



Inland container logistics and interports. Goals and features of an ongoing applied research

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1. Introduction

In a container transportation and logistics network, we define an interport as a common user hub facility located in the hinterland of one or several seaports, and where different services are available to carriers and shippers, such as: container stuffing and unstuffing, rail-road transshipping, temporary storage of import/export full and empty units, customs clearance and inspection, container tagging and sorting, container and vehicle maintenance and repair, and even the opening, manipulation and processing of the containers' content for later marketing efforts at ultimate destinations.

The interport's functions thus range from simple cargo consolidation/deconsolidation and intermodal switching to customs operations and advanced quasi-manufacturing and distribution logistic services (assembly, kitting, packaging, labelling, quality control, reverse logistics, city logistics, etc.). Interports represent an innovation posing challenges and opportunities for many operators involved in freight transport, logistics, manufacturing and trade.

In the following sections, after a brief general presentation of some main features of the containerisation and intermodality, we focus on inland container logistics and interports. More specifically, we deal with issues related both to the meaning of the term "interport" and the functions of this new kind of inland freight node with reference to the case of Italy and by considering the recent evolutions in container transportation and logistics networks. Furthermore, we introduce some preliminary topics related to the interport-seaport system in Campania, a region lying in Southern Italy, by describing some technical and organisational features of the regional rail freight network and in particular of the interport-seaport railway connections. We also illustrate the case of Marcianise in Campania as a relevant example of Italian interport. Finally, we describe the main goals and features of an ongoing research concerning an empirical application of a mathematical programming model to optimize the distribution of container flows through the Campania seaports and interports.

2. Containerisation and intermodality: a brief introduction

The year 2006 marked the 50th anniversary of the containerisation since the first containership, the Ideal-X, left the Port of Newark (New Jersey) to reach the Port of Houston (Texas). Instead, the first vessel employed in international containerised commerce sailed from New York to Rotterdam in 1966. During the last decades, the containerisation has grown rapidly, becoming a dominant technique in the international general cargo trade and irremediably transforming both the transportation industry and the geography of production and distribution (Levinson, 2006).

Containerisation can be considered as the industrial revolution of the general cargo transportation and handling methods. The main rationale behind the setting of container transportation systems was to improve the efficiency of transshipments from a cost, time and reliability standpoint. By the

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employment of such systems, the cargo is packed into the load unit at the consignor and taken out at the consignee. In between, all transport and turnover facilities can mechanically handle the container as a standard-type cargo. This reduces the cargo handling costs and the staying time of the transport vehicles in the nodes. Goods that might have taken even days to be loaded or unloaded from a transportation vehicle can now be handled more quickly and safely.

Containerisation and globalisation are synonymous with each other. The vast improvements in cargo handling efficiency due to the introduction of containers resulted in lower costs and freight charges and, in turn, boosted trade flows. The highly competitive nature of the container, together with its multimodal efficiency and ability to keep goods relatively safe and damage-free during transit, have enabled multinational companies to outsource their production to lower cost countries, especially in Asia.

By 1970, world ocean container traffic had reached approximately 4-5 million TEU¹; since then the growth has been explosive, and the volume of the full container traffic now stands approximately at 130 million TEU and is expected to reach a figure of roughly 140 million TEU by 2010. Instead, the world containerport throughput in 2006 has exceeded 440 million TEU, including sea-sea transhipped as well as empty containers, and is expected to reach a figure of approximately 630 million TEU by 2010 (Containerisation International Magazine, 2007; Drewry Shipping Consultants, 2006; Slack, 2001; ESCAP, 2005).

The content of a container can range, for instance, from personal computers to boxes of potato chips, and from shoes to sacks of cement. Even automobiles, refrigerated articles (such as meat and vegetables) and commodities normally shipped in bulk form, such as grain and coal, are sometimes carried in containers. About the only kind of freight that cannot be containerized consists of large dimensional commodities such as construction equipment, turbines and other oversized machinery (Middendorf, 1998).

Container transportation is nowadays the major component of the freight intermodality, that is the transportation of unitised cargo by a combination of truck, rail, barge and above all ocean shipping over long distances. In such a system the relative advantages of each mode of transport can be combined in order to provide the most efficient door-to-door service possible. On the other hand, the simplicity of the container has permitted its adaptability and flexibility in a wide range of market conditions (Ferrari 2000; Forte, 1994, 2008; Marchese, 2000; Petriccione e Carlucci, 2006; Siviero, 2005; Slack, 2001; Stopford, 1997).

Intermodality has become a major goal in European Union Common Transport Policy (and generally in any modern transport policy). It should allow for a more efficient and environmentally sustainable European Transport System, exploiting the characteristics of each transport mode and maximising practical benefits of the users (Galloni, 1999)².

Several infrastructural nodes facilitate the transfer of containers between transportation modes and vehicles, namely:

- initial and final seaport container terminals, where the load units are transferred between the ocean shipping and land transportation modes;
- hub seaports performing sea-sea transshipment operations within the framework of modern hub-and-spoke maritime systems³.
- inland freight nodes providing transfer facilities between land modes and permitting the extension of hub-and-spoke practices also in landside container logistics.

¹ In 1964, the International Organization for Standardization (ISO) established common dimensions for containers of 20 or 40 feet long and 8 feet wide. The acronym “TEU” stands for “Twenty-foot Equivalent Unit”, the standard unit of measurement for container traffic. A standard 40 feet long container equals 2 TEU.

² More recently, the European Commission has also introduced the new concept of “co-modality” to define a new transport policy approach promoting the domains of relevance of both the various single transport modes and their combinations, in the aim to obtain an optimal and sustainable utilisation of resources (EC, 2006).

³ Further hubbing practices in maritime transportation are those related both to the relay and interlining systems (Dynamar, 2007).

From the initial spreading of the containerisation up to now, modern ports and container terminals have been built to efficiently and efficaciously accommodate modern liner vessels and perform container transfer operations through the employment of specialised equipments. New nodes on hinterland routes of seaports have also been built to function as regional inland satellite terminals with frequent connections to the main container terminals. On the other hand, dedicated landside transportation services have been developed and promoted, such as for example the North American “land-bridges” providing container carriage by long, double-stack trains operated by independent subsidiaries of the rail companies between the East and West coasts of the continent. In Europe, rail-based container shuttle services have instead been developed by the railroads themselves, rail-trucking groups, shipping lines and forwarders (Beuthe and Kreuzberger, 2001; Crainic and Kim, 2007; Priemus and Konings, 2001; Rodrigue and Hesse, 2007; Slack, 1990, 1999, 2001).

Containerisation and intermodality revolutionised and redefined the modern shipping, ports and, at a later stage, inland transportation. Containerisation allows carriers to realise huge economies of scale in transportation (Brooks, 2000; Cullinane and Khanna, 2000), while the need to decrease turnaround times for the means of transport leads to the concentration of flows on a restricted number of nodes acting as turntables in extensive maritime and inland hub-and-spoke networks. Definitively, intercontinental shipping and the increasing concentration of container flows in a limited number of load centres generates a relevant increase in distribution requirements and, as such, favours the conditions for large-scale sea-sea and sea-land intermodal initiatives (Notteboom, 2001; Notteboom and Winkelmanns, 1998; 1999).

2. Inland container logistics and hinterland freight centres’ role for the efficiency and competitiveness of seaports and supply chains

Containerisation’s impact has been significant not only on the maritime transport systems but also with reference to inland transport systems which are functional and complementary to the formers, permitting the emergence of the globally and intermodally oriented integrated logistics. In particular, inland freight centers and port-hinterland distribution issues are currently gaining more and more importance in relation to the efficiency and competitiveness of seaports and international maritime-oriented supply chains.

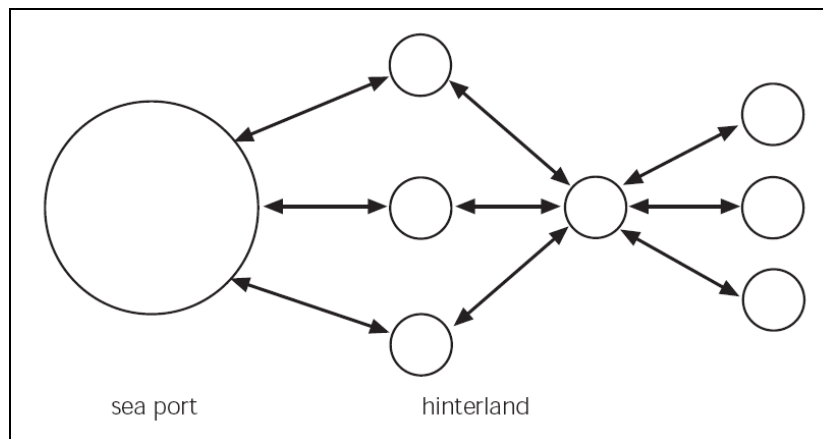
Some influential researches dealing with inland container logistics topics have been conducted by Beuthe and Kreuzberger (2001), Cappelli *et al.* (2007), China Intermodal Transport Services to the Interior Project (ITSIP) (2003), Crainic and Kim (2007), Dalla Chiara *et al.*, (2002), ECMT (2001), Hayut (1980), Libardo and Nocera (2006), Notteboom (1998, 2001, 2002, 2004a, 2004b), Notteboom and Rodrigue (2004, 2005, 2007), Notteboom and Winkelmanns (1998, 1999), Ocean Shipping Consultants (2004, 2007), Priemus and Konings (2001), Robinson (2002, 2005), RFI *et al.* (2005), Roso (2006), Roso *et al.* (2006), Salucci (2006), Slack (1990, 1999), and UNCTAD (1991). For instance, as reported in Notteboom (2004a), the portion of inland costs in the total cost of door-to-door container transport can be estimated to range from 40 per cent to 80 per cent. The shift of balance from ship costs to landside costs is favoured by transport price evolutions. As a matter of fact, containerships’ overcapacity poses limits on ocean freight rates, while inland pricing is much more cost-driven. As such, the increases of costs in landside container logistics tend to pass through to price levels more easily compared to ocean shipping operations, thereby increasing the absolute difference between both items.

