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A Conceptual Model of Port Clusters and Related Assemblages

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Abstract : *Recently we have seen a noticeable trend in ports to establish port clusters. Despite this trend, little research has actually been undertaken to fully define and analyse port clusters. A couple of exceptions have descriptively defined port clusters but the boundaries of port clusters are not apparent.*

Therefore, the aim of this paper is to define port clusters in terms of set theory and in particular look at them in terms of their distinct characteristics and system boundaries. The main concern of this paper is that there is a need to distinguish, from a system and a competition perspective, between port clusters, ports, maritime clusters and port ranges. This paper proposes a conceptual model relevant to the relationship among port clusters related assemblages and that has been applied to the north western europe region. This model suggests six levels of competition that will help port authorities and government to develop appropriate policies and strategies for port operation and port industry.

Key words : *Port clusters, Seaport, Maritime clusters, Port range, Set theory, Conceptual model*

1. Introduction

Recently we have seen a noticeable trend by ports to establish port clusters either via their port authorities or via municipal governments. Such a trend is aimed at increasing port competitiveness by enhancing relationships between the port and associated companies in the port area. Despite this trend, little research has actually been undertaken to analyse port clusters and their impact on ports' operation performance and that of the companies within the cluster. A couple of exceptions has been the research on the application of cluster theory in the port industry (Haezendonck, 2001) and performance measuring of existing three port clusters (De Langen, 2004).

While Haezendonck and De Langen have distinct, but related definitions of port clusters, we feel that the conceptual boundary of the port cluster is not clear. The unclear conceptual boundaries of port clusters make it difficult to progress analysis and to design effective systems. There is also a lack of clarity between ports and other related terms such as port ranges and maritime clusters. This study therefore aims to define port clusters in terms of 'Set Theory' (Lipschutz, 1979) and in particular look at them in terms of their distinct characteristics and system boundaries.

Sets are the most basic building blocks in mathematics, and it is in fact not easy to give a precise definition of the mathematical object set. Once sets are introduced, however, one can compare them, define operations similar to addition and multiplication on them, and use them to define new objects such as various kinds of systems. In fact, most of the topics in modern analysis are ultimately based on sets. Many results in set theory can be illustrated using Venn diagram, as in the above proof. However, such diagrams do not represent mathematically rigorous proofs. Nonetheless, before an actual proof is developed, it is first necessary to form a mental picture of the assumptions, conclusions, and implications of a theorem. For this process a Venn diagram can be very helpful. The reason why this study uses 'Set Theory' is to make clear the conceptual differences between port cluster and similar assemblages, such as port, maritime cluster, port range.

From the literature this study defines the characteristics of port clusters and identifies real-world examples of their applications. Development of a conceptual model of port clusters based on 'Set Theory' and its application using the North Western Europe region was followed as an example. Matter in fact, it is not just ports or port clusters that compete each other, but there are different levels of competition that exist including port ranges and maritime clusters. Understanding at what level this study competes aids in us developing appropriate systems and processes.

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2. Concepts on Port Clusters and related Assemblages

Frankel (1987) said a port is "a connection point or joining area between ocean traffic and land traffic." Goss (1990) defined a port as "a gateway through which goods and passengers are transferred between ships and the shore," and Button (1993) said a 'seaport' was viewed as a rather self-contained, organized place where goods and passengers are exchanged between ships and the shore. On the other hand, recognition that a port as a component or set of components of a broader technological system also has been starting (Hayuth, 1993 & Haezendonck, 2001).

Ports are playing an ever pivotal role in the development and operation of industrial supply chains. Nevertheless, port management has historically been reactive to legislative and customer pressures. Such a reactive approach has resulted in ad hoc port related companies including government agencies. Ports may thus be viewed as large-scale complex systems where there is a need to define a more holistic perspective of their design and operations. Even so, 'ports' are frequently considered as the competing units.

Haezendonck (2001) might be the first scholar who used the term 'port cluster' and draws from cluster theories. She defined a port cluster as:

> *"The set of interdependent firms engaged in port related activities, located within the same port region and possibly with similar strategies leading to competitive advantage and characterized by a joint competitive position vis-à-vis the environment external to the cluster" (p.136)*

De Langen (2004) does not define the port cluster concept itself but, he applied the cluster concept to seaports for enhancing the understanding of the performance of (seaport) clusters. He states that a cluster is;

> *"A population of geographically concentrated and mutually related business units, associations and public (-private) organizations centred around a distinctive economic specialization." (p.10)*

It is worth noting that he included research/education institutes in the cluster population to reinforce the innovation factor associated with expertise and knowledge.

