EVALUATION OF STRUCTURAL FACTORS IN A THIRD-GENERATION PORT: METHODS AND APPLICATIONS

GIUSEPPE MUSOLINO[1], ANTONIO CARTISANO[2], GIOVANNA CHILÀ[3], GIUSEPPE FORTUGNO[4] & MARIA ROSARIA TRECOZZI[5]
[1]Dipartimento di ingegneria dell'Informazione, delle Infrastrutture e dell'Energia Sostenibile, Università Mediterranea di Reggio Calabria, Italy,
[2]Transportation Specialized, Italy
[3]Environment and Public Works, Municipality of Motta San Giovanni, Italy.
[4]Italferr S.p.A. Italy.
[5]Dipartimento Infrastrutture, Lavori Pubblici, Mobilità, Regione Calabria, Italy.

ABSTRACT
UNCTAD identified the structural factors of commercial ports and introduced the general definition of 'port generation'. Third-generation ports were born with the container revolution in the last decades of the 20th century. The container became the main unit for the transport of goods, both intermediate and finished, between production and consumption regions. Containerization allowed the globalization of the economy and ports became the nodes of the global supply chain.
The paper proposes a methodology, based on consolidated theoretical models, to ex-ante evaluate the current and future scenarios of an international commercial port. The methodology has been applied to the container port of Gioia Tauro, with the aim to verify its ability to become a third-generation port as a generator of value added, rather than only a centre of cost. The results of the application allowed to identifying the development direction and the planned interventions in the port, as far as concerns general transport, agri-food logistics and mechanical logistics.
Keywords: agri-food sector, case study, general logistics, mechanical sector, port of Gioia Tauro, third-generation ports.

1 INTRODUCTION

UNCTAD described the ports' evolution according to the concept of generation (see [1]-[3], and the references included). The first-generation of ports was built close to the cities and the port-city was the dominant model for centuries. Ports of the second generation characterized the second part of the 20th century. They were built in proximity to industrial areas to supply the industrial plants of raw materials and final products. The third-generation of ports emerged after 1980s with the world-wide diffusion of container, combined with the growing requirements of the international trade. The ports became integrated transport centres and logistic platforms for international trade. From the economic point of view, third-generation ports increase the added-value of goods that transit through them, due also to the manipulations that are placed in the goods. In broad terms, it is possible to associate the exchange of final products to the first-generation ports, the exchange of raw materials (e.g. oil, chemical, steel and coke) to the second-generation ports; and the exchange of intermediate products mainly belonging to mechanical-automotive and agro-industrial sectors to the third-generation ports. New generations of ports raised in the last two decades ([4], [5]), but their description is out of the scope of this paper.

The paper presents a methodology, based on consolidated theoretical models, to ex-ante evaluate the current and future internal structural factors of a third-generation port (see references [6]-[12]). In other words, the methodology supports the evaluation of the internal

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characteristics of a third-generation port, considered as a 'fabric with its internal production processes' operating inside port areas ([13], [14]).

The port production is based both on physical (material) components, such as transport and logistic infrastructures, and on intangible (or immaterial) components, such as the research ones (segmented in research component inside each firm, inside an economic district, and inside the universities and the research centres). This paper does not consider the external interactions of the port with the closer urban areas and the strategic lines for their sustainable development ([15]-[19]).

The methodology has been applied to the container port of Gioia Tauro, with the aim to verify its ability to become a third-generation port as a generator of value added, rather than a centre of cost. The strategic development directions and the planned interventions for the port of Gioia Tauro have been defined inside the Regional Transport Plan of Calabria [20] and the strategic report of the Integrated Logistics Area of Gioia Tauro [21]. Detailed descriptions have also been recently published in [6]-[12]. The port of Gioia Tauro is specialized today in container transhipment operations, which need to be consolidated and strengthened; together with the connections to the European railway networks and the attraction of investments in the port hinterland.