Furthermore, Notteboom and Rodrigue (2004, 2005) have also identified a “port regionalization” phase representing a new stage in port development featured by higher levels of integration between seaports and inland distribution systems. In particular, customers are currently becoming more and more sensitive to the total logistic costs of transporting containerized goods, implying that it is increasingly being acknowledged that inland distribution constitutes an important area for efficiency improvements. Definitively, the evolution of the ports’ role in modern supply chain management requires the development of inland terminals and logistic centres to accommodate new

value adding port-hinterland linkages. Port regionalisation phase being taking place in some areas in Europe and USA is just featured by a strong functional interdependency and even joint development of specific seaports and selected multimodal logistic platforms in their hinterland.

The increasing volume of containers moving through the ports, regardless of hub ports, gateway ports or feeder ports, places great stress on the land transport interface, while generating a need for highly frequent, fast, reliable and cost-effective intermodal connections to the hinterland. On the other hand, the emergence of global manufacturing and trading systems, in which raw materials, components, and final products are sourced, manufactured, distributed, and shipped globally, has profoundly reshaped the entire distribution and transport industry, with port and shipping services being at the forefront of these changes. The expansion of international freight traffic resulting from production specialisation and economic globalisation feeds the congestion of roads around major cities and in harbours. Space becomes scarce and it results expensive to further expand the transport networks and to develop additional economic activities in the surrounding areas of seaports. Accordingly, containerisation and globalisation are inducing a search for new logistic network organisations and solutions through the development of inland facilities to relieve congestion in port areas, rationalise the pattern of inland freight movement, offer modern and integrated value added services, enlarge the port hinterland and attract additional traffic. Furthermore, some of these inland nodes may even develop into “master hubs” with connections extending to several seaports, dependent on the distances to these ports and related transit time and costs (Beuthe and Kreuzberger, 2001; Notteboom and Winckelmans, 1999; Slack, 1999). Amongst others, this development can lead also neighbouring smaller containerports to seek direct connections to the new master hubs, through which extended hinterland networks become accessible without having to remain dependent on large maritime hubs. An illustrative example of a hinterland network is depicted in Figure 1.

Figure 1 - Example of a hinterland network



Source: Ocean Shipping Consultants, 2004

In recent years, there has been some emphasis on the role of inland freight centres where operations not necessarily requiring to be carried out in the seaport area can take place. On the other hand, transportation planners are also recognising that hinterland nodes may enhance multimodal trade corridors.

From a functional perspective a distinction must be made between facilities providing only intermodal and cargo handling services, and those operating as intermodal and logistic centres where a range of value added services is supplied by different firms. In fact, the service portfolio of an inland center can be more or less broad. It may not only be functioning as the usual nodal point for bi-modal (road/rail or road/barge) or trimodal (road/rail/barge) container flows, but also as an inland depot for the lines where empty containers can be collected. In addition, a hinterland freight center may perform administrative services (e.g. customs declarations) and logistic services

(stuffing, stripping, goods handling, warehousing, quasi-manufacturing, and so on). Also, it may be tied to the production process of the importer by supplying the process with goods in a just-in-time concept (Ocean Shipping Consultants, 2004; 2007).

Moreover, by adapting the classification of Roso (2006) and Roso *et al.* (2006), it is possible to distinguish inland freight centers according to the distance from seaports, namely:

- distant inland freight centers;
- mid-range inland freight centers;
- close inland freight centers.

The advantages of a distant inland node consist of cost savings by making use of rail and/or barge, rather than road, over long distances, and of the extension of port hinterland. A mid-range inland node is likely to make use of road transport from the seaport and act as a consolidation point for rail and/or barge services, although high capacity flows may make dedicated container rail and/or barge services viable. A close inland node is situated in the immediate vicinity of a seaport and provides a buffer to the seaport by enabling greater terminal capacity, possibly through the operation of shuttle services.

The pricing structure of hinterland nodes generally is similar to that of seaports. However the price levels are significantly lower than at seaports. Inland freight centers usually have lower costs for land, surface, buildings, labour, information technology (IT) and equipment. Container storage rate and time conditions in particular are substantially more favourable, allowing the shipping lines to set up and maintain their inland depot function, and the shippers to optimize the terminal buffer function. Usually, the promotion of an inland node is not only directed at the regional head offices of the shipping lines, but especially at the local offices and agents of these lines in the vicinity of the center. Anyway, the focus is mainly on the importers and exporters in the catchment area of the center. They can instruct the lines to use the terminal, whether under merchant haulage, merchant inspired carrier haulage or full carrier haulage.

Moreover, the rail or barge connections established to promote traffic between seaports and hinterland freight nodes are normally operated by specialised companies, who also provide the traction and rail wagons or the barge vessels. In establishing a true network strategy, a port may also wish to become involved in such connections. This involvement may take place in different way, that is:

- operationally, by aligning the information services, planning, logistics and arrival/departure times;
- commercially, by promoting the connections;
- financially, by joining the risk of capacity utilisation.

However, joint ventures for new connections can be set-up to benefit from the operational, financial and commercial synergies (Ocean Shipping Consultants, 2004; 2007).

As reported in Bichou (2005), the integration of port operations and inland logistics may prove to be beneficial to ports at several levels. Firstly, it allows for a diversification of the port services mix, therefore reducing the dependence of port income on shipping services. Secondly, it redirects part of port investments and financial capabilities towards the improvement of landside networks, stimulating the regional socio-economic development. Thirdly, inland-oriented strategies provide ports with a prevailing competitive advantage over neighbouring ports and other rival competitors. Lastly, but not leastly, such strategies will enable ports to fully integrate the logistic and transport chain, hence providing for an effectual and central role for ports in competitive and efficient global logistics and distribution systems.

4. Interport as intermodal and logistic inland node: the case of Italy

The term “interport”, which indicates a particular type of inland freight center, has been informally put into force in 1970 during a round table on “Land, maritime, rail and air freight centres” held in the city of Padua (in Veneto region, Northern-Western Italy), while in international bibliography interports come under different terms, such as “plateformes logistiques” (France),

“guterverkehrszentren” (Germany), “transport centres” (Denmark), “freight villages” (United Kingdom), “rail service centres” (Netherlands), “centrales integrales de mercancías” (Spain). Instead, in Japan, Singapore, China and the USA, the most common and widely used term to indicate an interport is “logistic centre”. Therefore, there is no unanimous definition of this kind of inland freight node and in some cases differences between countries exist not only in terms, but as far as the concepts and detailed solutions are concerned as well (Ballis, 2006; Dalla Chiara *et al.*, 2002; Europlatforms EEIG, 2004; Jaržemskis and Vasiliauskas, 2007; Kapros *et al.*, 2005; Meidute, 2005; Rimiene and Grundey, 2007; Tsamboulas and Dimitropoulos, 1999; Uniontrasporti, 2007). Nevertheless, the article 1 of the Law No. 240 (“Italian State support for building Interports and developing intermodality”) decreed by Italian Parliament in 1990 established a legal definition as well as activities and functions of the interports. In particular, the Italian legislation, whose final goals consist of developing an integrated transport system and containing environmental impacts as much as possible, defines interport as “*an organic complex of integrated facilities and services providing for the exchange of goods between the various transport modes, including a railway yard capable of composing and accommodating complete trains and linked to seaports, airports, and highways*”. The main services of an interport consist of transport and sorting of load units, stocking of goods and further services such as customs, maintenance of vehicles and containers, service areas, etc. The key functions are those of rationalising transport flows and supporting modal shift from road to rail.

In 1992, Europlatforms, the European Association of freight villages (in Italy, France, Spain, Denmark, Portugal, Luxembourg, Greece, Hungary, Ukraine), defined the interport/freight village/logistic centre as “*...a defined area within which all activities relating to transport, logistics and the distribution of goods, both for national and international transit, are carried out by various operators. These operators can either be owners or tenants of buildings and facilities (warehouses, break-bulk centres, storage areas, offices, car parks, etc.) which have been built there. Also in order to comply with free competition rules, a freight village must allow access to all companies involved in the activities set out above. A freight village must also be equipped with all the public facilities to carry out the above mentioned operations. If possible, it should also include public services for the staff and equipment of the users. In order to encourage intermodal transport for the handling of goods, a freight village must preferably be served by a multiplicity of transport modes (road, rail, deep sea, inland waterway, air). Finally, it is imperative that a freight village be run by a single body, either public or private*” (Galloni, 1999).

Furthermore, in 2001, the United Nations - Economic Commission for Europe in collaboration with both the European Commission and European Conference of Ministers of Transport defined the interport/freight village/logistic centre as “*geographical grouping of independent companies and bodies which are dealing with freight transport (for example, freight forwarders, shippers, transport operators, customs) and with accompanying services (for example, storage, maintenance and repair), including at least a terminal*” (UNECE *et al.*, 2001).

From an operational point of view, the first prototype interports were created in France, notably Sogaris and Garonor near Paris, in response to urban policy criteria. In the late 1960s and 1970s, interports appeared in Italy and Germany, by following the concept of extended inland intermodal terminals. In the 1980s and 1990s, the number of interports multiplied in France, Germany, Italy, Netherlands, Belgium, and the United Kingdom.

