Case Studies and Theoretical Approaches in Port Competition and Cooperation

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Abstract. Main factors change the international freight transport alimenting (and being alimented by) the increasing of globalization. In this scenario, the role of ports also changes. The single port cannot compete in the new global economic scenario. The port system arises from the alliance, or merge, of several ports to optimize the resources of the individual ports. The paper is articulated into two main parts. The first one presents the main theoretical approaches to explain how ports could respond to the new requirements imposed by gigantism, carriers' alliances and land-sea integration. The second one presents a critical analysis of some representative case studies of cooperation among ports, in order to aggregate the observed processes in some macro-classes. The work may be considered a first step of a research, able to open several directions to study the competition and cooperation process among ports with Transport System Models (TSMs). The use of TSMs could allow to extend the consolidated quantitative methods developed in the field of passengers' mobility and freight distribution on terrestrial transport networks to the field of maritime transport and ports.

Keywords: Ports · Maritime transport · Coopetition · Fourth-generation ports · Case studies

1 Introduction

In the last decades of the twentieth century, globalization has led to an increase in world trade never occurred before. In general, some areas of the world became production regions (e.g. Far East), while others became regions where intermediate and final consumption is concentrated (e.g. Europe).

Maritime transport represented the pillar through which globalization could be achieved, thanks to some phenomena that changed the global game: the naval gigantism and the alliances between shipping companies, on the sea side; and the improvement of hinterland accessibility, on the land side.

As far as concerns *alliances between shipping companies*, the market recently knew a strong acceleration. Focusing on the container segment, the consolidation started in the 1990' with the creation of the global alliances and it passed through different periods. In 1996, the first alliances between mid-sized and small carriers were born in order to

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extend their market coverage at global scale and to reduce the costs of larger vessels. The cooperation took the form of coordination of capacity. Since 2011 the availability of mega-ships was an entry barrier by many smaller carriers; therefore, they intensified cooperation with existing alliances. Until 2017, where only three global alliances exist consisting of three very large companies of about the same size [1]. The average market share of the three alliance was 92.3% in 2018, with a peak of 98.8% on the Asia-Europe route (see Table 1).

Table 1. Market share [%] of the main three container shipping alliances along the East-West routes. Year 2018. (% TEUs of capacity).

	2M Alliance(*) [%]	Ocean Alliance(#) [%]	The Alliance(§) [%]	Sum [%]	Other [%]	Total [%]
Trans-Pacific	17.5	42.2	27.0	86.7	13.3	100.0
Transatlantic	47.8	15.2	28.5	91.5	8.5	100.0
Asia-Europe	36.5	37.4	24.9	98.8	1.2	100.0
Average	33.9	31.6	26.8	92.3	7.6	100.0

(*) Maersk and Mediterranean Shipping Company; (#) Cosco, CMA, CGM and Evergreen; (§) ONE, Yang Ming and Hapag-Lloyd. (Source: [2]).

As far as concerns *naval gigantism*, the total world fleet accounted in 2019 for 2.20 billion dead-weight tons (dwt) of capacity (95,402 ships). Bulk carriers maintained the largest market share of vessels' capacity (38.2%). Oil tankers followed with 25.8%, and container ships have a share of 12.1%. Container ships are the ones that obtained the greatest increase from 2018 (+4.9%) (Table 2) [2].

Focusing on the container segment, containerships grew through several generations since the beginning of containerization [5], as showed in Table 3. The ships' dimensions were constrained by technical limits of Panama Canal, that was object of an infrastructural expansion in 2016.

The first generation of containerships was born with the birth of container technology in the mid-1950s. The early containerships were adapted from bulk vessels or tankers with capacity up to 800 TEUs and they were equipped with cranes on-board. They were followed by the cellular containerships since the end of 1960s which used the whole ship to stack containers and had no cranes on-board. During the 1980s the increasing success of container pushed for the construction of larger containerships, called Panamax and Panama max, with a capacity up to 4,500 TEUs.

The second generation of containerships, Post Panamax, aroused at the end of 1990s when the transport of a sufficient amount of cargo along a longer route (Africa circumnavigation) became profitable. Once the Panamax threshold was passed, containerships increased their capacities reaching 8,500 TEUs (Post Panamax I and II). By 2006, new Post Panamax containerships were built having a capacity between 11,000 and 15,000 TEUs. They were called Very Large Container Ships (VLCS) since they exceeded the limits of the expanded Panama Canal. An extension was the Ultra Large Container Ships (ULCS) above 18,000 TEUs in 2013, further expanded in 2017 above 21,000 TEUs.