The remaining part of the paper is articulated as follows. Section 2 presents a literature review on existing general methodologies to support the analysis and evaluation of transport and logistics operations inside a port. Section 3 reports the proposed methodology to analyse and evaluate the current and future scenarios of an international commercial port. Section 4 presents the current situation of the port of Gioia Tauro (Italy), and of the leading sectors of Calabria Region: mechanical and agri-food. Section 5 reports the scenarios and the planned transport interventions inside the port. Finally, the conclusions and the perspectives.

2 LITERATURE REVIEW ON EXISTING METHODS

The methodologies and models existing in large literature to support the analysis and evaluation of transport and logistics operations inside a port may be broadly classified into three main categories:

- *Transport Systems Models (TSMs)* ([22]-[25], and the references included), to estimate freight costs and flows on transport networks;
- *Logistics Models (LMs)* ([26]-[29], and the references included), to estimate logistics costs and flows of products along the supply chains;
- *Economic Impact Models (EIMs)* ([30]-[36], and the references included), to estimate freight flows and economic impact (e.g. value added, employment) generated by port operations (e.g. handled freight) and by investments (e.g. transport infrastructure).

The great variety of methods and models of each of the above categories may belong to one of the following three components (see Table 1). The Supply (S) component estimates the performances resulting from users (e.g. transport or logistics operators), infrastructures and services. The most common approach used is the topological one, given by a network model, with links, nodes and costs. The Demand (D) component estimates users' choices resulting from activities (production, consumption, trade) and infrastructure and service performances. The most common approaches used may be classified among behavioural, or micro-economic founded (e.g. random utility models); and not-behavioural, or not micro-economic founded (e.g. entropic-gravitational). The Demand-Supply (D-S) interaction component estimates the

Table 1: Classification of methods and models: outputs for each category ([23], [24], [26]).

Component/ Model	*Supply(S)*	*Demand(D)*	*D-S interaction*
TSMs	Transportation costs on transport network	Freight flows between trip origin-destination	Freight flows and costs on transport paths and links
LMs	Logistic costs on supply chain (distribution network)	Freight flows between the logistic nodes	Freight flows and costs in logistic nodes and distribution channels
EIMs	• Financial costs on value chain • Urban land for residential and service activities	• Financial flows between production-consumption regions • Urban population and employment generated by port	• Interregional trade flows and costs and economic impact in transport nodes • Urban flows of people (e.g. from residential areas to workplaces)

mutual interaction between users' choices and the performance of the infrastructures and the services. The approaches used may classified between equilibrium (e.g. user equilibrium/ system optimum [23] for TSMs, Computable General Equilibrium [33], [34] for EIMs) and not-equilibrium (e.g. network loading [23] for TSMs, Multi-Regional-Input-Output (MRIO) [29], [31] and Lowry [35] for EIMs, …)

Table 1 provides the outputs of each modelling component belonging to every category of models. As far as concerns the TSMs, the (S) component provides the costs on transport network, the (D) component the freight flows between the trip origins-destinations, the (D-S) interaction component the freight flows and costs on paths and links of the transportation network. As far as concerns the LMs, the (S) component provides the logistic costs on the supply chain (distribution network), the (D) component the freight flows between the logistic nodes of the supply chain, the (D-S) interaction component the freight flows and costs in logistic nodes and along the distribution channels. As far as concerns the EIMs, the (S) component provides the financial costs on the value chain; the (D) component the financial flows between production-consumption regions, the (D-S) interaction component the interregional trade flows and costs.

It is worth noting that freight flows are commonly expressed in units of load (e.g. container, swap body) or in vehicles between trip origin-destination inside TSMs, in units of load or in quantities between logistics nodes (e.g. warehouses, distribution centres, …) in LMs, and in monetary value between production-consumption regions inside EIMs. It is not univocally defined how to convert vehicles/units of load into quantities, or to convert quantities into monetary value and vice versa in order to change from one category of model to another.

3 METHODOLOGY

The methodology proposed in this paper allows to analyse and evaluate the current and future scenarios of an international commercial port according to the theoretical background presented in the previous section.

