

AIIT 2nd International Congress on Transport Infrastructure and Systems in a changing world
(TIS ROMA 2019), 23rd-24th September 2019, Rome, Italy

Sustainability of Freight Transport through an Integrated Approach: the Case of the Eastern Sicily Port System

Matteo Ignaccolo^a, Giuseppe Inturri^b, Nadia Giuffrida^{a*}, Vincenza Torrisi^{a*}, Elena
Cocuzza^a

^aUniversity of Catania, Department of Civil Engineering and Architecture, Via S. Sofia 64, Catania, 95125, Italy

^bUniversity of Catania, Department of Electric Electronic and Computer Engineering and Architecture, Via S. Sofia 64, Catania, 95125, Italy

Abstract

Port systems, especially if close to the city centre, are affected by significant traffic flows from and towards the port area causing congestion issues, security and several externalities on the mobility system. In fact, the main problems affecting port cities are generated by the mismatch between different vehicle flows (of goods, citizens, cruises, passengers, private cars and heavy vehicles) and the consequent creation of bottlenecks, greatly affecting the functionality of both the port and the city. The objective of this paper is to apply a framework of actions and measures to foster the three pillars of sustainability in the case study of the Eastern Sicily port system, involving the ports of the cities of Catania and Augusta. Data concerning freight traffic and flows have been acquired from the port authority and from the main terminal and logistic operators, while; data on terminal operation efficiency have been acquired from previous studies. The study shows advantages and disadvantages of already implemented measures and new planning scenarios for the two ports that are part of the system.

The paper clearly defines the key elements needed to be taken into account when demonstrating efficiency of a ports' system. The methodology can be considered suitable in order to support administrations in the assessment of different alternatives in the short and in the long period.

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Peer-review under responsibility of the scientific committee of the Transport Infrastructure and Systems (TIS ROMA 2019).

Keywords: Transport planning; Port optimization; Port sustainability; Port-city relationship

* Corresponding author. Tel.: +39-095-738-2211; +39-095-738-6061.

E-mail address: nadiagiuffrida@dica.unict.it; vtorrisi@dica.unict.it

1. Introduction

In the last centuries, ports have profoundly changed their role in the economic system of cities, moving from simple landings to commercial centers (Ignaccolo et al., 2018).

The recent increase of maritime international trade and goods movement involved diversified and qualified operations of ports in order to support the growth of local businesses; often the unplanned distribution of these heterogeneous functions and activities results in overlapping and intersecting flows of freight/passenger, with the generation of congestion, accidents and environmental criticalities (Ignaccolo et al., 2019b). The activities of such industrial and logistics centers also contribute significantly to pollution in coastal urban areas (Marine Insight, 2011). In fact, other to operations in the harbor also to the increase of road transport caused by handling operations in the hinterland (Viana et. al., 2014) generate externalities in the port cities. Besides, maritime trades are expected to grow in the following years. Therefore, the environmental issues of ports are now a relevant aspect for their competitiveness, a key concept for port planning and management. Port Authorities must act as community managers, finding the compromise among the several port stakeholders to improve collaboration and port performance (Verhoeven, 2010; Acciaro et al., 2014a). Furthermore, if one single port authority can address planning and operation of several ports, optimization and performance can be increased through an effective division of tasks. The objective of this paper is to test an A-S-I (Avoid Shift Improve) framework to foster port sustainable development (Ignaccolo et al., 2019a), for the case study of a Port Authorities System, in order to improve the operations performance and port city integration. The case chosen is the Eastern Sicily Port System, composed of the two ports of Catania and Augusta, which have good chances of task subdivisions.

2. Background

2.1. Italian Policy and Legal Framework

With a ministerial decree in 2016, Italian government has promoted a rationalization of port management with the introduction of 15 new Port Systems Authorities, decision-making centers gathering together the 57 major realities, i.e. the ports defined as 'core' by the European Community. The 15 Port Authority Authorities are entrusted with a strategic role of guiding, planning and coordinating the port system of their area. They have the function of attracting investments on the various airports and connecting public administrations. The approved ministerial decree, introduced three key points: a bureaucratic simplification; a reorganization of ports in Port System Authorities; a new governance model. The Management Committee is composed of a few people and is led by a president expert in transport and port economics and with extensive decision-making powers, chosen by the Minister of Infrastructures and Transport in agreement with the Regions concerned by the System Authority.