Table 2. World fleet by principal vessel type, 2018–2019 (Thousand dead-weight tons and %).

Principal types	2018		2019		19/18
	d.w. tons x 1000	%	d.w. tons x 1000	%	%
Bulk carriers	818921	38,2	842438	38,2	2,9
Oil tankers	562035	26,2	567533	25,8	1,0
Container	253275	11,8	265668	12,1	4,9
Other types	218002	10,2	226854	10,3	4,1
Offshore	78269	3,7	80453	3,7	2,8
General cargo	73951	3,4	74000	3,4	0,1
Gas carriers	64407	3,0	69078	3,1	7,2
Chemical tankers	44457	2,1	46297	2,1	4,1
Ferries	6922	0,3	7097	0,3	2,5
Other/not avail.	23946	1,1	23929	1,1	– 0,1
Total	2144185	100,0	2203347	100,0	2,8

(Source: [2]).

The fourth generation of containerships, New-Panamax, or Neo-Panamax (NPX) was designed to fit exactly the limits of the expanded Panama Canal, opened in 2016. These ships have a capacity of about 12,500 TEU.

Next generation of container ships, the Malacca Max, could carry about 27,000–30,000 TEU, but they will not build until there are not sufficient volumes on the limited routes and ports they could serve.

As far as concerns *hinterland accessibility*, two (or more) ports, with the same (e.g. container) or with different functions and markets, might find convenient to jointly enhance hinterland access, rather than doing it in an independent or competitive way. This may be done by integrating their facilities in two different ways:

- with rail, road or fluvial gateways, or
- with a distripark, or a Special Economic Zone (SEZ).

In this context, ports gained strategic importance as they became crucial nodes in the global supply chain [3] and [4]. Ports were protagonists of epochal changes with respect to their vision and missions, modifying their historical attitude of mutual *competition* towards an attitude of progressive *cooperation*. It can be recalled the increasing cost for the port authority to dock depth following the ship depth [6].

The so-called *fourth-generation ports* were born ([7–9]). They are port systems, generally composed of two main ports, in which port operators and administrations cooperate by creating alliances on market segments, or by sharing infrastructures and

Table 3. Containerships' growth generations.

Generation	Year of constr	Name	TEUs		LOA$^{(\circ)}$
			Min	Max	[mt]
First	1956	Early Container	500	800	137
	1970	Fully Cellular	1000	2500	215
	1980	Panamax	3000	3400	250
	1985	Panamax max	3400	4500	290$^{(*)}$
Second	1988	Post Panamax I	4000	6000	300
	2000	Post Panamax II	6000	8500	340
Third	2006	VLCS	11000	15000	397
	2013	ULCS	18000	21000	400
Fourth	2014	New-Panamax	12500	366$^{(\$)}$	49$^{(\$)}$

$^{(\circ)}$ Length Over All; $^{(*)}$ technical limits of Panama Canal before the expansion in 2016, ($) technical limits of Panama Canal after the expansion in 2016. (Source: [5]).

services for customers, or by integrating different production segments. The aim is to increase the utilities of different stakeholders reducing the investments. The cooperative-competitive behaviour of fourth-generation ports can be called *coopetition.*

The remaining part of the paper is articulated as follows. Section 2 presents the background theory of port coopetition, introducing a theoretical equilibrium model of competition-cooperation, based on the topological-behavioral paradigm of Transportation System Models (TSMs). Section 3 reports some case studies regarding port cooperation, selected from the literature. The last section reports the conclusions and the research perspectives.

2 Theoretical Approaches on Port Coopetition

The port industry has undergone a process of rationalization during the last years of the twentieth century. UNCTAD introduced the definition of fourth generation of port [7], in order to describe this process that considers common operators and administrations. The first works on the theme of passage from strong competitions to (weak) new form of cooperation are published in last two decades.