As far as concerns TSMs, the following analysis of transport variables related to a commercial port have been considered in this paper:

- supply: aggregated estimation of current handling capacity of the port, both on the sea-side (docks, quays, ….) and on the land-side (railway and road last-mile connections, …); and identification of critical elements of the existing infrastructures and services;
- demand: aggregated estimation of current and forecasted freight traffic, both on the sea-side (transhipment container traffic) and to the land-side (imported-exported freight via railway and road) according to existing sources, in order to determine the reference market of the port;
- identification of the strategic development directions and of the planned transport interventions.

The comparison of transport variables, by means of TSM, between different ports is executed according to the cost reduction minimization, as long as ports are considered a mere place of transit for goods (first- and second-generation ports). Given a port *a* and a port *b*, eq. (1) certifies that port *b* is more competitive than port *a* (transport costs are in absolute value):

$$\textit{transport costs in port } b < \textit{transportcosts in port } a \tag{1}$$

As far as concerns LMs, the general elements a supply chain, which include the maritime shipping service, are the following ([16], [18]):

1. production/processing area, where the freight is produced, and eventually processed;
2. consolidation centre, where the freight is consolidated into a container, or a swap body;
3. port of origin, where the container (swap body) is loaded on a container, or on a ro-ro, ship;
4. port of destination, where the container is unloaded and transported;
5. distribution centre, where the freight is unpacked from the container and distributed in smaller parcels;
6. selling /consumption place, where the freight is sold by retailer and/or finally consumed.

The third-generation port incorporates the activities 2 and 3, regarding respectively the consolidation and the deconsolidation (distribution) of freight (see Fig. 1).

The functional structure of a distribution centre is described in Fig. 2. The distribution centre receives the freight, consolidated in one cargo unit (e.g. container), from the port of destination and deconsolidates it into several smaller parcels (e.g. pallets) to be delivered to one (or more) selling/consumption area(s), where retailers (consumers) are present.

The distribution centre has some inputs and provides some outputs. The input of the distribution centre is the container, which arrives at the port of destination from abroad. The output is a

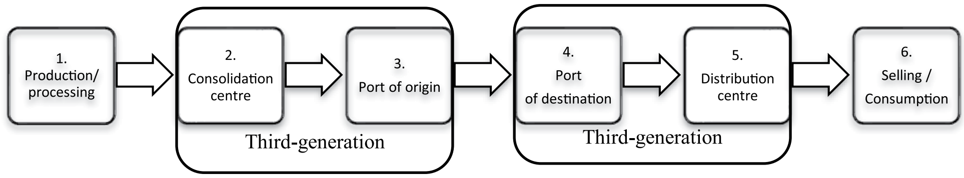

Figure 1: Main components of a supply chain.

Figure 2: Schematic representation of a distribution centre.

set of pallets (of freight), which are delivered to a number of retailers/consumers. Each retailer generally demands a small amount of freight: the minimum quantity is generally one pallet.

The following analysis of logistics variables related to a commercial port have been considered in this paper (see also [8], [11], [12]):

- current characteristics and critical elements of the existing supply chains connected with the examined port;
- potentialities of the existing supply chains, in order to determine the reference market of the port;
- strategic development directions and planned logistics interventions and estimation of the future logistic capacity of the port.

The estimation of logistics variables of a port, by means of LMs, is executed according to the criterion of transforming the port from a centre of cost to a centre of value added generation, as long as a port is considered a third-generation port. Given a port *a*, eq. (2) certifies that *a* is a third-generation port if (transport costs are in absolute value):

$$\textit{transport costs in port a} < \textit{added value in port a} \tag{2}$$

As far as concerns EIMs, a common method to estimate the economic impact of a commercial port relies on the MRIO approach (see [29], [30], [31]). MRIO models allow to estimating the direct, indirect and the induced impact, through the identification of inter-sectoral linkages. Recent studies allowed on MRIO provide an assessment of the port embeddedness inside the maritime trade network and inside the global supply-chains [32]. Some limitations of MRIO models (e.g., fixed production technology) could be solved in spatial computable general equilibrium models. The model of Norwegian economy [33] includes an explicit production function for the transport sector.

The following analysis of economic variables related to a commercial port have been considered in this paper:

- current economic impact (e.g. value-added, employment) generated by transport/logistic operations inside the port;
- potentialities of the port in order to determine its reference market;
- estimation of the future economic impact of the port.