2.2. Port sustainability practices and A-S-I framework

| | | | |
|---------------|--|--|---|
| ENVIRONMENTAL | Reducing the number of trips performed by gasoline vessels | Reduction in road transport. Infrastructure utilization to minimize congestion | Use of clean fuel and production of energy. Facilities and equipment for routing improvement |
| | Introduction of charges and taxes. Pre-custom clearance of international freight | Optimum use of space | Efficient gate assignment and processing system. Planning policies related to port-city integration |
| | Collaboration among ports' actors | Information campaign | Waterfront requalification. Safety measures for no motorized traffic |
| | AVOID | SHIFT | IMPROVE |

Fig. 1. A-S-I- approach applied to port systems (Ignaccolo et al., 2019)

The A-S-I approach aims to improve the port sustainability through environmental, economic and administrative, social measures that better the efficiency of port system. Among these, some are to improve transport system efficiency (also reducing emission and congestion), to improve energy efficiency, to optimize land use and performance of port infrastructures and operations, to integrate port-city policies and planning and involve the stakeholders (Fig.1).

3. Application of an A-S-I approach to Eastern Sicily Port System

3.1. Territorial framework

Catania is a coastal medium-sized city of about 300.000 inhabitants, located in the south of Italy, part of a greater Metropolitan Area (750.000 inhabitants), which includes the main municipality and 26 surrounding urban centers (Ignaccolo et al., 2017). Since 2016 the port of Catania belongs to the Eastern Sicily port system, a public authority with the institutional purpose of managing and organizing goods and services in port area, coordinating the activities of two ports, the port of Catania and the port of the city of Augusta. The Port of Catania is an international commercial seaport, located in a strategic geographical position, with a high degree of accessibility and the proximity of the airport, the railway station and the inland terminal. At the current moment, port of Catania's space is organized as shown in Figure 2a: *Nuova Darsena* and *Molo di Mezzogiorno* areas host the Ro-Ro freight traffic; at the right of *Molo di Mezzogiorno* there is *Zona Cantieri*, an area for vessels-building; container traffic is located in *Molo Crispi* area; lastly, the area including *Porto Vecchio*, *Sporgente Centrale*, *Piazzale Triangolare* and *Molo Levante* is occupied by passenger terminal and leisure and yachting activities.

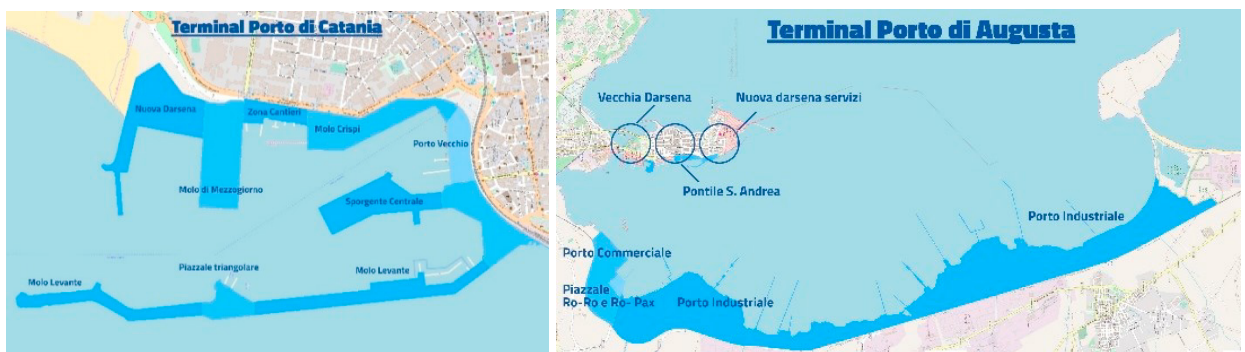


Fig. 2. (a) Port of Catania; (b) Port of Augusta. Source: <http://www.porto.catania.it/porto-di-catania> - <https://www.adspmaresiciliaorientale.it/porto-di-augusta/>

The port of Augusta is one of the Strategic Ports of the European Union of the TEN-T "CORE" NETWORK due to its central position along the international traffic routes. Its location is very close to an important industrial center and it is the largest natural harbor in the lower Mediterranean area; it includes a petroleum port, a commercial port, a military base and a port/city (Figure 2b).