The behaviour of many port operators was investigated in [10] by observing that, in the era of the global economy, a port no longer enjoys a natural monopoly, as it did in the past. It is therefore necessary to initiate forms of competition and cooperation between ports to provide services that fit the strategies of shipping companies. On this basis, a new strategic option is proposed known as coopetition, the combination of competition and cooperation, for the port industry, analysing a case of coopetition between the container ports of Hong Kong and southern China.

The general problem posed in [7] of the relationship between competition and cooperation between ports, was investigated using game theory. The ports of Shanghai and Ningbo are analyzed by means of game theory in [11]. In the paper, the most advanced strategies of cooperation are investigated, for example, bleak strategy, punitive strategy, face-to-face strategy.

In the following years several works have addressed the issue of coopetition with game theory, among others it can be recalled. The ports of the Yangtze River Delta are analyzed in [12]. The problems of coopetition between ports are formalized in [13], in which each individual port makes investment decisions, anticipating protective anticipating the congestion problems that the overall system has. In a subsequent work [14], a bi-level approach to improve the resilience of the overall port network is presented.

From what emerges from the literature there are no works that address the issue of coopetition between ports using the Transport System Models (TSMs). A further research was carried out using search engines freely accessible on the web via keywords, which led to the same result.

TSMs simulate a transport system through a process, in which transport supply and travel demand interact. The three main elements of the TSM are therefore: the transport supply model, the travel demand model and the supply-demand interaction model.

The transport supply model must represent the utilities for users deriving from the use of transport infrastructures and services. The approach used is the topological model, given by a network model, with links, nodes and cost functions (e.g. time-flow relationship).

The travel demand model simulates user choices based on the performance of infrastructure and services. Travel demand models can be behavioural or non-behavioural. In the behavioural approach [15], demand models can be stochastic or deterministic according to whether the (dis) utility associated with each user's choice is a random variable; or a deterministic variable.

The supply-demand interaction model allows simulating the interaction between the user's choices and the performance of the infrastructure and the service. The model uses the topological-behavioural paradigm. The demand-supply interaction models can be classified into ([16, 17]): static and dynamic, according to whether they allow to simulate a transport system in stationary or evolving conditions due to travel demand peaks or temporary changes in supply capacity. Static models can be divided into: free-flowing models, such as Network Loading (NL), and models based on an equilibrium approach, such as User Equilibrium (UE) and System Optimum (SO) ([18, 19]).

The class of models based on the equilibrium approach is the one of interest for the solution of the coopetition problem. The idea is to extend the TSMs from the consolidated field of passengers' mobility and freight distribution on terrestrial transport networks to a different field: the one of maritime ports. This is a distinctive feature from the existing published studies.

UE and SO equilibrium models rely on different behavioural assumptions.

- UE model simulates the behaviour of a carrier, who choices a port among the available set of ports, in order to minimize his individual cost. *There is a competition attitude between ports.*

- SO model simulates the behaviour of a carrier, who choices the port among the available set of ports, in order to minimize the total cost (of all carriers). *There is a cooperation attitude among ports*. The SO costs and flows correspond to objectives that a port system manager generally pursues.

3 Port Systems Coopetition: The Fourth-Generation Port

The last two decades were characterized by the behaviour of closer ports to cooperate, other than the traditional behaviour to compete [20]. As reported in the introduction, three were drivers of the cooperation process.

- The alliances between shipping companies reduced the bargaining power of port authorities and made ports vulnerable in relation to the requests of deeper channels and berths, and of higher capacity of container terminals [21].
- The naval gigantism together with hub-and-spoke shipping services determined pressure on ports to invest in the development of sea-side material facilities. But, not all the ports can sustain this competitive game, which requires relevant amount of funds and which risks to replicate similar investments in ports located in proximity [22].
- Some ports in proximity find more convenient to jointly enhance hinterland access and to develop shared port centric logistics systems, rather than acting in an autonomous way.

In each port, different specific background factors and measures (e.g. planned investments in physical infrastructures, management, in human resources and organisation by the individual port authorities) could be identified to respond to above drivers. They could have generated some increase in traffic demand for the individual ports irrespective of the cooperation initiatives.

The forms of cooperation among ports are different. They may be classified from a very general point of view according to the following experimental criteria:

- cooperation in the ports' governance (Sect. 3.1), merging the previous authorities;
- cooperation among ports on multiple market segments (Sect. 3.2);
- cooperation on one market segment (e.g. container) (Sect. 3.3)
- cooperation based on a supply infrastructural project (Sect. 3.4).