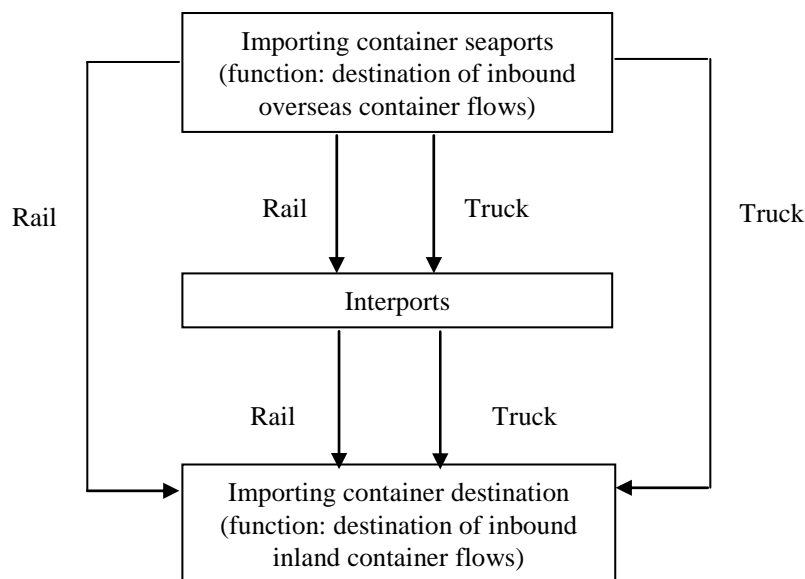
Italy has been the first European country to conceive and realize interports as infrastructural networks for intermodal transport and nowadays the Italian interport system is one of the most important in the continent. In particular, the first interport has been put into operation in the 1966 in Rivalta Scrivia (in Piedimont region, Northern-Western Italy) with the aim to accommodate the traffics of the Genoa Port, while during the 1970s also the interports of Bologna (in Emilia Romagna region, Northern-Eastern Italy), Verona and Padua (in Veneto region) were realised. Subsequently, the introduction of the Law 240/90, by financially supporting the interports’ development and the related concentration of various activities in these sites, contributed to make

the most of rail transport and increase both the effectiveness and range of interport logistic services. As a matter of fact, from their initial development up to now, Italian interports have also increased their services in terms of handling, storage, palletisation and manipulation of goods. What is also significant is the effort the interports are making with regards to management of particular services such as the banking and, above all, information technology (IT) systems.

Definitively and by considering the recent evolutions in container transportation and logistics networks in Italy and abroad, we define an interport as a common user hub facility located in the hinterland of one or several seaports, and where different services are available to carriers and shippers, such as: container stuffing and unstuffing, rail-road trans-shipping, temporary storage of import/export full and empty units, customs clearance and inspection, container tagging and sorting, container and vehicle maintenance and repair, and even the opening, manipulation and processing of the containers' content for later marketing efforts at ultimate destinations.

The functions of these inland freight centres thus range from simple cargo consolidation/deconsolidation and intermodal switching to customs operations and advanced quasi-manufacturing and distribution logistic services (assembly, kitting, packaging, labelling, quality control, reverse logistics, city logistics, etc.). Figure 2 summarises a typical process of inland distribution of imported containerised goods involving interports. The process is reversed for containerised goods to be exported.

Figure 2 - Inland distribution of imported containerised goods involving seaports and interports: a conceptual schema



Source: authors' adaption from Cullinane *et al.* (2002)

Normally, an interport is located in a 40-150 ha territory served by major transportation arteries, but depending on the activities, the size can also reach up to 400-500 ha. The facilities of the interports should include the followings:

- Intermodal terminal and handling equipments;
- Customs area and equipments;
- Container freight station (CFS) for stuffing and unstuffing services;
- Warehouses;
- Large-sized warehouses (for logistics activities);
- Warehouses interfaced to railway tracks;
- Public warehouses;
- Controlled temperature warehouses;

- Offices for administration activities and IT services;
- Container and/or vehicle maintenance area and equipments;
- Filling station;
- Car park;
- Bank/post office;
- Motel;
- Restaurant/self service/bar.

Interport represent an innovation posing challenges and opportunities for many operators involved in freight transport, logistics, manufacturing and trade, while particularly offering to the local productive systems the best solutions in terms of transportation, warehousing and logistics activities. The close co-operation between different companies within such a type of inland node creates opportunity to plan international transport and optimise the use of equipments and resources. On the other hand, the geographical concentration of firms favours synergies and economies of scale which make the chosen location even more attractive and further encourages also other firms to carry out activities in the interport.

An important feature is the interport's tendency to co-operate nationally and internationally, and therefore create innovative and efficient transport chains and network logistic solutions for optimal cargo distribution. Furthermore, an interport located near a large city may help to reduce traffic congestion inside urban areas, increase the transportation vehicles' load factor, limit the transport effects on the environment, and definitively improve the regional competitiveness and quality of life.

According to the data of the Italian Ministry of Infrastructure and Transportation reported in a recent research on logistic topics carried out by SRM (2007), Italian interport system is currently composed by 19 operational facilities, a large number of which are recognized by Law 240/90, plus additional 9 facilities yet to be completed and 8 facilities in the planning phase (Table 1).

A common characteristic of the Italian interports is that for their realization, the collaboration of several bodies coming from different sectors was required, such as for instance:

- Local actors (e.g. chambers of commerce, local transport and/or manufacturers associations, etc.);
- Government bodies;
- Transport companies (e.g. intermodal operators);
- Banks.

Nevertheless, the investments for the development of the interports were made mainly by using the funding by public bodies and the Italian Railways. According to the Italian legislation, interports may be realised either as public companies or as a Public-Private Partnerships (P.P.P.).

The land is often property of the development companies and may either be bought or rented. Anyway, by taking into account that a great proportion of the companies established in the interports are small and medium sized users, the leasing is often more popular than buying buildings, facilities and land.

According to a recent study issued by CENSIS and UIR (2006), the direct employment generated by the interports currently operating in Italy amounts to 27,000 workers, while the added value amounts to 1.6 billion euros, equal to 2% of the added value generated by the whole national transport sector and supporting logistic activities. Even more significant is the Italian interport system's contribution to the transport supporting logistic activities sector only, accounting for 11% of the added value and 9% of the direct employment. Finally, by taking into account the total sales and the intermediate costs for facility operations and investments made by the Italian interport network, the total financial resources mobilised amounts to 4.9 billion euros, which constitute to the GDP generated by the sector.

Table 1 - Geographic distribution of Italian interports

Area	Operational interports	Interports to be completed	Interports in planning stage
Piedimont region	4		
Lombardia region	0		3
Liguria region	1		
Aosta Valley region	0		
Northern-Western Italy (total)	5	0	3
Veneto region	4		1
Friuli Venezia Giulia region	2		
Trentino Alto Adige region	1		
Emilia Romagna region	2		
Northern-Eastern Italy (total)	9	0	1
Lazio region	1	3	
Toscana region	2		
Marche region		1	
Umbria region	0		
Central Italy (total)	3	4	0
Abruzzo region		1	
Molise region			1
Campania region	2		1
Apulia region		1	
Basilicata region			1
Calabria region		1	
Sicily region		2	
Sardinia region			1
Southern Italy (total)	2	5	4
ITALY (TOTAL)	19	9	8

Source: elaboration of SRM (2007) on data of the Italian Ministry of Infrastructure and Transportation

5. An example of Italian interport: the case of Marcianise in Campania region

5.1 Brief presentation of the Campania interport-seaport system

Campania is a very dynamic region of the Southern Italy, the Italian “Mezzogiorno”. It is endowed with a wide road and railway network and it is crossed by the Berlin-Verona/Milan-Bologna-Naples-Messina-Palermo TEN-T railway corridor planned at European Union level and to be fully completed in the future.

Campania first-tier sea-land intermodal logistic system (Figure 3) is currently based on the Tyrrhenian regional seaports of Naples and Salerno, and on the interports of Nola and Marcianise. A third interport, in Battipaglia, is currently under construction. Furthermore, in Campania there is an international airport (Capodichino) as well.

Campania region can be considered as an important territorial logistic platform of the whole Southern Italy, by providing good access conditions and services for containerised goods over the Asia-Europe route. Even if the Campania interport-seaport system’s container trades currently extend only over a regional/national commercial hinterland, in perspective also Northern European areas can be served. On the other hand, by considering the current intermodal transit times from Shanghai to Munchen both via Naples and Rotterdam, it can be observed a relevant benefit in terms of time (six days) for the first option (Table 2).