3.2. Issues due to Ro-Ro terminal capacity in Port of Catania

The Port Authority of the Eastern Sicily Port System is committed to continuous data collection on freight transport, by producing both monthly and annual statistics about port commercial activity.

As regards the commercial activity of the Port of Augusta, it is characterized by solid and liquid bulk freight traffic components. Specifically, liquid bulk represents almost the totality of goods (96,82%), while solid bulk constitutes a small percentage of the total (3,18%). The Port of Catania is instead characterized by a commercial activity with absolutely different characteristics. With specific reference to Ro-Ro freight traffic, in the last fifteen years it is noticeable an increase in the number of departures and arrivals of vessels from/to the port of Catania (76% growth rate from 2001 to 2016). Looking at the different percentages of freight traffic components, the greatest

contribution to the port terminal operations is given by Ro-Ro traffic, as it possible to see in Figure 3a. Data elaborations show that 89,11% of the total amount of traffic freight in the Port of Catania is characterized by Ro-Ro traffic, which is representative of the majority rate of freight traffic components. In fact, it is nearly one order of magnitude higher than others, followed by containers (6,27%), solid bulk (4,31%), liquid bulk (0,16%) and other goods (0,16%). More specifically, considering only the Ro-Ro traffic component, from Figure 3b it is possible to observe a constantly increasing of trend of Ro-Ro traffic (in terms of tons), with a growth by even 322% in 2016 compared to 2001 of quantity of goods handled in the port terminal.

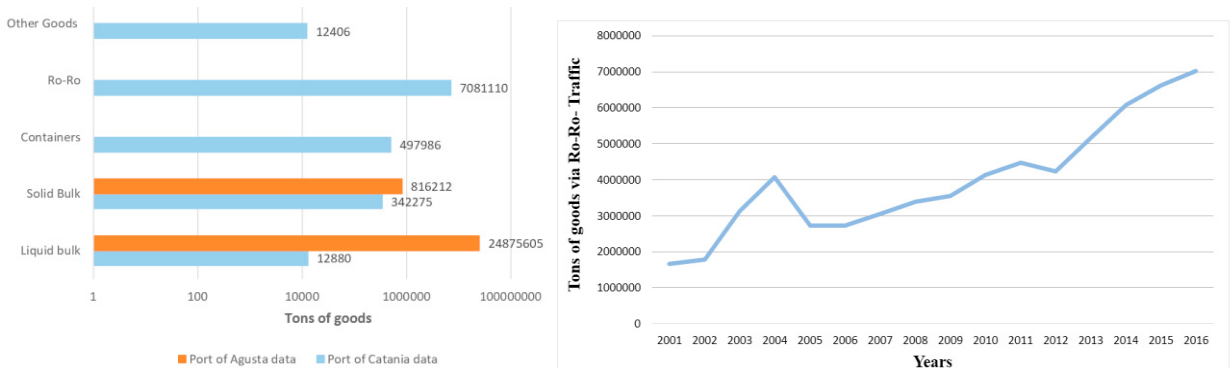


Fig. 3. (a) Percentages of freight traffic components of port of Catania and port of Augusta, 2016 and (b) trend of Ro-Ro traffic [tons] from/to port of Catania, 2001-2016 Source: Port Authority of Catania

For this reason, due to the amount of Ro-Ro traffic in the port of Catania, in 2015 a new commercial area of the port, called Nuova Darsena, has been constructed, to host the increasing number of semitrailers serving Ro-Ro traffic. Nuova Darsena is a 75.000 m2 area, divided in five equal parts 3/5 of which are managed by Grimaldi Group, an Italian ship owning company operating in the maritime freight transport sector. The 45,000 m2 terminal can host up to 450 semitrailers, to be loaded on ships of about 200 seats, with several destinations in Italy and abroad (Table 1). From an in-depth interview conducted with Grimaldi Group operator, one of the main critical issues emerged which regards the size of their Ro-Ro terminal in the Port of Catania, even though the recent opening of Nuova Darsena: such issue has also been confirmed by a previous study conducted by the authors on the terminal's capacity (Ignaccolo et al., 2018).