From a system analysis perspective Roelandt and Hertog (1998) classify clusters into three types:

1. national level - a relationship between industries within a total economy,
2. industrial level - a relationship between industries producing similar end-goods but at different levels or an internal relationship between industries,
3. business level - a relationship between part suppliers around one or a few core companies.

Alternatively, Lee (2002) classified clusters according to; the function, knowledge activity, formation process, and behaviour. Therefore, this study comprehensively combines Roelandt and Hertog (1998)'s and Lee (2002)'s framework of clusters into one (as shown in Fig. 1) and apply it to existing real-world existing situations; namely, Maritime London, Dutch Maritime Network, Detalinqs Rotterdam, Connecticut Maritime Coalition and the Port of Busan. In the case of the latter there are as yet no clearly defines port clusters.

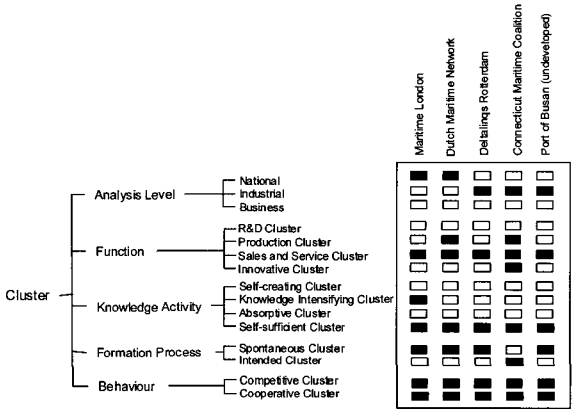

Fig. 1 The characteristics of ports, port clusters and maritime clusters

Haezendonck (2001) defined 'port range' as a geographic area encompassing a hinterland that is served by a number of different competing ports, port operators and port services. The exact boundary of a port range is ill defined and may change over time depending on competitive pressures and the focus of the study. Hence, the port range is an important unit of analysis when this research considers a port's competitive strategy. Examples of port ranges include Hamburg-Le Havre, Tokyo-Yokohama, Osaka-Kobe and Marseilles-Barcelona.

Also worth considering is the concept of a 'maritime cluster'. This term is used quite extensively in the maritime industry (De Langen, 2004)). Each of the examples in Fig. 1 has different constructs for port clusters and maritime clusters and are very much dependent on their

particular circumstances and historical development.

In spite of serial literature survey on the concepts relevant to the port clusters, the conceptual boundary of the port cluster was still not clear, and the unclear conceptual boundaries of port clusters could make it difficult to progress analysis and to design effective systems. There is also a lack of clarity between ports and other related terms such as port ranges and maritime clusters.

For a clearer understanding about the relationship between port cluster related concepts, this study develops a conceptual model using set theory in the next chapter.

3. Conceptual Model of Port Clusters and Related Concepts

3.1 Model

A Venn diagram, shown as Fig. 2 is developed based on the existing cases of maritime clusters and port clusters given in Fig. 1.

In Case 1 the port range covers several countries while in Case 2 the port range is limited to a single country. In both cases a 'port cluster' that is specific to a port can be shown as a subset of the 'maritime cluster' as well as the 'port'. From a 'Set Theory' perspective (Lipschutz, 1979) this study can define the following relationships;

$$PR \; MC \; PT \; PC \quad [1]$$

for Case 1

$$PR \; MC \quad [2]$$

for Case 2

$$PR = MC \quad [3]$$

where

PR = Port Range
MC = Maritime Cluster
PT = Port
PC = Port Cluster

and

PC = {Direct service providers for Port Activity, Logistics and Transportation Industries relevant to the port, Public Institutes, Research and Education Institutes,.....}

PT = {Port clusters, Port infrastructure, Dock labour, Cultural sites, Health and safety services…}

MC = {Ports, Shipping clusters, shipbuilding cluster, marine equipment supplies cluster, offshore cluster, inland shipping cluster, dredging cluster, port cluster, maritime services cluster, fishing cluster, navy sector, yacht building industry cluster, ship classification, tourism and recreatio n,……}