The comparison of economic variables between different ports, by means of EIMs, is executed according to the criterion of the value-added maximization, as long as a port is considered a third-generation port. Given a port *a* and a port *b*, eq. (3) certifies that (third-generation) port *b* is more competitive than (third-generation) port *a*:

$$\textit{added value in port b} > \textit{added value in port a} \tag{3}$$

4 APPLICATION TO GIOIA TAURO PORT: CURRENT CONDITIONS, SCENARIOS AND PLANNED INTERVENTIONS

The port of Gioia Tauro, located in Calabria (Italy), is the first container transhipment port and one of the most important port for the automotive logistics of Italy ([6], [7], [8], [12]). The container traffic was 2.55 million of TEUs (Twenty-Equivalent Units) and the number of handled vehicles was 213,000 in year 2019; while in 2020 the container traffic increased of +26% respect to 2019.

Two terminal operators currently operate in the port:

- Terminal Investment Limited (TIL), belonging to Mediterranean Shipping Company (MSC) Group, which operates in container transhipment with lo-lo services;
- Automar, which operates in the automotive logistics with ro-ro services.

The port has a great expansion capacity to become a third-generation port, in terms of increasing added-value connected to the transit and manipulation of goods. On the other hand, there is a demand for logistics in Calabria related to different sectors of the regional economy. The most important sectors in Calabria are the mechanical and the agri-food ones.

The following paragraphs present the current transport infrastructures in Gioia Tauro (Section 4.1), a description of mechanical and agri-food sectors in Calabria Region (Sections 4.2 and 4.3).

4.1 Current Situation

4.1.1 Transport infrastructures

The strong infrastructural equipment of the port of Gioia Tauro makes it a competitive transhipment container port, in relation to other existing ports in the Mediterranean basin. Its second strength is represented by its advantageous location with respect to the intercontinental maritime routes, crossing the Mediterranean basin from Suez to Gibraltar.

The connection of the port of Gioia Tauro with the Italian and European railway networks is an element of weakness. Today the port is connected to the national railway network through

Figure 3: View of the port of Gioia Tauro (source: www.portodigioiatauro.it)

the single track and electrified line Rosarno -S. Ferdinando. The line has a double track, but only one is operational, since the terminal section necessary for connection with the Rosarno railway station is missing on the other track.

From the port of Gioia Tauro, through the Rosarno station, up to 20 weekly block trains were sent to the intermodal ports of Nola (Naples), Bari, Frosinone, Padua, Melzo (Milan), Bologna and La Spezia, for then in 2008, due to the continuing loss of competitiveness of the railway system compared to the road system, to the almost total cancellation of activities by train.

Road accessibility to the port area is guaranteed by the 'Mediterranean Motorway' Salerno-Reggio Calabria (connected to the port via a ring road) and by the SS 18.

From the point of view of performance characteristics, the railway network belonging to the national railway company Rete Ferroviaria Italiana (RFI), has a fairly heterogeneous configuration in terms of shape of the tunnels, maximum admitted train lengths and loads.

As regards the shape of the tunnels for combined transport, the Battipaglia (Praia) - Paola, Rosarno-Reggio Calabria, Sibari-Catanzaro Lido and Reggio Calabria lines have a P/C32 shape; while the Paola-Rosarno and Rocca Imperiale – Sibari -S. Antonello - S. Lucido has a P/C45 shape.

As regards the maximum axial mass, heterogeneous bounds exist, which are variable from category C3 (with limitations) to category D4 (with limitations) along the most relevant directions. In particular, the entire network is already characterized by category D4 (22.5 tonn/axle) with limitations. The Metaponto-Sibari-S. Antonello corridor has an axial mass of category C3 (20 tonn/axle) with limitations, while between S. Antonello and S. Lucido the axial mass category is C3 (20 tonn/axle). A further element of weakness is represented by the absence of a homogeneous double-track layout.

The road connections of the port with the motorway A3 Salerno-Reggio Calabria, that is subject to an ongoing structural modernization, is need to be maintained in order to allow to increase the level of service.

