP

Maritime Cluster Performance Indicators	United Kingdom	Holland	Greece	Singapore
Maritime Cluster Organization	150	150	0	150
Maritime Cluster Sectors	135	150	105	75
Maritime Cluster Shipping Companies	21	24	150	24
Maritime Cluster Fleet Global Share (DWT)	33	7	150	36
Maritime Cluster Fleet Size	25	20	150	30
Direct Added Value	100	51	17	51
Maritime Cluster Companies	87	100	29	43
Maritime Cluster Employment	100	53	30	38
Average Employment per Cluster Company	84	39	76	100
Maritime Cluster Statistical Data	50	100	50	50
Maritime Cluster Educational initiatives	100	100	100	100
Maritime Cluster Organization Website	50	50	0	50
Maritime Cluster Investment on Education	0	0	0	50
Maritime Cluster Share in GDP	21	21	49	50
TOTAL	957	864	906	847

Table 11: Weighted Maritime Cluster Performance Indicators

After this step the indicators evolved as per table 11. It is clearly evident that even though the United Kingdom Maritime Cluster still receives the top score overall, there have been significant changes in the ranking of the remaining clusters. Furthermore it is clear that one single indicator can change the overall ranking of all the clusters as all their scores are very near.

8. Conclusions

The concept of clusters has been widely adopted by policy makers and the industry, ever since its inception by M.Porter in the 1990s.

The concept was especially suited to the maritime industry as a result, and several regional and national maritime cluster organizations have been formed all over Europe in the last decade and a large amount of research has been conducted on the subject, which has served to illustrate the considerable economic significance of the maritime industry for the European economy. This has shown that the maritime industry contributes a large portion of GDP to the European economy while providing employment to thousands of people.

The various studies have demonstrated however that there still remains some confusion as to the definition of the maritime cluster and its sectors among the different maritime cluster organizations and maritime cluster researchers, mainly caused by the differences of scope that are evidenced between different maritime clusters. This has led into inconsistencies between the statistical data gathered for different clusters, making maritime cluster benchmarking very difficult.

Furthermore the performance indicators that are used for the benchmarking of maritime clusters are mostly qualitative in nature which in conjunction with the lack of immediately comparable statistical data makes cluster comparison futile.

In our comparison of four major maritime clusters , the UK maritime Cluster , the Dutch Maritime Cluster, the Greek Maritime Cluster and Singapore's Maritime cluster based on a set of fourteen measurable performance indicators, the United Kingdom maritime cluster consistently scored the highest points. The comparison also served to illustrate that while the four maritime clusters have established initiatives for the attraction of young people to the maritime profession, there is no cluster funding of maritime education apart from the Singapore cluster and no funding for research for the promotion of innovation.

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