Table 1. Origin and destination of the main maritime traffic [tons] for (a) Port of Catania and (b) Port of Augusta, 2018 Source: Our elaboration from Port System Authority of the Eastern Sicilian Sea

| a. | | | | | | b. | | | | |
|--|-------------|-------------|------------|---------------|---------------------|--|-------------|-----------|------------|---------|
| Countries and macro geographical areas | Liquid Bulk | Solid Bulk | Container | Ro Ro | Other General cargo | Countries and macro geographical areas | Liquid Bulk | | Solid Bulk | |
| | | | | | | | In | Out | In | Out |
| Italy | In 5.046 | In 35.027 | In 205.938 | In 4.431.456 | In 291 | Italy | 379.776 | 1.331.509 | 28.737 | 52.214 |
| | | Out 14.066 | Out 98.984 | Out 2.624.614 | Out 19 | Europe | 1.618.643 | 1.848.479 | 81.607 | 178.577 |
| Europe | | In 122.899 | In 184.969 | In 317.891 | Out 706 | North America | 233.796 | 37.000 | 11.758 | 50.000 |
| | | Out 114.502 | Out 72.951 | Out 249.509 | | Central America | 1.044 | 13.705 | | |
| North America | | In 3.000 | | | | South America | | 4.600 | | |
| North Africa | | In 11.550 | Out 1.295 | | | North Africa | 3.399.151 | 966.861 | | |
| | | Out 84.450 | | | | East Africa | | 72.000 | | |
| Middle East | | In 21.203 | | | | West Africa | 125.018 | 9.300 | | |
| | | Out 17.035 | | | | Middle East | 1.773.738 | 387.198 | 9.063 | 41.700 |
| India | | | | | | India | | 1.409 | | |
| Far East | | | | | | Far East | 2.059 | 38.300 | | |

3.3. Recently adopted Measures

Construction of Nuova Darsena

The privileged geographical condition of the port of Catania also reflects on the regional territory, it is sufficient to think that it serves a terrestrial basin represented by six provinces and a global population of three million

inhabitants. Other fundamental characteristics are represented by the different activities performed inside the port: commercial, cruise, shipbuilding, fishing and yachting activities, both recreational and sport.

With reference to the ever-increasing commercial activity of the port, mainly characterized by Ro-Ro traffic (as evidenced in section 3.2), it was necessary to improve the capacity of the port terminal itself, in order to increase its performance. In this direction, the focus has been on the port infrastructure, through the building a new dock for storing goods (basically semitrailers serving Ro-Ro traffic), above mentioned “Nuova Darsena” (Figure 4). This new infrastructure was inaugurated in 2015. It has about 1,100 meters of linear quays with an area of 75.000 m², allowing the development of both a commercial traffic essential for the port, and all commercial activities related at the sea. The opening of Nuova Darsena has meant that the port of Catania became a fundamental fulcrum of junction with other cities. In fact, there are more than 40 million tons of goods handled in the ports from Catania to Pozzallo, which represent over 63% of the total amount handled on the Sicilian Island. Furthermore, the delocalization of most commercial traffic in this area has allowed the recovery of over 50% of areas under Port Authority's competence, for the creation of a waterfront with numerous services (i.e. traffic cruise) and initiatives to support the socio-economic development of the city. However, with the completion of this infrastructure destined to Ro-Ro traffic and containers, the port of Catania has only completed the first phase of the large infrastructure process of the terminal, since considering the criticalities that have emerged, it will have to start a second phase of improvement, rationalization and strengthening of existing areas and infrastructures.