Figure 3 - Campania region first-tier sea-land intermodal logistic network configuration (plus Capodichino airport)

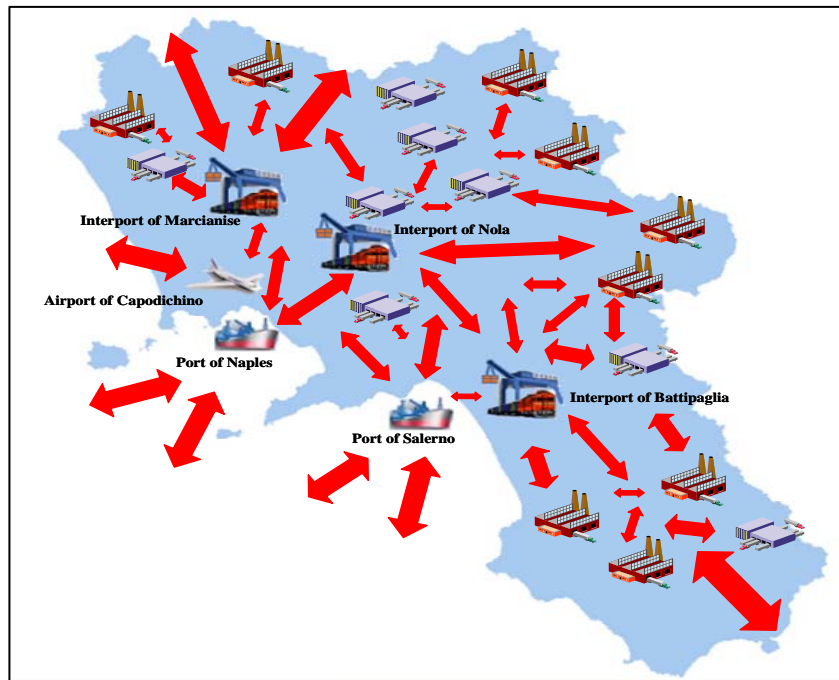


Table 2 – Intermodal transit times from Shanghai to Munchen via Southern and Northern Europe

	Shipping line	Transit time from Shanghai port to the European port (days)	Rail company	Transit time from the European port to Munchen (days)	O/D transit time (days)
From Shanghai port to Munchen via Naples port	MSC	21	RTC/Kombiverkehr	3	24
From Shanghai to Munchen via Rotterdam port	MSC	29	Intercontainer	1	30

Source: elaboration of Marchetiello (2007) on operators' data

Moreover, it is also expected that Campania will perform a significant logistic role with regard to the trade growth favoured by the future establishment of the Euro-Mediterranean Free Trade Area and therefore by the possibility of easily interconnecting Northern and Central European industrial and consumer areas with the shores of Northern Africa and Middle East (D'Agostino and Iannone, 2004; Iannone and Varrone, 2006; Marchetiello, 2007).

5.2. Some technical and organisational features of the Campania railway network and interport-seaport connections

Figure 4 illustrates the infrastructure network for the rail freight traffic interesting Campania region and in particular the railway routes connecting seaports and interports.

By analysing the rail network's morphology, it is possible to identify the following lines and line segments of national relevance (Iannone, 2006; La Pietra, 2005; RFI *et al.* 2005):

- Alongside the North-South axis, two line segments belonging to the “Milan-Bologna-Firenze-Rome-Naples-Salerno-Reggio Calabria” line of the Italian railway network. Such line, over its route between Rome and Salerno, splits in two line segments: the first one via Formia, and the second one via Cassino-Caserta-Cancello. The first line segment via Formia is mainly dedicated to the passenger traffic and has better technical feature (in terms of rolling stock coding) than the second line segment via Cassino-Caserta-Cancello. Instead, this latter is mainly dedicated to the freight traffic. Both the two line segment are electrified and double track.
- Alongside the East-West axis, the electrified single track line “Caserta-Benevento-Foggia” and the line segment “Battipaglia-Sicignano (Potenza)”. In general, their layout is quite tortuous; in particular, their technical features are lower than those of the previous North-South line segments.

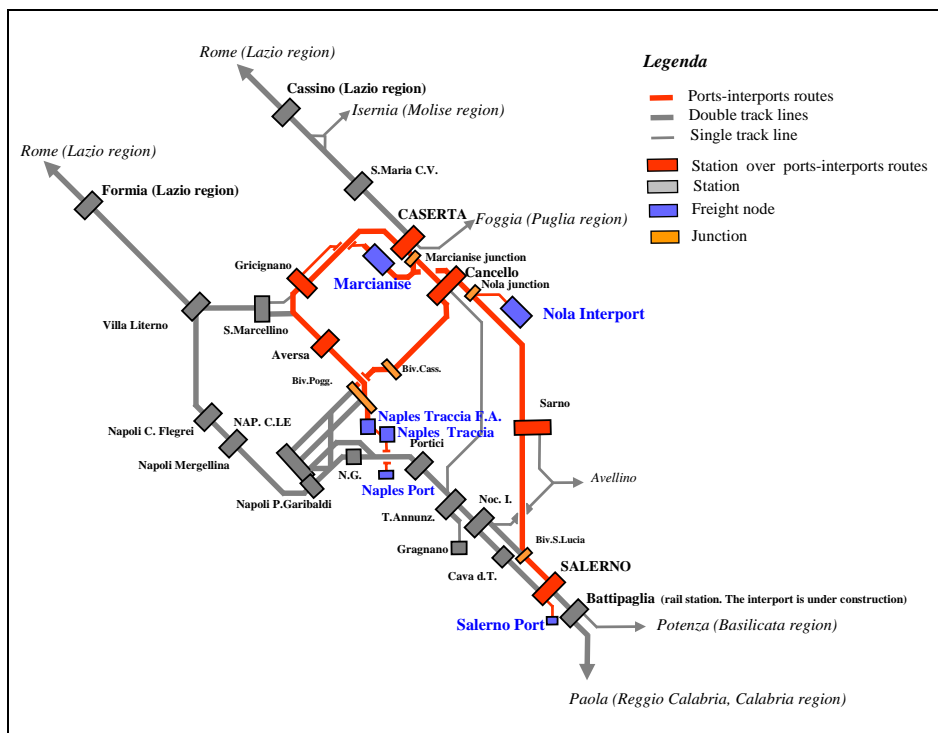
Other national relevant line segments in Campania region are the following:

- Benevento-Cancello (electrified single track);
- Caserta-Cancello-Naples (electrified double track);
- Caserta-Aversa (electrified double track);
- Villa Literno-Aversa (electrified double track).

Instead, the following line segments can be considered as line segments of regional relevance:

- Aversa-Naples (electrified double track);
- Santa Maria Capua Vetere-Marcianise-Cancello (electrified double track), serving Marcianise rail freight shunting station;
- Torre Annunziata-Castellammare di Stabia (electrified double track);
- Castellammare di Stabia-Gragnano (electrified single track);
- Cancello-Torre Annunziata (electrified single track).

Figure 4 - Campania rail freight network configuration and interports-seaports routes⁴



Source: adaption of Iannone (2006) from RFI *et al.* (2005)

⁴ Where not indicated in brackets, stations and destinations of rail routes represented in the figure belong to Campania region. Moreover, in the graph, Marcianise freight node encompasses Marcianise rail freight shunting station plus Marcianise interport.

By analysing the network, it is possible to point out that rail freight traffic on the North-South axis (both from/to Formia and Cassino) have to transit in the Marcianise rail freight shunting station, which is the node in which all national trains crossing the North-South axis of Campania rail network can perform train shunting operations, train composition operations, exchange of personnel, exchange of locomotives.

Cancello railway station has instead the role of fundamental node interconnecting various and different railway routes as well as Campania ports and interports. From the northern direction, trains coming from Rome (Lazio region) both via Formia station and Cassino station arrive in Cancello, by crossing either Caserta station (railway passenger services) or Marcianise rail freight shunting station (railway freight services). In any case, when arriving in Cancello, the trains directed to the Marcianise Interport continue their trip towards the Marcianise rail freight shunting station. Here the wagons are detached from the electric locomotives and coupled to the diesel locomotives of *RFI-Trenitalia*⁵ and *NAOS*⁶ in order to reach the intermodal terminal of Marcianise interport.

Towards the east, it is possible to reach Puglia region from Cancello either via Benevento or Avellino. Instead, from Naples (the Campania regional chief town) it is possible to reach Cancello both via Aversa and Acerra. In particular, the trains originating from Naples and destined to Nola interport have to reach before Cancello station because there is not a junction between the line segments Naples-Cancello and Salerno-Cancello. As a matter of fact, the rail station of Nola interport is located along the Salerno-Cancello line segment. Moreover, for organisational issues, such trains destined to Nola interport cannot reverse their direction in Cancello station and they are therefore obliged to continue their trip from Cancello to the Marcianise rail freight shunting station. Only in Marcianise rail freight shunting station the trains can reverse their running direction and continue their trip to the final destination of Nola interport (again via Cancello station)⁷.

From the Southern directions, trains arrive in Cancello station both from Salerno (via Nola junction) and Torre Annunziata. Due to infrastructural problems, also trains originating from southern Campania and directed to Nola interport via Sarno station have to cross Cancello station, Marcianise rail freight shunting station and again Cancello station before of arriving to destination. Furthermore, on all these line segments above indicated there are many level crossings interfering with road system and therefore increasing the transit times of freight trains from/to interports; in addition, such lines are employed for passenger traffic as well.

The Campania Region Public Authority for Transportation is closely cooperating with Gruppo *FS* (*RFI* in particular) and management companies of the first-tier intermodal and logistic regional nodes in order to overcome organisational and infrastructural difficulties currently affecting the operations over the railway network. Moreover, Campania is involved in an important infrastructure investment program related to the completion of a high-speed/high-capacity (HS/HC) railway line for passengers between Rome (Lazio region) and Naples, up to its extensions to other areas located in Southern Italy. The line is already in service from December 2005, even if various sections of its will be opened in different periods of time⁸. When fully completed, the 204.6km new high-speed line between Rome and Naples, will release capacity for freight transport on the existing railway network employed for both passengers and freight. In Figures 5 and 6 it is represented the Campania HS/HC railway infrastructural situation planned for June 2008⁹.

⁵ *RFI - Rete Ferroviaria Italiana* (in English, “IRN - Italian Railways Network”) is the State-owned company managing the whole Italian rail infrastructure network. *RFI* belongs to the State-owned “Gruppo *FS - Ferrovie dello Stato*” (in English, “SR - State Railway Group”). Also *Trenitalia* belong to the Gruppo *FS*. And it responsible for rail traction services.