4.1.2 Mechanical sector

The mechanical sector in Calabria does not have high specialization indices in terms of the number of companies and employees, if compared to the rest of Italy. However, it is important in the regional economy, especially if evaluated in relation to three characteristics: capital intensity, highly qualified workforce, strong presence of engineers and high-level technical personnel [37].

The sector weights about one-third on the value of regional exports. It has local production units of world-leading multinational groups and presents interactions with universities and research centres of the area, but yet not fully structured.

The structure of mechanical production in Calabria is similar to the rest of Italy: some settlements of large leading companies are flanked by small and medium-sized manufacturing units. The sector's specializations, both in terms of number of firms and of employees, are that of metal products manufacturing, in particular of large metal carpentry

In Gioia Tauro there is one of the most dynamic mechanical firm of Calabrian territory, De Masi Industrie Meccaniche, which operates in the construction and trade of agricultural machinery. The firm invests massively in research and development to create and develop high-tech devices and products.

However, there are also other mechanical poles in the Calabrian territory, where the leading firm belongs to a multi-national leading company, are centred around of Nuovo Pignone in Vibo Valentia, and around of Hitachi Rail (ex-Ansaldo Breda) in Reggio Calabria ([38], [38]).

There is a high demand for mechanical logistics in Calabria, but this demand remains unsatisfied due to the following critical elements:

- the lack of some transport and logistics infrastructures allows the growth of the main existing activities in the port: transhipment and automotive logistics, and
- the presence of isolated large mechanical firms in Calabria region, linked with several small and poorly structured ones.

4.1.3 Agri-food sector

The agri-food sector is one of the most important in Calabria and it is a distinctive element of regional productions. The specificities of agri-food production in Calabria concern the olive oil and citrus sectors, as well as the cereal and bakery, and viticulture sectors. Calabria produces, if compared to the total production in Italy, more than 50% of clementine, more than 30% of oranges, more than 25% of mandarins, all the bergamots and cedars, about 25% of table olives and of fresh figs ([38], [39], [40]).

The positive trend of production and export of Calabria has recently affected the increase in the agricultural sector in the Southern Italy. The value of regional agricultural production has recorded an annual increase of +10.6%. The performance from Calabria was mainly determined by the positive trend of olive growing, citrus fruits and vegetables. The production of olive oil in 2019 doubled, thanks above all to the province of Reggio Calabria; Calabria, together with Campania and Puglia, contributed to the growth of olive oil production at the national level, which, with an increase in the volume of production of 27.6% and in the added value of 29.6%, represents the agricultural product that recorded the best performance in 2019. Moreover, among the most representative fruit and vegetable products of the Calabrian territory, fennel is also worthy of note: the district of Crotone stands out nationally for the production of this vegetable [39].

Among the most important industries in the agri-food sector, there are: Callipo and Intertonno (tuna), VegItalia and GIAS (frozen food), Liquirizia Amarelli (licorice), Capua1880 (citrus) which are well-known all over the world [38]. Other important agri-food industries are: Mangiatorella (mineral waters), Ilcar (meat processing), Fattorie Del Sole and Calabrian Milk Associations, Fattoria della Piana (dairy products), Distilleria F.lli Caffo (liqueurs), OP Interpiana and Agrumaria Reggina (citrus fruits), Antiche Vigne di Pironti, Ceraudo, Librandi, Statti, Tenuta del Conte, Tramontana, Val di Neto, Zagarella (wine).

The agri-food sector and the related logistic infrastructures present several critical elements [39]. In most cases, they have few employees, and have a poor degree of horizontal and vertical integration. The production chains are sometimes incomplete and companies are forced to import local products (figs, citrus fruits, olive oil) from outside the Region, due to the high prices deriving from the regional production and the inefficiencies in the primary sector [39].

The limited availability of dedicated transport and logistics infrastructures does not allow to respond to the needs of the regional agri-food production. In particular, there are no cold-poles for the logistics, with refrigerated warehouses that allow the storage and the manipulation at different temperatures. The lack of specific infrastructures, that guarantee the cold chain, does not allow to manage large quantities of perishable products, which characterize the production of Calabria, nor to manage seasonal products deferred over time, as in other Italian regions (e.g. port of Salerno in Campania).