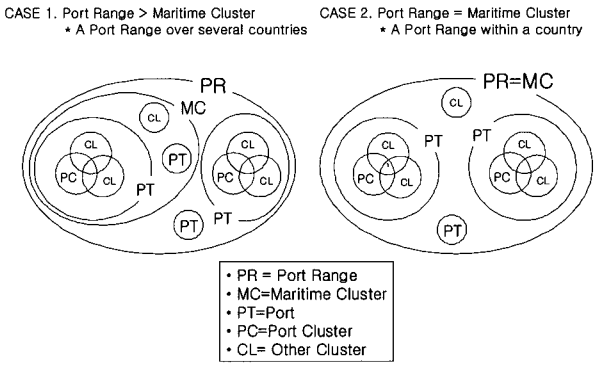

Fig. 2 Conceptual model of port clusters and relevant assemblages

3.2 Application

The conceptual model developed in paragraph could be applied to the North Western Europe region, it is because that region is one of the most advanced area in the world from the port cluster point of view. This study especially focuses on the port cluster associated with Rotterdam, which has been one of the most commercially active clusters in the world. In the 'Hamburg-Le Havre' port range there are many ports including the ports of Hamburg (Germany), Bremen (Germany), Amsterdam (Netherlands), Rotterdam (Netherlands), Antwerp (Belgium), Dunkerque (France) and Le Havre (France). This is an example of Case 1.

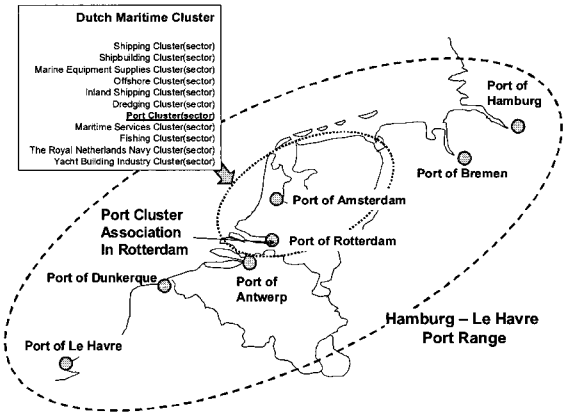

Fig. 3 Application of the conceptual model to North Western Europe

The Dutch Maritime Cluster covers several Dutch ports including the ports of Amsterdam and Rotterdam. Inside the Port of Rotterdam, there is the Rotterdam Port Cluster Association. The Port Range and its associated sub-sets are shown in Fig. 3.

4. Testing and Expansion of the Conceptual Model

The verification and validation process of the proposed conceptual model on the port clusters was not easy because of following reasons: first, a concept of port cluster itself is not popular yet, second, there are few scholars or experts who are well acquainted with the port relevant industry at the same time as the clusters.

This study tried to verify and to validate this conceptual model relevant to the port clusters through interviews to 16 experts and scholars, who have various nationalities at 2004 IAME (International Association of Maritime Economics) Annual Conference in Izmir/Turkey (28 June to 2 July 2004). In this procedure, 11 people (68.7%) among experts or scholars agreed to this conceptual model and 4 people (25.0%) of them disagreed. One of them answered no opinion. The expert, who had no opinion about it, explained his position that definition of the port clusters boundary such as this model is not so meaningful under a rapidly changing world and dynamical port environment.

The four of them, who disagreed to this conceptual model, pointed out that nowadays the processing plants or the multi-national companies (MNC) spring up at the FTZ similarities (Free Trade Zone). Even though some countries are using slight difference concepts such as Free Port, Free Zone, Bonded Area, Integrated Bonded Area, Special Economic Zone and Special Economic District, etc. those are slightly different from the FTZ concept, but they are still active in the world. They asserted that these also have to be included in the port clusters conceptual boundary. In other words, it means that the concept of the port cluster also should be higher and wider than the concept of the port.

When we collectively thought about all of their ideas, we could recognize that the port clusters concept is expanding out of the port concept (see Fig. 4).

Nevertheless, we still understand their opinions as an aim for the future rather than reflecting on our port cluster concept immediately for these two reasons: first, the FTZ similarities are still not general in every port in the world; and second, it is still difficult to find the apparent difference between manufacturers working in and out of the FTZ similarities. It is because many of the manufacturers are working in the FTZ only for the benefit of tax without concerning the port.

In both Case 1 and Case 2, a 'port' that is specific to a port cluster can be shown as a subset of the 'maritime cluster' as well as the 'port cluster' (compare with Fig. 2). We can also define the following relationships:

$$PR \supseteq MC \supset PC \supset PT \quad [4]$$

for Case 1

$$PR \supset MC \quad [5]$$

for Case 2

$$PR = MC \quad [6]$$

where

PR = Port Range
MC = Maritime Cluster
PT = Port
PC = Port Cluster

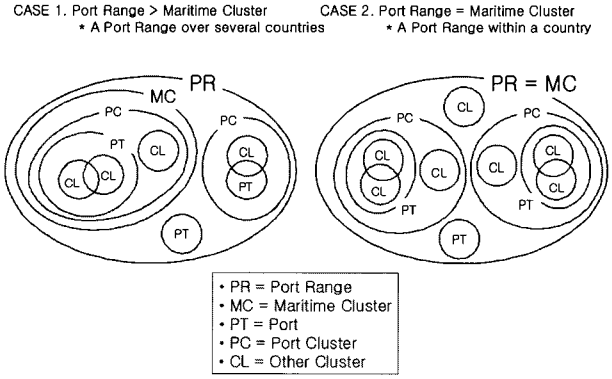

Fig. 4 Expanded conceptual model of the port clusters and related concepts

5. A Conceptual Model of Competition around Port Clusters

As mentioned in the introduction, this study aims to establish a model that highlights the level at which competition happens. The concept of port clusters started with the aim of developing more appropriate strategies to win orders between competing ports. This study proposes that competition may arise at different levels of which port clusters are just one. Without understanding at which level

competition arises then the wrong strategies may be developed.