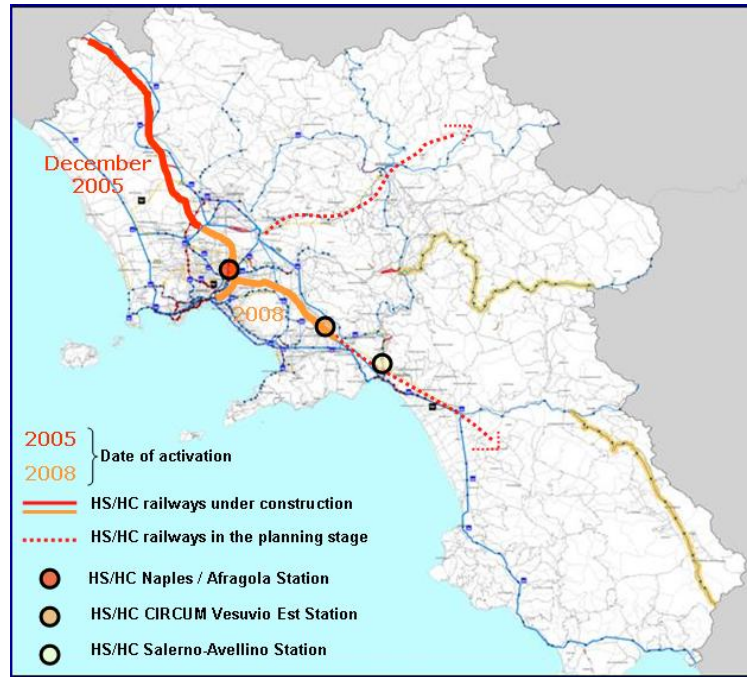
⁶ *NAOS* is a subsidiary company of the management and development company of Marcianise interport.

⁷ Summing up, a train originated from Naples and destined to Nola Interport has to transit alongside the “Naples-Cancello-Marcianise-Cancello-Nola” route.

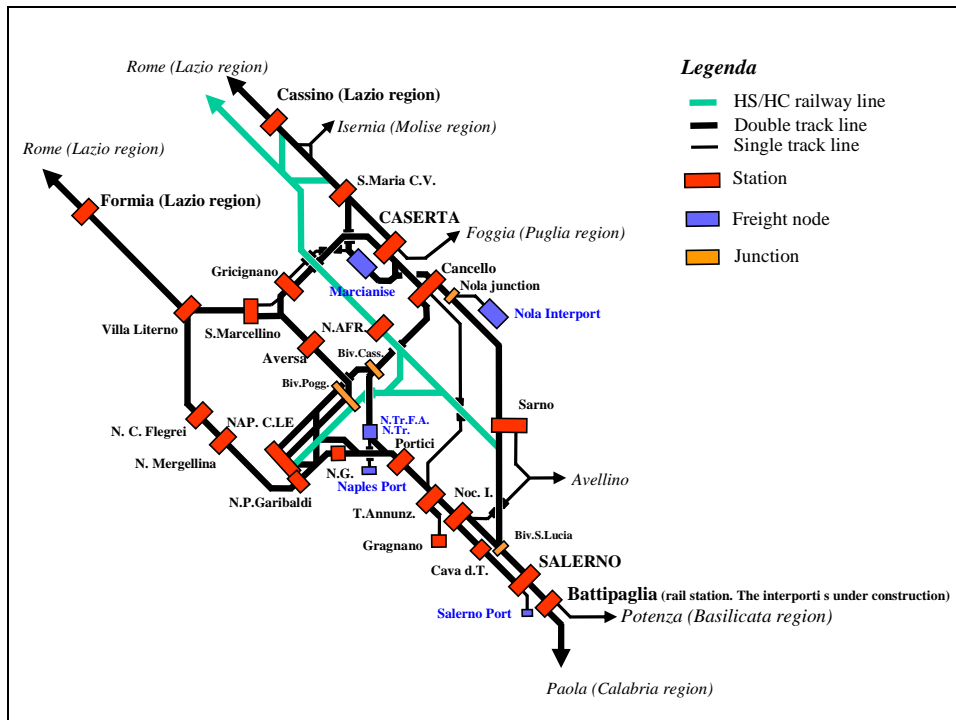
⁸ In Italy, besides the Rome-Naples line, high-speed lines for passengers are also in service from Turin to Novara, Milan to Treviso, Padua to Venice, and from Florence to Rome.

⁹ The new Rome-Naples line is a section of a wider HS/HC railway infrastructure project that, for example, in 2009 should connect six of the most important cities in Italy (Turin, Milan, Bologna, Florence, Rome and Naples) through a

Figures 5 and 6 - Rome-Naples high-speed/high-capacity railway line: the programmed situation in Campania for June 2008



Source: courtesy of Campania Region Public Authority for Transportation, 2005



Source: adaption of Iannone (2006) from RFI *et al.* (2005)

630km new line for passengers, bringing major reductions in journey times and a huge increase in capacity. This will be also coupled with the completion of some important track doubling project, while other more high-speed lines are either planned or in planning stage. In 2009, it will be also particularly completed the final 18km section of the new Rome-Naples line.

5.3. Technical and organisational features of the interport of Marcianise

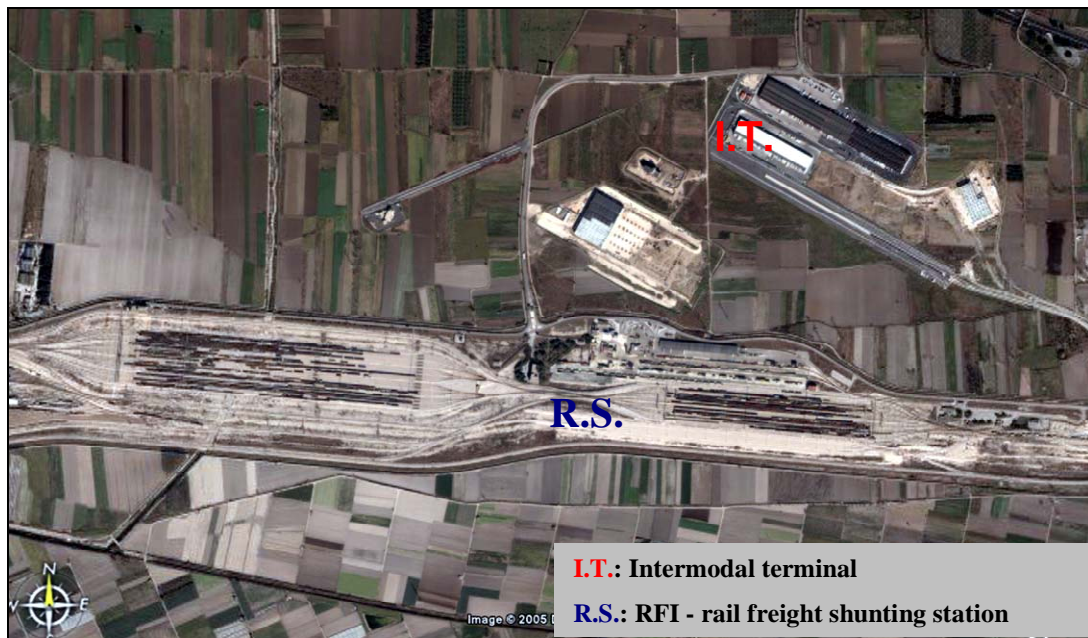
Marcianise interport, developed and managed by the *Interporto Sud Europa (ISE)* company (a subsidiary company of the *Barletta Group*), is a Campania relevant intermodal and logistic infrastructure belonging to the Italian National Integrated Transport System. It is one of the first-tier Italian interports and has been admitted to benefit from the public financing national Law No. 240/90. It is also member of Europlatforms EEIG.

Several third party logistics and freight transportation service providers, as well as distributors and retailers are located within Marcianise Interport, such as for example: *TNT, DHL, Schenker, Logista, Omnia-logistica, Artoni Trasporti, Chrono Express, Carrefour, and Decathlon.*

The interport lies on a 400 ha surface area endowed with rail-road intermodal facilities, warehouses, a commercial centre, and sophisticated anti-intrusion and entry monitoring security systems. It can easily serve and facilitate the trades coming from/directed to Capodichino international airport and seaports of Naples, Salerno, Taranto (Puglia region), Gioia Tauro (Calabria region), and Civitavecchia (Lazio region). As a matter of fact, Marcianise interport is located about 15 kilometres from Naples city and 4 kilometres from Caserta city, at the heart of Campania region and inside one of the Southern-Central Italy's richest areas in terms transport infrastructure. It is directly linked with the Naples-Milan A1 highway and the Caserta-Salerno-Bari route-Reggio Calabria A30 highway. All Southern Italy regions can be reached within a day completing the road haulage working schedule (back and forth driving, loading and unloading).