4.2. Scenarios and planned interventions

The container transport market of the Euro-Mediterranean region is constantly increasing, even if there is a strong competition between the Mediterranean ports. Some estimates, indicate for 2025 a number of containers handled between 78 (instability case) and 84 million TEU (recovery case) in the Mediterranean basin ([41], [42]).

The completion of Gioia Tauro as third-generation port could meet the demand of transport and logistics of mechanical and agri-food companies, on one side; and boost the growth of these sectors in the economy of Calabria, on the other side. The strategic development scenarios, defined in ([20], [21]), aim to support the development and the integration of existing supply chains, to enhance the Gioia Tauro hinterland in order to attract mechanical and agri-food factories, operators, transport and logistics companies, encourage mechanical and agri-food production for the local and the international markets.

This section proposes the set of planned transport interventions (Section 4.1) and the interventions for the realization of the mechanical and agri-food logistics scenarios (Sections 4.2 and 4.3).

4.2.1 Planning transport interventions

Strategic development directions towards third-generation port of Gioia Tauro are proposed and based on three general objectives defined in [20]:

- objective five, which concerns the logistics system and the port system;
- objective six, which concerns the core system of Gioia Tauro;
- objective seven, which concern network integrations;
- objective nine, which concerns specific measures to improve safety and security in ports.

The objective five is finalized to increase and improve the quality and competitiveness of the logistics services provided through an approach of synergy and coordination, which guarantees functional and managerial integration of the port systems, starting from the integration of the nodes in the European core network with the nodes of the comprehensive European network. Specific measures must be envisaged to increase regional GDP, starting with the advanced engineering, agri-food, mechanical and automotive cruise and tourist port sectors [20].

The objective six is finalized to the economic development of Calabria, related to the development of the economic and transport macro node of Gioia Tauro in the Euro-Mediterranean and intercontinental context. The overall promotion of the area must be developed at a unified regional level, through communication channels for the presentation of the overall supply of services and infrastructures in the area. Specific measures are envisaged for the simplification and attraction of investments, giving impetus to the development of the hinterland, starting with the establishment of a special Economic Zone (SEZ) and of an Integrated Logistics Area [21]. The transhipment in Gioia Tauro must be consolidated and strengthened, including through the activation of a gateway, and specific node interventions, supported by research and operational applications [20].

The objective seven is finalized to aim at an overall improvement in the performance of the infrastructural system for the different types of traffic, starting with the TEN-T infrastructures. It is necessary to act on the recovery and modernization of the existing infrastructural capital, on the bottlenecks of rail and road connections for short and long-range accessibility, on the existence and quality of last-mile connections, on regional and local linear and nodal infrastructures, on pedestrian and cycling systems. An observatory must be provided for monitoring the costs and times of construction of the infrastructures.

The objective nine is finalized to development of a mobility system with the vision of zero victims on the road as a reference target by 2050; safety must be expressed in terms of safety and security, with specific references to safety in the port area.

The different actions should allow increase added-value in the sectors mainly connected to the port: general logistics [8], agri-food logistics [11], mechanical and automotive logistics [12].

The general logistics interventions are composed of interventions aimed to:

- the expansion of the port infrastructure (sea-side), and
- the increase of the railway and road infrastructure (land-side).

The planned interventions related to smart town, research and development are respectively proposed in [9] and [10].

4.2.2 Scenario and interventions in the mechanical logistics

Global firms currently operating in the mechanical sector (e.g. automotive), whose intermediate and final productions are generally distributed among several plants, look for a third-generation port as a generator of value-added, rather than a centre of cost. This could happen when the port is equipped with:

- material infrastructures, such as logistics and storage areas, intermodal centres, last-mile connections with railway and road networks;
- immaterial infrastructures; concerning tax incentive tools, research and training centres, ICT (Information Communication Technology).

The above dotation of infrastructures ensures the third-generation port to be embedded inside the maritime trade network and inside the global supply-chain.

The port of Gioia Tauro aims to add a ‘third-generation function’ by enhancing the role of the large industrial agglomeration of about 1,500 hectares present in its hinterland, destined to industrial, production and service activities ([43], [44]).