The following paragraphs report four case studies regarding port cooperation, selected from the literature according to the above classification. Even if several case studies may be recalled for each criterion of cooperation, the paper presents the most exemplificative ones.

3.1 Cooperation in the Ports' Governance: The Italian Ports Merger

Italy is the only country which proposed the "port system" concept at national scale in 2015 [23].

Before the reform, Italy had 24 Port Authorities and Italian commercial ports handled 483,8 [tons x 10^6] of freight, composed by liquid bulk, with 182,3 [tons x 10^6] and 37,7% of share; container, with 114,7 [tons x 10^6] and 23,7% of share; and ro-ro with 93,9 [tons x 10^6] and 19,4% of share [24].

The Italian Port and Logistics Strategic Plan [23] proposed as final objective to obtain larger port systems than the previous ones respected to each region interested. The attention was focused to have a sort of one-to-one port system and administrative region, where in each port system there is one port core (see Table 4), as defined by EU (see [25, 25]).

Table 4. Authority port systems in Italy.

Name	***Ports***
Mar Ligure Occidentale	Genova(*), Savona, Vado and Prà
Mar Ligure Orientale	La Spezia(*), Marina di Carrara
Mar Tirreno Settentrionale	Livorno(*), Capraia, Piombino, Portoferraio, Rio Marina, Cavo
Mar Tirreno Centro Settentrionale	Civitavecchia, Fiumicino, Gaeta
Mar Tirreno Centrale	Napoli(*), Salerno, Castellammare di Stabia
Gioia Tauro e della Calabria	Gioia Tauro(*), Corigliano Calabro, Crotone, Palmi
Stretto (di Messina)	Messina, Milazzo, Tremestieri, Reggio Calabria, Villa S. Giovanni
Mare di Sardegna	Cagliari(*), Foxi-Sarroch, Olbia, Porto Torres, Golfo Aranci, Oristano, Portoscuso-Portovesme, S. Teresa di Gallura
Mare di Sicilia Occidentale	Palermo(*), Termini Imerese, Porto Empedocle, Trapani
Mare di Sicilia Orientale	Augusta(*), Catania
Mare Ionio	Taranto(*)
Mare Adriatico Meridionale	Bari(*), Brindisi, Manfredonia, Barletta, Monopoli
Mare Adriatico Centrale	Ancona(*), Falconara Marittima, Pescara, Pesaro, San Benedetto del Tronto, Ortona
Mare Adriatico Centro-Settentrionale	Ravenna(*)
Mare Adriatico Settentrionale	Venezia(*), Chioggia
Mare Adriatico Orientale	Trieste(*), Monfalcone

(*) core port.

The attempt of the reform was to insert historical ports, as Genova and Naples, in a larger context as a port system. The port of Genova with the ports of Savona, Vado and Prà, are structured in the “Autorità di Sistema Portuale del Mar Ligure Occidentale”.

The port of Naples with the ports of Salerno and Castellammare di Stabia, are structured in the "Autorità di Sistema Portuale del Mar Tirreno Centrale".

In two cases the port system was designed to be larger than regional administrative borders: in the North Adriatic range and in the South Tyrrhenian range.

The first proposal of the North Adriatic port authority defined a port system composed of ports belonging to four Regions: Trieste (Friuli), Venezia (Veneto), Ravenna (Emilia), Ancona (Marche). However, the final version of the national law, instead of one system, proposed four ports authorities reproducing the status-quo. For what concerns the South Tyrrhenian range, the "Autorità di Sistema Portuale del Mar Tirreno Meridionale" unified all the ports of Calabria Region, leaded by port of Gioia Tauro, with the ports of Messina and Milazzo in Sicily. Today, this port system has been subdivided into two sub-systems, the "Autorità di Sistema Portuale dello Stretto", including the Sicilian ports of Messina and Milazzo and the Calabrian ports of Reggio Calabria and Villa S. Giovanni, and the "Autorità di Sistema Portuale di Gioia Tauro e della Calabria", including Gioia Tauro and the remaining Calabrian ports. It can be noted the slimming evolution from the original proposal, determined by local policy.