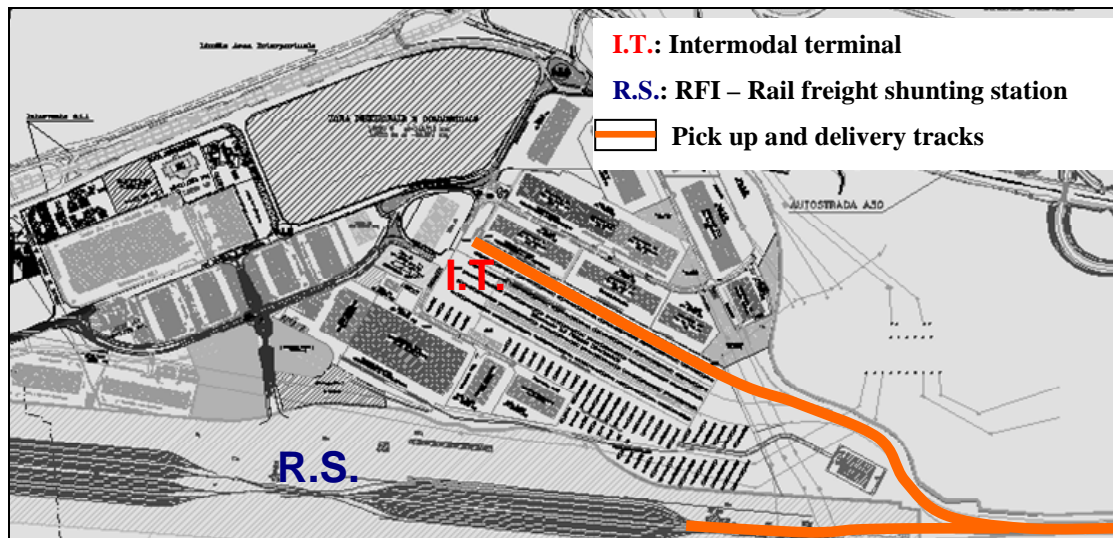
As far as the railway is concerned, Marcianise interport is located along the Tyrrhenian national backbone close to the high-speed Porta Campana station. It is also strictly close to the *RFI*-owned Maddaloni-Marcianise rail freight trains shunting station (200 ha), the largest rail shunting facility in Italy and also one of the most equipped and innovative in Europe. The interport and *RFI* station operate in strict synergy, constituting a unique integrated infrastructure lying on a 600 ha surface (Figures 7 and 8).

Figure 7 - Marcianise interport's satellite ortophoto



Source: adaption of Iannone (2006) from La Pietra (2005)

Figure 8 - Marcianise Interport planimetry



Source: adaption of Iannone (2006) from La Pietra (2005)

Definitively, in the interport of Marcianise the following 3 macro-areas can be distinguished:

- intermodal and logistic area;
- commercial and management area;
- *RFI* shunting station.

The intermodal and logistic facilities cover an area of approximately 2.6 million square meters, in large part currently being realised or in planning stage. Within this area, rail-road shunting operations, load unit storage, hazardous goods storage, customs services, goods handling, consolidation/deconsolidation, warehousing, distribution, quasi-manufacturing value added logistics and other supporting services, such as for example fuel filling, and maintenance and repair of load units, are performed.

In particular, the intermodal terminal lies on a 50,000 square meters surface and is currently equipped with 5 non-electrified tracks for trains loading/unloading and wagons temporary parking (Figure 9). In the future, a further terminal of approximately 60,000 square meters endowed with 7 tracks will be opened. The railway and intermodal terminal operations within the Marcianise Interport are carried out by *NAOS*, a subsidiary of *ISE*. In particular, besides the terminal operations, *NAOS* also operates diesel locotractor services to carry rail freight wagons from/to the Interport's intermodal terminal to/from Interport's non electrified pick up and delivery tracks. Furthermore, at the moment, Marcianise interport's terminal is endowed with a single reach stacker and various fork lift trucks and vehicles for handling. Sometimes, during traffic peak periods another reach stacker is rented.

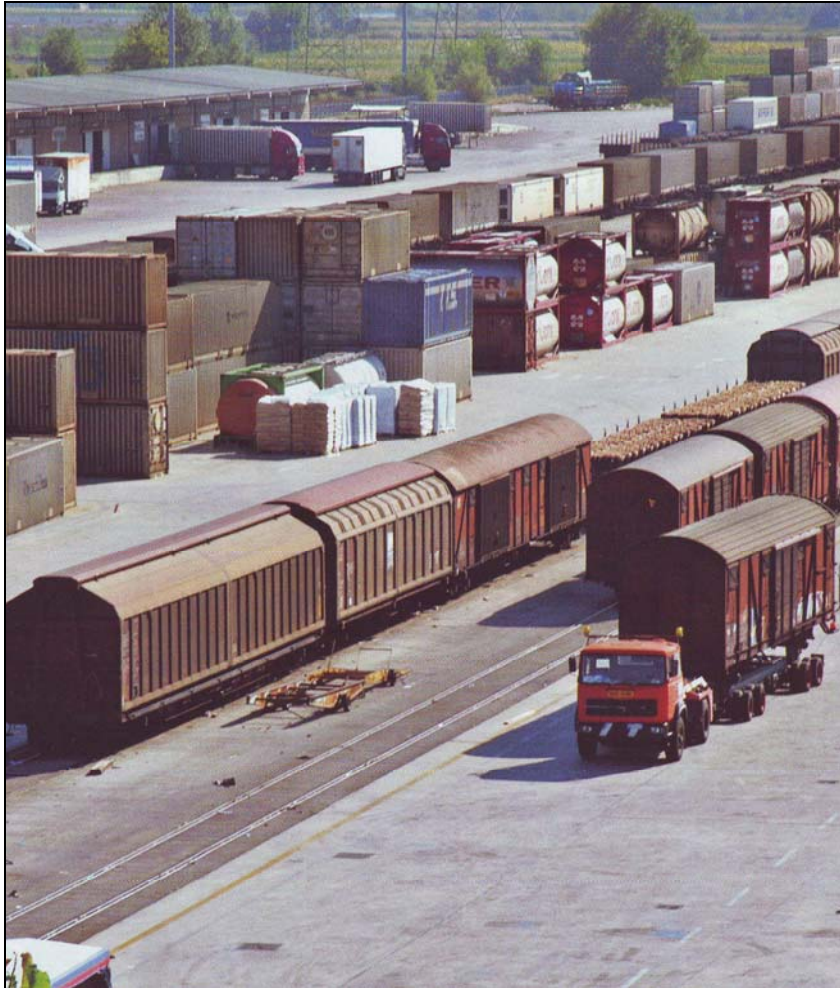
A significant share of Marcianise Interport rail traffic concerns conventional bulk cargo wagons carrying lumber (Figure 10). The lumber-carrying wagons originate from both Eastern Europe and Germany, arriving in Marcianise via Austria. From Marcianise the lumber is then distributed by road in Campania region, Puglia region, Basilicata region, and Calabria region.

The rail container traffic from/to the interport is currently increasing, with a huge potentiality particularly related to shuttle services from/to the port of Naples and Taranto, as well as from/to the Southern Rome area (e.g. Pomezia). Further rail cargo traffics of the interport are those related to the activity of *Logista* (logistic company specialised in tobacco and cigarette distribution) and *Omnialogistica* (*FS*-owned logistic company specialised in distribution of consumer goods on behalf of manufacturing firms).

The warehouses of the interport extend for over 180,000 square meters and further 450,000 square meters are to be completed and opened according specific requirements of customers. At the moment, two warehouses, respectively operated by *Logista* and *Omnialogistica* are directly

connected to the intermodal terminal tracks. In the Figures 11 and 12 are illustrated some warehouses of the interport.

Figure 9 – Marcianise interport’s intermodal terminal operations



Source: courtesy of Trenitalia and ISE, 2005

Figure 10 – Lumber rail wagons terminal operations within the Marcianise Interport’s intermodal terminal



Source: courtesy of LOGICA, 2005

Figure 11 and 12 – Some warehouses in the interport of Marcianise



Source: courtesy of ISE, 2006



Source: courtesy of Trenitalia and ISE, 2006

Moreover, the Customs activities in the interport are performed within an area of over 10,000 square meters of which 1,500 sqmt house offices of the new Customs House of Caserta, Coast Guard and carriers, while the remaining part is employed for storage and inspection purposes.

The commercial and management facilities of the interport extend over a surface of 1.3 million square meters of which 0.8 million sqmt consist of the “Campania” Shopping Centre area (with 180 specialised shops and hypermarkets, 25 restaurants and a multi screen cinema) and further warehouses, while the remaining 0.5 million sqmt are dedicated to management/executive offices, hotels, and other public offices and areas.

Finally, *RFI*-owned rail freight shunting station is equipped with a bundle of 21 arrival tracks, a bundle of 32 departures tracks (other 16 are under construction) and a bundle of 10 transit arrival tracks (Figure 13). These facilities are currently able to handle 150 national and international trains/day, that is up to a maximum of 3,500 freight wagons/day.

In particular, Marcianise rail freight shunting station handles almost the overall rail-road combined traffic of swap-bodies and road semi-trailers interesting the Campania region. Moreover, it handles a good share of total container-carrying rail wagons circulating over the Campania railway network. In the immediate proximity of the station there is an important independent intermodal terminal managed by *CEMAT*, an *FS*-controlled company moving the major share of national and international swap-bodies circulating over the Campania railway network.

Figure 13 - RFI rail freight shunting station's tracks (Marcianise-Maddaloni)



Source: courtesy of LOGICA, 2005

6. Goals and features of an optimisation empirical model for the distribution of maritime containers through Campania ports and interports: a preliminary presentation

Port regionalisation processes are being featured by the implementation of landside hub-and-spoke logistic networks. In particular, interports constitute a new kind of hub facilities and a challenging innovation in container distribution systems, being laid out in port hinterland areas and offering plentiful intermodal, customs and logistic facilities. Carriers and shippers may thus firstly minimise the containers' dwell time in the port areas (which may be expensive) by performing container import and export related operations at such inland nodes. Moreover, there are also opportunities related to the value enhancement of the goods carried in containers through advanced logistic services performed by interports' operators.