Given the current situation presented in the previous section, the scenario aims to achieve the following objectives:

- favour the development of connections and the strengthening of the logistic capacities of the international groups settled in the port of Gioia Tauro;
- enhance the port hinterland to attract businesses, operators, local and international transport and logistics companies, which carry out entrepreneurial, commercial or handling activities, storage of goods related to the logistical processes of mechanical and automotive.

The scenario of mechanical logistics will be implemented through the design and, therefore, the implementation of interventions in the Integrated Logistic Area of the port of Gioia Tauro [21].

The cluster of planned interventions is located within the industrial area of the port of Gioia Tauro, inside the municipalities of Gioia Tauro, Rosarno and San Ferdinando (Fig. 4).

The decision to locate the interventions in this area is closely linked to the necessity to guarantee the connections determined by the proximity to the motorway network and the availability of areas already partially equipped with material and immaterial infrastructures.

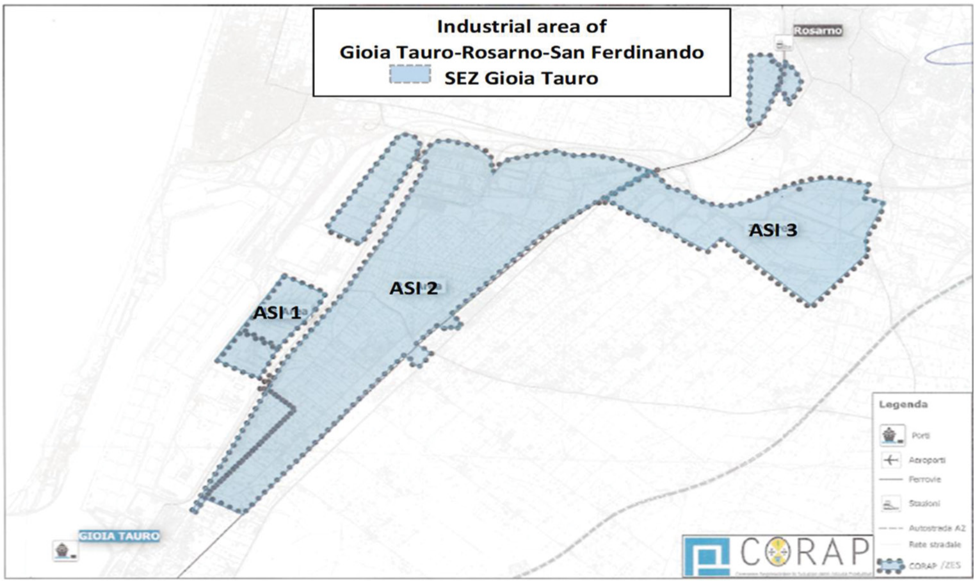

Figure 4: Industrial area of port of Gioia Tauro (source: [43]).

The cluster of interventions in mechanical logistics is composed of three sub-groups (see a detailed description in [12]):

- automotive logistics: multi-floor terminal for cars, retraining of yards and complementary areas, special connecting roads;
- light maintenance: dry dock, container repairing and cleaning, light mechanical platform;
- general infrastructures, for increasing level of service and security of the port.

4.3. Scenario and interventions in the agri-food logistics

Firms and logistic companies currently operating in the agri-food sector tend to locate their consolidation/distribution centres (Fig. 1), which are mainly refrigerated warehouses, inside port areas, in order to reduce or eliminate the transport costs connected to the trips from to consolidation centre to the port of origin, and to the trips from to the port of destination to the distribution centre. They look for a third-generation port as a generator of value-added, rather than a centre of cost. If the port is adequately equipped with material infrastructures and immaterial infrastructures, the port is candidate to become fully embedded inside the (containerized) supply-chain, in other words to become a third-generation port.

The agri-food logistics scenario (see [20], [21]) is based on the development of a cold-pole, considering the current conditions and potentialities of the agri-food sector of Calabria.