Fig. 5 shows a conceptual model of levels of competition between port clusters and related assemblage; ports, maritime clusters and port range. Fig. 5 is based on the model of Fig. 2 and builds on Haezendonck's (2001, p.15) competition framework in it. Haezendonck proposes four levels of competition, namely; inter-port competition on a port authority level, inter-port competition on a commodity level, inter-port competition on an operator level and intra-port cluster competition. However, Fig. 5 shows six different kinds of port competition in the conceptual model.

The first level is the 'intra-port competition', that is competition on a company level within a single port. An example is competition between two stevedoring companies.

The second level is the 'inter-port cluster competition'. For example, two port clusters such as the Antwerp Port Cluster and the Rotterdam Port Cluster compete in order to gain an increased market share of traffic, cargo handling and value adding services.

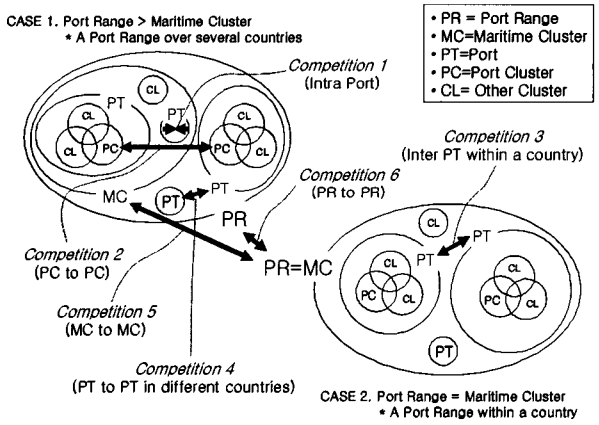

Fig. 5 A model of competition between port clusters and related assemblage

The third level is the 'inter-port competition within a country'. For example, two ports such as Amsterdam and Rotterdam, or Southampton and Felixstowe, compete within a country, which in itself usually defines the maritime cluster. Competition is not limited to purely commercial organisations but may also include port authorities and municipal government.

The fourth level is the 'inter-port competition between two different countries'. For example, Rotterdam in the Netherlands and Hamburg in Germany compete for market share, whether or not a maritime cluster or a port cluster have been established. Competition is not limited to purely commercial organisations but may also include port authorities, municipal government and central government.

The fifth level is the 'inter-maritime cluster competition between two different countries'. This may involve full scale competition between two different countries with intervention by central governments. For example, two different maritime clusters such as Dutch Maritime Cluster in the Netherlands and the London Maritime Cluster in the United Kingdom compete to gain leadership in the maritime field although in two different ways. The Dutch Maritime Cluster portrays itself as the gateway for the Europe. The London Maritime Cluster aims to be the leading centre for maritime finance, law and insurance in the world.

The final level is the 'inter-port range competition'. For example, the Hamburg Le Havre Port Range and the Mediterranean Port Range compete in order to gain an increased market share of cargo handling and traffic of the same hinterland

6. Conclusion

Based on secondary data set theory has been utilised to visualise the interrelationship between various assemblages such as ports, port clusters, maritime clusters and port ranges. This helps to clarify the confusion that sometimes arises between the various terms. This study has shown the potential application of the model to the North Western Europe region. More importantly the model is extended to include six kinds of competition in it from which appropriate company and port strategies, and government policies may be developed.

The model developed is conceptual and requires testing. Verification, and validation to check its credibility is still required. This will be undertaken at the next research with a particular focus to establish suitable strategies and policies. The next research will involve fully characterising the various sub-sets of the model and to determine the extent of competition that actually arises in the real-world. The methodology adopted will include survey and case based research.

Another implication for further research is to extend the set theory approach and utilise the structured analysis and design technique to detail the conceptual model. This will help to extend policy and strategy into tactical planning and operations so as to develop efficient and profit in the port clusters. These conceptual models contribute to the system analysis and design of port clusters by clearly identifying the system boundary and aiding in understanding the assemblage around the port cluster system.

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