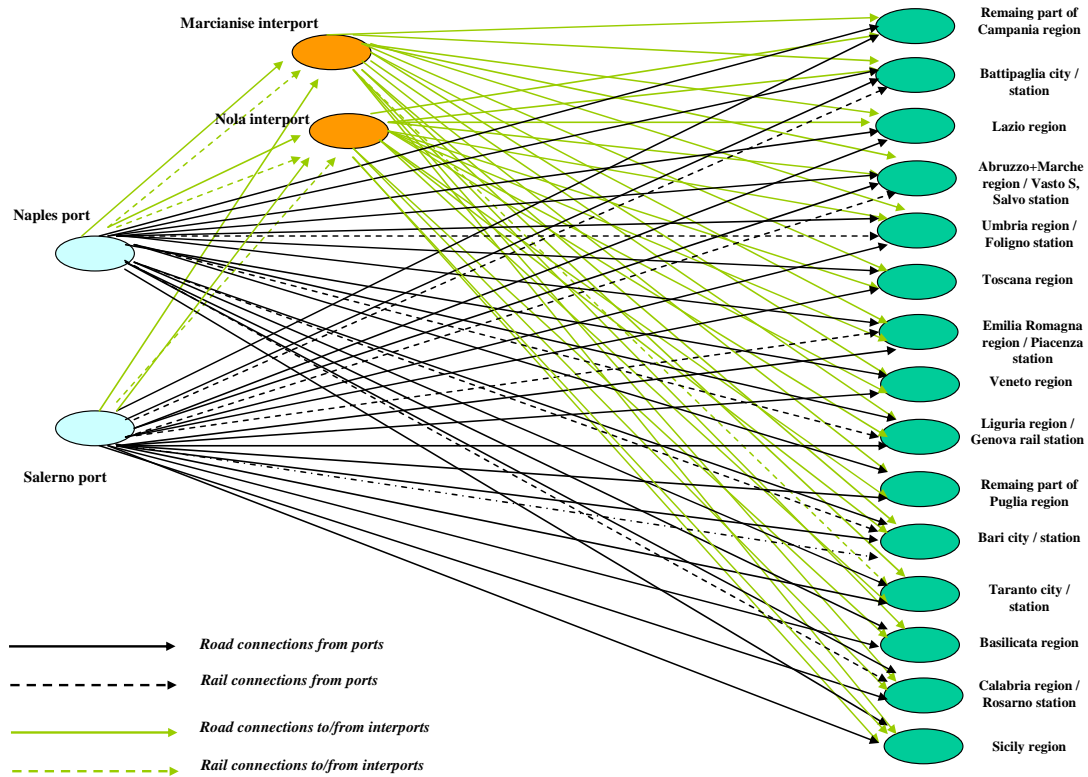
We have had the opportunity to study the first-tier container transportation and logistics network of the Campania region. In future papers we shall complete the description of the Campania intermodal and logistic nodes, while also discussing data concerning rail and road O/D traffic, costs and times for operations, and capacity constraints, with particular attention to terminal, railway, customs and logistic activities. From a mathematical modelling perspective, we identify the "interport model" as an extension of the conventional transportation and hub-and-spoke mathematical optimisation models complemented with features indicating whether routing of traffic from/to any port via the interports may occur or not.

Spatial models, and hub-and-spoke models in particular, have been extensively studied by several scholars, such as for example: Aversa *et al.* (2005), Bontekoning (2006), Bryan and O'Kelly (1999), Campbell (1994), Crainic and Kim (2007), Cullinane *et al.* (2002), Groothedde (2005), Horner and O'Kelly (2001), Lee *et al.* (2006), Luo (2002), O'Kelly (1987), O'Kelly and Miller (1994), O'Kelly and Bryan (1998), Racunica and Winter (2005), Thompson and Thore (1992), Thore (1991), Thore and Iannone (2005). The purpose of the interport model will be to highlight both economic advantages and disadvantages that shippers and carriers may enjoy in routing their maritime containers through the interports.

In particular, we will propose and discuss an empirical application portraying the Campania intermodal and logistic first-tier network, and considering Italian regions and cities as the final road

and railway destinations (“inward model” or “import model”) and/or origins (“outward model” or “export model”). An example of the network we are currently investigating is reported in Figure 13.

Figure 13 - Graph of the inward model



The mathematical programming network model aims at minimizing the sum of all container-related logistic transportation costs throughout the entire network (including, as the case may be, customs inspection costs, handling charges and storage charges at ports and interports), and subject both to balancing conditions at all nodes and railway and nodes’ capacity constraints. The time dimension can be included in demurrage charges computed through dwell times for empty containers, inspected full containers and non-inspected full containers at ports and interports. Alternatively, the time dimension could instead be modelled explicitly through a multi-objective mathematical programming approach. Finally, the model can also include the possibility of value enhancement of the goods carried in containers in the interports (value added semi-manufacturing logistic services). In this case, the optimisation problem will consist of maximising the value of all “upgraded” containers processed at the interports, calculated net of the transportation logistic costs throughout the entire network, and subject to balance conditions at all nodes and railway and nodes’ capacity constraints.

7. Conclusions

Interports are becoming a privileged standpoint to understand the evolution of container transport within the framework of globalisation and increasing competitiveness among regions to attract productive investments. As a matter of fact, an efficient and effective landside container logistics represents a vital element for seaports and maritime-oriented global commodity chains.

The role of Campania region as a “European gate” of relevant international trade corridors has to be further investigated and commercially promoted. On the other hand, the national and regional needs of improving the transportation infrastructures has to be accompanied to other relevant improvements in the fields of value added logistic services and demand-driven supply chain management.

The immediate and concrete development of a “Value Adding Integrated Sea-Land Logistic System” in Campania will allow to benefit from both the comparative advantages and right experience needed for an effective exploitation of this perspective. Intelligent and integrated logistic management of Campania seaports and interports, as well as supporting activities, will be able to determine important socio-economic benefits, while particularly decreasing the regional unemployment and giving the possibility to the local productive systems to efficaciously compete and cooperate in international markets within the framework of wider and more discontinuous and profitable supply and demand areas. The efficiency and effectiveness of an integrated planning, organisation and promotion of Campania ports and interports, with the related co-modality possibilities, represent important issues which will mark the competitive evolution of business logistic systems and shape a hierarchy of different projects for territorial and market positioning.

Bibliography

- Aversa, R., Botter R. C., Haralambides, H. E., Yoshizaki, H. T. Y. (2005), “A Mixed Integer Programming Model on the Location of a Hub Port in the East Coast of South America”, in *Maritime Economics & Logistics*, No. 7.
- Ballis A. (2006), “Freight Villages. Warehouse Design and Rail Link Aspects”, in *Transportation Research Record: Journal of the Transportation Research Board*, No. 1966.
- Beuthe M., Kreutzberger E. (2001), “Consolidation and Trans-shipment”, in Brewer A. M., Button K. J., Hensher D. A. (eds.), *Handbook of Logistics and Supply-Chain Management*, Pergamon/Elsevier, London.
- Bichou K. (2005), “Seaport land interface assessment: analytical tools and instruments”, UNCTAD, Geneva.
- Bontekoning Y. (2006), *Hub exchange operations in intermodal hub-and-spoke networks*, TRAIL Research School, The Netherlands.
- Brooks M. R. (2000), *Sea Change in Liner Shipping*, Pergamon Press, Oxford.
- Bryan D. L., O’Kelly M. E. (1999), “Hub-and-spoke networks in air transportation: an analytical review”, in *Journal of Regional Science*, Vol. 39, No. 2.
- Campbell J. F. (1994), “Integer programming formulations of discrete hub location problems”, in *European Journal of Operations Research*, No. 72.
- Cappelli A., Libardo A., Nocera S. (a cura di) (2007), *Binari sul mare. Scenari di integrazione del trasporto merci*, Officina Edizioni, Roma.
- CENSIS, UIR (2006), *Il sistema degli interporti per una logistica ad alto valore aggiunto. Le opportunità di un cluster terra-mare attraverso il sistema interportuale*, Rome.
- China Intermodal Transport Services to the Interior Project (ITSIP) (2003), *Inland Container Depot (ICD) Operation Manual*, August.
- Containerisation International Magazine (2007), *40th Anniversary*, special issue, April.
- Crainic T. G., Kim K. H. (2007), “Intermodal Transportation”, in Barnhart C., Laporte G. (eds.), *Transportation*, Handbooks in Operations Research and Management Science, Vol. 14, North-Holland, Amsterdam.
- Cullinane K., Khanna M. (2000), “Economies of scale in large containerships: optimal size and geographical limitations”, in *Journal of Transport Geography*, Vol. 8, No. 3.
- Cullinane K., Ping J., Wang T.-F. (2002), “A Multi-objective programming approach to the optimisation of China’s international container transport network”, in *International Journal of Transport Economics*, Vol. 29, No. 2.
- D’Agostino Z., Iannone F. (2004), “Un nuovo approccio alle politiche istituzionali per il governo dei sistemi logistici territoriali”, in *Proceedings of the 7th Scientific Meeting of the Italian Society of Transport Economists*, University of Genoa, 18-20 November.
- Dalla Chiara B., Marigo D., Benzo G. (2002), *Interporti e terminali intermodali*, Hoepli, Milano.
- Drewry Shipping Consultants (2006), *The Drewry Annual Container Market Review and Forecast 2006/07*.