It is still too early to observe tangible effects of cooperation among the ports, involved in each "port system", given the reduced amount of time since the national reform took place.

3.2 Cooperation on Multiple Market Segments

The ports of Copenhagen and Malmö lie in the Oresund Strait between Sweden and Denmark. Copenhagen is the capital of Denmark. Malmö is the third city of Sweden. In 2005 the Oresund Bridge, the "fixed link" between Sweden and Denmark, was opened enhancing the integration and the centrality on the region, and favouring the settlement of clusters of internationally oriented industries.

The cooperation between the two ports started in 2001, leading to a new subject called Copenhagen Malmö Port (CMP) [26]. This process led to the first case of bi-national port in Europe.

The following key factors encouraged the cooperation process: the risk that the Oresund Bridge would lead to a loss of traffic among the two countries (ferry and container); the better utilization of resources (labour, land, capital) and of infrastructures (capacity); the creation of scale economies in management and administration, and of synergies in investments; the creation of a new single player in the market visible by customers. The negotiation lasted some years, and it reached success because it was supported by the CEOs of both ports and from the political and societal community, driven by the aim to increase the integration of Oresund Region.

3.3 Cooperation on a Market Segment

3.3.1 Seattle and Tacoma (USA)

The ports of Seattle and Tacoma are located in the Puget Sound Region, along the Pacific North-West Cost of North America. Tacoma has a population of about 860,000 and has historically been industrially based. Seattle has a population of over 2.1 million and has emerged as a new technology centre and tourist destination.

The two ports have competed against each other for decades [26] [21]. However, in 2015, they took the decision to set a long-term cooperation by forming the North-West Seaport Alliance; in order to compete in the container market with new ports along the West Coast, and with ports on the East Coast accessible from Asia through the expanded Panama Canal. Because of the differences in the scope and size of the two ports, and due to political and institutional reasons, the container business was the only asset "assigned" to the Alliance, even because it was of similar entity between the two ports.

After a long negotiation, the decision of the two ports to cooperate was accelerated after the Grand Alliance decision to relocate from the Port of Seattle to the Port of Tacoma. This decision helped both private and public stakeholders to become aware about the local problems determined by the competition between the two ports. The common accepted opinion was to give up the doing nothing option [28]).

According to the business plan elaborated in 2014 for the ten-years lasting period of the alliance [21], the ex-ante estimation was to pass from 3.4 million of TEUs in 2014 to 3.85 million of TEUs in 2019 until reaching 6.0 million of TEUs in 2026; and from 34,000 jobs in 2014 to 48,500 jobs in 2026, The ex-post analysis shows that the number of the containers handled were 3.77 million of TEUs in 2019 and the number of jobs were 36,800 in 2017.

3.3.2 Kobe and Osaka (Japan)

In Japan large port complexes have played a role of critical importance to the economic as well as urban development of these bay areas. They have developed not only marine terminals for domestic and international shipping, but also spaces for industrial and urban activities through extensive land reclamation in the bays [29]. The Osaka Bay area has long been the centre of the country: politically, economically, and culturally. Today it has a population of about 20 million and roughly 17% of the nation's GDP.

In 2015, the ports of Kobe and Osaka handled cargos for 97 and 74 million tons, respectively. Kobe is more international trade oriented than Osaka with the share of international trade being 53% for Kobe and 47% for Osaka. As for foreign trade containers, Kobe and Osaka respectively handled 2.1 million and 2.0 million TEU, for a total of 4.1 million TEU. The total international container throughput of Japan was 17.3 million TEU in 2015.

In 2014, under a new national port policy, the ports of Kobe and Osaka jointly established a port management company, the Kobe-Osaka International Port Corporation (KOIP), to merge their container terminal business. It is not the merger of the two port authorities, but that of their container terminal business, retaining the mother port authorities running separately as before [22].

The objectives of KOIP were: (1) effectively develop terminals without duplication, (2) respond more flexibly to market needs and changes, (3) strengthen bargaining powers to shipping lines, and (4) provide more choices of port services with shippers.

The company leases terminal infrastructures from their respective owners, the national government, city governments and the two LCTCs. KOIP is a product of compromise between retaining the autonomy of the two cities and promoting the collaborative management of their container terminals.