The scenario, moreover, foresees the definition of a logistic network inside Calabria, that is based on several logistic platforms that will include (Fig. 5):

- intercontinental nodes, complementary to the European nodes active in the Northern Range (Gioia Tauro);
- international nodes, for international production, such as tuna, and for international distribution (Lamezia and Sibari);

Figure 5: Schematic representation of the potential locations of the agri-food logistics nodes at intercontinental, international and national scale (source: [20]).

- national nodes, for regional or interregional productions in Southern Italy and for national distribution (Vibo Valentia, Locri, Crotone);
- regional nodes, for regional or interregional productions and for regional or interregional distribution.

The realization of agri-food logistics scenario takes place through different planned interventions, that are located in the industrial area close to the port of Gioia Tauro to guarantee their connection with the road and the railway networks.

The planned interventions for agri-food logistics in Gioia Tauro port are: cold-pole, transport and energy supply, general infrastructures (see a detailed description in [20] and [11]). The cold-pole is the core intervention and includes: refrigerated warehouses, railway tracks and road connections to the national motorway and rail networks, yards and service areas; expropriation of areas. Transport and energy supply concerns the realization of plants for the production of renewable energy from sea waves [45], from wind and solar energy, from the closer dam along the Metramo river, from the regasification. General infrastructures concern the extension of the level of service and level of security in port area.

5 CONCLUSIONS

The paper presented the methodology, based on consolidated theoretical models, to evaluate the current and future scenarios of an international commercial port. The methodology proposed some general criteria (equations) that allow to certify if a commercial port belongs to a third-generation port category. The goods manipulated inside a third-generation port belong mainly to the following sectors: mechanical and agro-food logistics, and general cargo.

The methodology has been applied to the container port of Gioia Tauro, with the aim to verify its ability to become a third-generation port as a generator of value-added, rather than a centre of cost. The strategic development directions and the planned interventions as far as concerns general transport, mechanical and agro-food logistics, have been defined inside the

Regional Transport Plan of Calabria [20] and the strategic report of the Integrated Logistic Area of Gioia Tauro [21].

The general transport interventions aim to achieve the following specific objectives:

- strengthen transhipment, increasing the infrastructural sea-side supply to support the activities of settled terminal operators, and to encourage the settlement of new terminal operators;
- enhance the combined transport (ship-to-rail and ship-to-road), by means of the gateway and of the increased accessibility of A2-Motorway.

The planned sea-side port interventions aim to:

- maintain the level of service of the quays and yards to the standards required by the container and ro-ro terminal operators;
- increase the capacity of the port in order to receive and handle last-generation container and ro-ro ships;
- settle further operators in the port.

The above sea-side transport interventions could increase the transhipment handling capacity of the port by at least 1 million of TEUs; the capacity of the deep sea e ro-ro services of at least 100.000 cars, and the capacity of the short-sea ro-ro service of 200.000 trucks of articulated lorries.

The land-side port interventions aim:

- the composition of trains of 750 meters, which is the current standard in Europe, allowing to reduce the travel cost on the railway mode;
- the improvement and the realization of the road last-mile connections between the port and the Italian A2 Motorway; thus, incrementing the accessibility to the domestic freight production areas and consumption markets.

As far as concerns the agri-food logistics, the interventions allow the establishment and consolidation of regional agri-food productions, which is one of the pillars of the regional economy. The core set of interventions concerns the realization of a cold-pole with two refrigerated warehouses for rail-road, and two refrigerated warehouses for all-road transport.

The estimations about their storage capacity is 40,000 pallets for the ‘rail-road warehouses’ and 40,000 pallets for the ‘all-road warehouses’.

As far as concerns the mechanical logistics, the planned interventions aim to:

- boost the logistics related to the automotive sector, currently present in the port;
- support the development and consolidation of regional mechanical productions, which is one of the pillars of the regional economy.

The core intervention is the multi-floor terminal for assembling and storing cars, in line to the development trajectories observed in the main European ports manly dedicated to automotive logistics, such as Hamburg and Zeebrugge.

The planned interventions in the port of Gioia Tauro are identified according the methodology defined, in order to overcome the above criticalities and to create a specific industrial area inside the port-hinterland.

The presented methodology is suitable to be applied in other ports, that are experimenting a similar evolution towards the third-generation nature.

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