- Dynamar (2007), *Transshipment & Feeder Trades, Operators, Ships*.
- ECMT (2001) (ed.), *Land access to seaports*, Economic Research Centre ECMT-OECD, Paris.
- ESCAP (2005), *Regional Shipping and Port Development Strategies (Container Traffic Forecast)*, United Nations, New York.
- EC (2006), *Keep Europe moving - Sustainable mobility for our continent. Mid-term review of the European Commission's 2001 Transport White Paper*, COM (2006) 314, Brussels.
- Europlatforms EEIG (2004), "Logistics Centres. Directions for use", January.
- Ferrari C. (2000), *Imprese terminalistiche nel trasporto containerizzato: funzione di produzione e forme di mercato*, ECIG, Genova.
- Forte E. (1994), *Trasporti Politica Economia*, CEDAM, Padova.
- Forte E. (2008), *Trasporti Logistica Economia*, CEDAM, Verona, forthcoming.
- Galloni G. (1999), *FV-2000 - Quality of Freight Villages Structure and Operations - Final Report for Publication*, Partners: Europlatforms EEIG, CSST SpA, Sogesca Srl, Interporto Bologna SpA, Sogaris, Segar Ingegnerie, Garonor Services, CILSA, N.T.U., D.T.C., T.F.K., F.D.T.; Project funded by the European Commission under the Transport RTD Programme of the 4th Framework Programme.
- Groothedde B. (2005), *Cooperative Logistics and Transportation Networks: A Modeling Approach to Hub Network Design*, Trail, Delft, 2005.
- Hayut Y. (1980), "Inland container terminal - function and rationale", in *Maritime Policy & Management*, Vol. 7, No. 4.
- Horner M. W., O'Kelly M. E. (2001), "Embedding economies of scale concepts for hub network design", in *Journal of Transport Geography*, Vol. 9, No. 4.
- Iannone F. (2006), "Technical and organisational features of the Campania Logistic System and relationships among ports and interports", mimeo, August.
- Iannone F., Varrone M. E. (2006), "La Campania e il Mediterraneo meridionale e sud-orientale: le relazioni commerciali e la rete di servizi marittimi di linea", in *Proceedings of the 8th Scientific Meeting of the Italian Society of Transport Economists*, University of Trieste, 29-30 June - 1 July.
- Jaržemskis A., Vasiliauskas A. V. (2007), "Research on dry port concept as intermodal node", in *Transport*, Vol. 22, No 3.
- Kapros S., Panou K., Tsamboulas D. A. (2005), "Evaluation of intermodal freight villages using a multicriteria approach", paper presented at 84th Annual Meeting of the Transportation Research Board, Washington, D.C.
- La Pietra A. (2005), *I collegamenti ferroviari tra porti ed interporti nel bacino campano: criticità ed ipotesi di intervento*, Degree thesis in Transportation Engineering, "Luigi Tocchetti" Transportation Engineering Department, Faculty of Engineering, Federico II University of Naples (supervisor: Prof. Ir. Andrea Papola; co-supervisor: Ir. Dario Aponte).
- Levinson M. (2006), *The Box. How the Shipping Container Made the World Smaller and the World Economy Bigger*, Princeton University Press, New Jersey.
- Libardo A., Nocera S. (a cura di) (2006), *Interporti, scali merci, centri logistici e sviluppo competitivo*, Aracne, Roma.
- Lee L. H., Chew E. P., Lee L. S. (2006), "Multicommodity network flow model for Asia's container ports", in *Maritime Policy & Management*, Vol. 33, No. 4.
- Luo M. (2002), *Container Transportation Service Demand Simulation Model for U.S. Coastal Container Port*, Ph.D. Dissertation, University of Rhode Island, USA.
- Marchese U. (2000), *Lineamenti e problemi di Economia dei trasporti*, 2^a edizione aggiornata, ECIG, Genova.
- Marchetiello D. (2007), "The Campania region. The logistics platform between Europe and Far East", mimeo.
- Meidute I. (2005), "Comparative analysis of the definitions of logistics centres", in *Transport*, Vol. 20, No. 3.

- Middendorf D. P. (1998), “Intermodal Terminals Database: Concepts, Design, Implementation, and Maintenance”, report prepared for Bureau of Transportation Statistics U.S., Department of Transportation.
- Notteboom T. (2001), “Spatial and functional integration of container port systems and hinterland networks in Europe”, in ECMT (ed.), *Land access to seaports*, Economic Research Centre ECMT-OECD, Paris.
- Notteboom, T. (2002), “The interdependence between liner shipping network and intermodal network” in *IAME Panama 2002 Conference Proceedings*, 13-15 November, Panama.
- Notteboom T. (2004a), “Container Shipping And Ports: An Overview”, in *Review of Network Economics*, Vol. 3, No. 2.
- Notteboom T. (2004b), “A Carrier’s Perspective on Container Network Configuration at Sea and on Land”, in *Journal of International Logistics and Trade*, Vol. 1, No. 2.
- Notteboom T., Rodrigue J. P. (2004), “Inland Freight Distribution and the Sub-harborization of Port Terminals”, in Licheng S., Notteboom T. (eds.), *Proceedings of the First International Conference on Logistics Strategy for Ports*, 22-26 September, Dalian.
- Notteboom T., Rodrigue J. P. (2005), “Port Regionalization: Towards a New Phase in Port Development”, in *Maritime Policy & Management*, Vol. 32, No. 3.
- Notteboom T., Rodrigue J. P. (2007), “Re-assessing Port-Hinterland Relationships in the Context of Global Supply Chains”, in Wang J. et al. (eds.), *Ports, Cities, and Global Supply Chains*, Ashgate, London.
- Notteboom T., Winkelmanns W. (1998), “Bundeling van containerstromen in het European havensysteem en netwerkontwikkeling in het achterland”, *Tijdschrift Vervoerwetenschap*.
- Notteboom T., Winkelmanns W. (1999), “Spatial (de)concentration of container flows: the development of load center ports and inland hubs in Europe”, in Meersman H., Van de Voorde E., Winkelmanns W. (eds.), *Proceedings of 8th World Conference on Transport Research. Transport modes and systems*, Vol. 1, Pergamon Press, Oxford.
- Ocean Shipping Consultants (2004), *Marketing of Container Terminals*.
- Ocean Shipping Consultants (2007), *Container port strategy. Emerging issues*.
- O’Kelly M. E. (1987), “A quadratic integer program for the location of interacting hub facilities”, in *European Journal of Operational Research*, Vol. 32, No. 3.
- O’Kelly M. E., Miller H. J. (1994), “The hub network design problem”, in *Journal of Transport Geography*, Vol. 2, No. 1.
- O’Kelly M. E., Bryan, D. L. (1998), “Hub location with flow economies of scale”, in *Transportation Research B*, Vol. 32, No. 8.
- Petriccione S., Carlucci F. (2006), *Economia dei trasporti*, CEDAM, Padova.
- Priemus H., Konings R. (2001), “Dynamics and Spatial Patterns of Intermodal Freight Transport Networks”, in Brewer A. M., Button K. J., Hensher D. A. (eds.), *Handbook of Logistics and Supply-Chain Management*, Pergamon/Elsevier, London.
- Racunica I., Wynter L. (2005), “Optimal location of intermodal freight hubs”, in *Transportation Research Part B*, Vol. 39, No. 5.
- RFI, ISFORT, LOGICA (2005), *Studio sul trasporto ferroviario delle merci nel bacino Campano*.
- Robinson R. (2002), “Ports as elements in value-driven chain systems: the new paradigm, in *Maritime Policy & Management*, Vol. 29, No. 3.
- Robinson R. (2005), “Capturing value in port-oriented landside logistics pathways: critical issues for an effective policy framework”, in *IAME Cyprus 2005 Conference Proceedings*, 23-25 June, Limassol.
- Rodrigue J. P., Hesse M. (2007), “North American Perspectives on Globalized Trade and Logistics”, in Leinbach T., Capineri C. (eds.), *Globalized Freight Transport: Intermodality, E-Commerce, Logistics and Sustainability*, Transport Economics, Management and Policy series, Edward Elgar Publishing, Cheltenham.

- Rimiene K., Grundey D. (2007), “Logistics Centre Concept through Evolution and Definition”, in *Engineering Economics*, Vol. 54, No. 4.
- Roso V. (2006), “Emergence and significance of dry ports”, Division of Logistics and Transportation, Chalmers University of Technology, Gothenburg.
- Roso V., Woxenius J., Olanderson G. (2006), “Organization of Swedish dry port terminals”, Division of Logistics and Transportation, Chalmers University of Technology, Gothenburg.
- Salucci M. V. (2006), “Intermodal freight terminals. In search of efficiency to support intermodality growth”, paper prepared for EC - Directorate General for Energy and Transport, European Communities.
- Siviero L. (2005), *Economia dei trasporti intermodali e innovazione logistica*, FrancoAngeli, Milano.
- Slack B. (1990), “Intermodal transportation in North America and the development of inland load centres”, in *Professional Geographer*, Vol. 42, No.1.
- Slack B. (1999), “Satellite terminals: a local solution to hub congestion?”, in *Journal of Transport Geography*, No.7.
- Slack B. (2001), “Intermodal Transportation”, in Brewer A. M., Button K. J., Hensher D. A. (eds.), *Handbook of Logistics and Supply-Chain Management*, Pergamon/Elsevier, London.
- SRM (2007), *Poli logistici, infrastrutture e sviluppo del territorio*, Giannini Editore, Napoli.
- Stopford M. (1997), *Maritime Economics*, Second edition, Routledge, London.
- Thompson G. L., Thore S. A. (1992), *Computational Economics: Economic Modeling with Optimization Software*, Scientific Press, San Francisco.
- Thore S. A. (1991), *Economic Logistics: The Optimization of Spatial and Sectoral Resource, Production and Distribution Systems*, Quorum Books, Westport, Connecticut.
- Thore S. A., Iannone F. (2005), “The Hub-and-Spoke Model. A Tutorial”, mimeo, August.
- Tsamboulas D. A., Dimitropoulos I. (1999), “Appraisal of investments in European nodal centres for goods - freight villages: A comparative analysis, in *Transportation*, Vol. 26, No. 4.
- UNECE, ECMT, EC (2001), *Terminology on combined transport*, United Nations, New York and Geneva.
- Uniontrasporti (2007), *Linee di sviluppo dell’intermodalità e dei centri logistici in Europa*, Retecamere, Roma.
- UNCTAD (1991), *Handbook on the Management and Operation of Dry Ports*, Geneva.