3.3.3 Ningbo and Zhoushan (China)

The "one port-one city" policy in China in the last decades of the XX century generated the development of similar port development projects, even within the same province, causing inter-port competition to capture cargo within the same hinterland. The slow-down of China's economic growth accelerated the port cooperation process in order to optimize resources allocation and to meet clients' requirements.

Ningbo and Zhoushan ports are two adjacent ports in Zhejiang Province (China). They are located in the same area, use the same channel and anchorage, and share the same hinterland. However, each port had independent policies and planning objectives, construction, operation and management structures. In 2006 the Chinese Ministry of Transport launched the regional port integration programme between Ningbo Port and Zhoushan Port.

Before the integration in 2005, Ningbo port handled 5.21 million of TEUs and Zhoushan port only 54.9 thousand of TEUs. After 10-year of integration, the total throughput of Ningbo-Zhoushan port reached 26.5 million of TEUs in 2017. The cooperation on the container market segment boosted the growth of container handled in the two ports.

The growth of container throughput was registered also in other Chinese ports, but it was not of the entity Ningbo-Zhoushan one. Shanghai Port, that shares a common inland market with Ningbo-Zhoushan port, passed from 18.08 million of TEUs in 2005 to 40.18 million of TEUs in 2017. The integration process of the two ports contributed very significantly to the fast-growing container throughput of Ningbo-Zhoushan port, if compared with the ports increase without port integration, whether in the same economic region or not [30]. The other contribute was due to the economic growth at the Yangtze River Delta in last decade.

The main ports of Pearl River Delta (Guangzou, Shenzen, Hong Kong) are working to verify different ways of cooperation, starting from the cooperation between Shenzen and Guangzou [31].

3.4 Cooperation on a Supply Infrastructural Project

3.4.1 Los Angeles and Long Beach

The ports of Los Angeles and Long Beach are located directly adjacent to each other within San Pedro Bay, California [32]. Since their founding over a century ago, the Ports of Los Angeles and Long Beach have been subject to numerous merger proposals. However, their reciprocal attitude was substantially competitive until the beginning of the 80s' [27]. In those years an authority between the ports was created, in order to finance and develop an intermodal railyard to manage the hinterland congestion. Later, in 1989, the ports used the same mechanism of the authority, to finance, develop and operate a second regional railroad project, known as the Alameda Corridor Project. These projects represent the highest degree of governance integration undertaken by the two ports. In the latest decades, further projects on material and immaterial infrastructures were planned and implemented to consolidate the cooperation process of the two ports.

The growth of container throughput was constant and continuous during the last four decades of cooperation of the two ports. As far as concerns the container segment, the number of handled container in the two ports passed from 1,13 million of TEUs, with 56% (0,63 million of TEUs) of market share of Los Angeles and 44% (0,51 MTEUs) of Long Beach in 1980, to 16,9 million of TEUs in 2017, with similar market shares. The cooperation based on a supply infrastructural project created the conditions for an increment of handled freight in the two ports.

3.5 Lesson Learned

The critical analysis of the four experimental typologies highlights that different levels of cooperation among ports exist. The cooperation may be defined as a continuum from a maximum level, that is the merger, to a minimum one, that is the alliance on specific projects, as Fig. 1 shows (see [28, 33, 34]).

The merger conveys the decisions of the individual partners (e.g. authorities) into a new institutional subject (e.g. one new authority), that defines and pursues new and coherent goals. The description of the reform of the Italian port system in 2015, reported in Sect. 4.1, is an exemplificative case of merger process among port authorities.

The alliance allows the individual partners (e.g. authorities) to keep their own independency in order to pursue common objectives. The alliance has a limited period before becoming extinct.