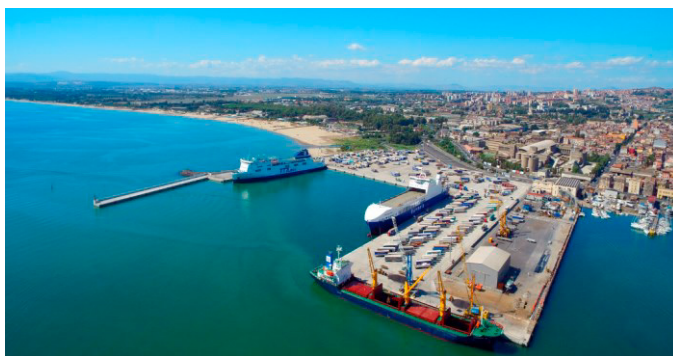


Fig. 4. Nuova Darsena – Source: Port Authority of Catania

Demolition of the harbor wall

On October 2016, as part of an institutional agreement between the mayor of Catania and the president of the Italian council at the time, the recovery of the waterfront of the port of Catania began with the demolition of a first section of the wall that historically separates port activities from the city. The concept is to create a contact between the city and the sea, to overcome the old harbor wall concession and to have a continuous access for pedestrians and cyclists. It's an important measure in terms of sustainable mobility, as the area of the maritime port will become more usable for citizens and tourists and a further step towards the recovery of the waterfront, in a view to develop Catania port's tourist and cruise vocation, in addition to the well-established, mercantile one. The works will also include the construction of a small square and an international competition of ideas for the waterfront, in which several urban architects will be involved for planning and planning future port spaces.

3.4. Application of A-S-I framework and measure proposal

In this section the specific actions that are included within the proposed framework are identified for the case study of the Easter Sicily Port System, as summarized by Figure 5. Among the identified measures, some of them have already been realized, such as the construction of Nuova Darsena and the demolition of the harbor wall, while the others represent possible proposals that can be implemented, both in the short and long term.

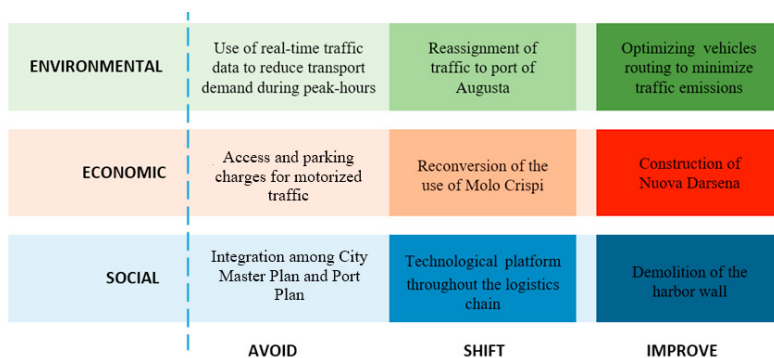


Fig. 5. Framework for sustainability measures of Eastern Sicily Port System

3.5. Proposals

The main measures to be taken into account aim at: the improvement of the transport system efficiency in order to reduce overlapping operations; emissions reduction; optimization of port land use; improvement of operation performance thanks to technological innovations. Furthermore, a fundamental aspect is the integration between port and city planning, breaking down physical barriers.

Introduction of access and parking charges for motorized vehicles

Port pricing policies are usually related to the use of properties belonging to the port, fees for the services to the vessels and fees for the vessels entering the port, leaving out the pricing policies related to private cars access. In the case of port of Catania, the mix of urban and port functions and activities is of the main criticality, with overlapping traffic flows of heavy and private vehicles and no-motorized mobility, which cause several negative factors. These externalities are additionally increased by the current possibility of free parking inside port areas, which, due to the closeness of the port to the city centre, are often used as car park for the attractive areas of the city. In this context the introduction of port access charges for private vehicles and a parking tariff could discourage such intersection of flows, imagining the port entrance as a urban road toll aiming at promoting non-motorized mobility within the port area, positively regulating the whole port environment.

Integration among City Master Plan and Port Plan

The Catania port area extends 3 km along the coast and it is currently enclosed by a fence for customs purposes which separates it from the very city center. The city is currently waiting for the design and approval of a new City Master Plan and a new Port Plan, two planning tools that could radically modify the area of the waterfront but which refer to two bodies, the municipal administration and the authority of the port system, which are totally autonomous from a regulatory point of view in Italy. Thus an integration among city and port planning policies would be desirable since it would be a unique opportunity for the requalification of the urban waterfront, the realization of public facilities and green areas, and to select neighbouring zones that could be designated for new functions and activities for residents and tourists in the city (Cocuzza et al., 2015).

Reassignment of traffic to port of Augusta

This section explores the possibility to exploit the currently under-utilized spaces of the port of Augusta, with arrival of the vessels at the port of Augusta and the connection by road transport between Augusta and Catania. The main issue of this proposal is that, although the increase in travel time might seem not significant (increase by road is of about 45 km, increase by ship increases of about 18.6 miles), the costs supported by the companies and operators due to such distances must be properly evaluated. The externalities due to such dislocation of trades could be reduced by the construction of a new interport and a commercial and industrial area located close to Augusta.

A second proposal could be the arrival of the ship to the port of Augusta and connection Augusta-Catania by rail, through the use of the Bicocca railway logistic terminal, in the industrial area of Catania, which currently moves just a single train per day. The railway network project within the port of Augusta has not yet been started, but it's a challenging project, including pick-up and delivery tracks in the port area, electrification and centralization of the connection between the station and the tracks of the port beam to make entry and exit operations faster and easier.

The main issues of this proposal are the use of specific cranes for loading and unloading of the CTUs inside the terminal and at destination and, moreover, the fact that it can't be considered a door-to-door service, so the cost of the road transport used to reach the destination of goods from the train station in Catania should be added.

Reconversion of the use of Molo Crispi

At the current state of the port layout, the area called *Molo Crispi* hosts container traffic. The solution proposed in this section refers to the use of Molo Crispi for Ro-Ro traffic, which would mean an additional space of 32.000 mq and two further docks for the arrival of vessels (Figure 6). The main challenge of this proposal would be the shift of container traffic to Augusta Port, due to the same evidences found in previous section.



Fig 6. Port of Catania Layout: (a) actual configuration and (b) proposal

Technological and operation innovations

Port industries are in a conducive position to fully grasp the potential generated by this current tidal wave of technological innovation and of integration. Seaports are playing catch-up with the large transport and logistics players when it comes to developing solutions based on Internet of Things (IoT), fully capitalizing the potential of this applications, in order to become a true “Smart Ports”. In this context, the use of Intelligent Transport Systems (ITS) technologies can be a driving force behind the Smart Port. In fact, the ever-increasing demand for sea transport, effectively involves enhancing the attention to systems capable of “intelligently” addressing the mobility problems in their entirety, by allowing more effective and efficient overall performance of the system (Torrise, 2017). The city of Catania has the opportunity to be provided with a traffic monitoring, estimation and forecasting system, realized by the Department of Civil and Architecture Engineering of Catania’s University. It consists of a network of radar sensors installed within the urban area (Torrise et al., 2016) and a software for traffic estimation and prediction on-line, combining the dynamic assignment with traffic measures and events in real time. This system propagates the spatial and temporal traffic flows measured in less than 1% of the network links, integrating available radar detectors’ data and Floating Car Data (about 1500 cars), allowing to know the traffic status on the entire simulation network (Torrise et al., 2017a, 2017b). These data can constitute a valid support to identify specific actions which should be taken by adopting appropriate policies and measures (e.g. use of real-time traffic data to reduce transport demand during peak-hours) and management strategies (e.g. optimizing the vehicles routing to minimize traffic emissions). Therefore, the knowledge of traffic flows in the surrounding area of the port becomes essential and will certainly be decisive for the identification of the magnitude of vehicles at terminal gateways and their contribution to the rest of urban mobility. Furthermore, the systematic and planned integration of ITS should be

based on the same technological platform throughout the logistics chain, including railways and highways, to optimize transport operations and offer ongoing responses to changing market requirements.

4. Conclusions

Transport is traditionally a sector in which commercial factors are decisive, but already for a long time the aspect of sustainability is increasingly valuable and this increases the pressure on challenging port authorities around the world to find ways of operating and managing their ports efficiently and effectively in terms of economic, social, as well as environmental development, in a nutshell in a more sustainable way.

In this connection, a framework for sustainability of ports has been applied for the analysis of the Eastern Sicily Port System and in particular for the port of Catania, presenting some already undertaken virtuous measures and proposing new solutions and showing which aspects still need to be addressed. This last aspect concerns above all actions aimed at reducing the demand as far as possible, through economic and administrative measures. While, for what concerns possible proposals to be implemented, they avail themselves of actions and measures aimed at the improvement of trip efficiency and at the reconversion of the use of areas, as well as of the optimization of transport infrastructure efficiency through technological and operation innovations.

The framework can be an aid in the choice of measures to be undertaken in the improvement of ports and in the analysis of the current state of ports' sustainability.

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