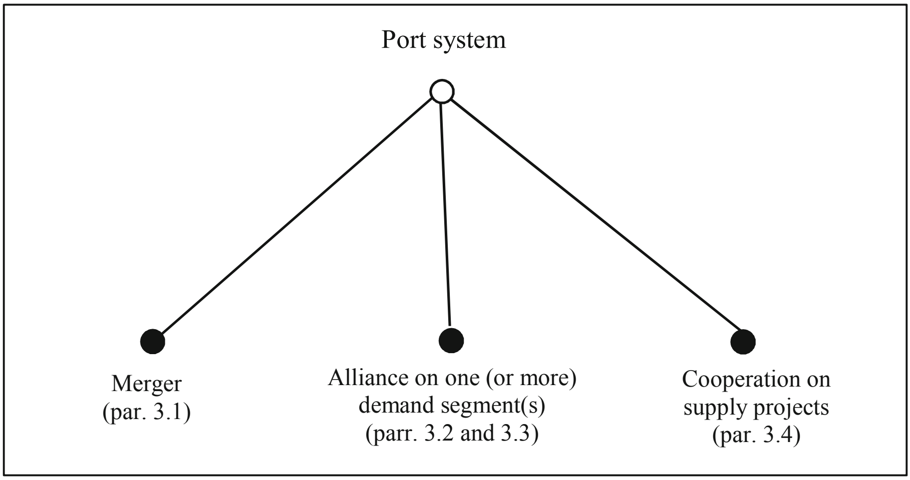

Fig. 1. Different levels of cooperation between ports.

Three functional types of alliance may be identified [22].

- *The cooperation in multiple market segments provides for the maintenance of strategic authority in each of the ports, and the sharing of management for the shared economic sectors.* The description of the pioneering cooperation between the two ports of Copenhagen and Malmö, belonging to different states, is representative of this type of cooperation.

- *The alliance on one market segment is particularly widespread for the container sector in which the three processes (gigantism, alliances, sea-land integration) have the greatest impact.* The three case studies of Seattle and Tacoma (USA), Kobe and Osaka (Japan), and Ningbo and Zhoushan (China), are representative of this type of alliance as their cooperation was carried out by sharing the container market segment. The opening of a discussion table between Shanghai and Ningbo-Zhoushan, which could produce the largest container port system in the world, is an example of the prospects that this type of alliance offers.
- *The cooperation on a single infrastructure project is the weakest form of alliance. In this case neither the policy nor the management are shared. The collaboration is only on the creation of an infrastructure of common interest for the two ports.* The case study of Los Angeles and Long Beach (USA), who started to cooperate on the base of a common infrastructural project, belongs to this type of alliance.

According to this approach, the definition of fourth-generation port [7], that considers common operators and administrations, may be actualized by considering two main categories of cooperation (see [27, 30]):

- vertical cooperation of ports.
- horizontal cooperation among the ports.

In the two cases the term cooperation holds. While the cooperation between shipping lines has been popular since several years and co-exists with competition; the attitude to cooperate between ports in proximity, or inside a territorial system, was carried out by port authorities, and in general by public bodies. Their general strategy may be deployed by means of two elements. The first one allows ports, belonging to a territorial system, to have cooperative interactions in order to increase the competitiveness of the whole territorial system (or of the port) while simultaneously improving the performances of individual ports [34] and [35]. The second one supports the inclusive port development of the economy participating to the development of the port related area [37].

4 Conclusions

The problem of merger and of alliance between the ports is a crucial issue of the current evolution of maritime transport. Due to carrier alliances and to increasing dimension of ships, some ports operate according to new patterns, moving from the historical and well-known competition attitude towards a cooperation one.

This process could be observed in some important nodes of transport and logistics of world trade scenario: from Europe, to USA, Japan and China. The issues of this change could allow to understanding the future evolution of the international port network.

The main conclusions that can be drawn concern two main elements. The first concerns the possibility of using the basic equations of Transportation System Models (TSMs) to explain how port systems respond to the major changes that have occurred in the maritime transport sector (gigantism, alliances, land-sea integration). The second group of conclusions concerns the possibility of aggregating the real observed cases in some representative macro-cases of coopetition between ports, in order to be able to study the resulting systems with TSM methods.

The work may be considered as a step of the research because it opens several directions to study the maritime system with TSMs. The core equations of TSMs could allow to extend the consolidated quantitative methods developed in the field of passengers' mobility and freight distribution on terrestrial transport networks to the field of maritime transport and ports. The use of the TSM makes it possible to compare in the same formal context the different conditions in which the various ports that are part of the alliance can operate, without the need to use different formal environments for the various conditions of coopetition that may arise.

The proposed approach is particularly useful for policy makers because it allows to study the system in the various phases, evaluating, for each one, the costs for the users and therefore the effectiveness. The approach is also useful for technicians because it allows to integrate the port node in the simulation models of the overall transport system (sea and land), thus allowing to arrive at a single overall model.

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