Port Cities Symbiosis. Port Network Authority of the Eastern Adriatic Sea and of Sardinia Sea (Italy)

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Abstract. Port cities have always been key hubs for the transport of goods and people. Ports meet global transportation needs, while being integrated into geographies subject to local policies. Maritime and logistical flows pass through ports and densely built-up areas, creating new environmental challenges. Political interests and strategies, technological development, migrations, trafficking of goods and flows of people are factors that influence spatial organization as well as land use to respond to the new challenges of the global market. This also involves changes in the morphology of port cities, which are by their nature dynamic, cosmopolitan and more open to change and the reorganization of the coastal space, from port cities to port regions. Ports are becoming increasingly hybrid, progressively changing shape and inserting new functions even beyond their administrative borders, renewing the relationships of Port Cities Symbiosis. In this paper we focus on the hybridization process of ports, to address new international challenges in particular. By analyzing some theoretical and real cases of Italian port system authorities - of the Sardinian Sea of the Eastern Adriatic Sea, Ports of Trieste and Monfalcone -, it is proposed to evaluate a synthetic hybridization matrix of ports, within the framework of the broader Port cities symbiosis phenomenon.

Keywords: Port-Cities · Port Cities Planning · Port Cities Symbiosis

1 Introduction

The ports have long been the foundation of socio-economic development in many coastal regions where they have played and continue to play multiple roles. In their historical evolution, the ports have chronicled the economic, technological and social transformations of the territories on which they gravitated.

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The European territorial context is configured in a network of over 1,200 seaports and the horizontal relationships established between 'land and sea' are manifested through - positive and negative - environmental, socio-economic and cultural impacts. The port areas see the transit of around 420 million passengers and a 74% handling of imported and exported goods. At the same time, it is necessary to consider that daily these coastal areas are traversed and experienced by some 1.5 million workers who are employed in the different port sectors - logistics and cargo handling, passenger services, infrastructure maintenance, etc. - and who contribute to strengthening the local economy by facilitating economic, cultural and tourism exchange.

Hence, different and multiple vertical and horizontal relationships are put in place between the port, neighboring cities and gravitation regions. Globalization and revolution in the transport sector, such as containerisation and intermodality, have in fact contributed to modifying and intensifying these connections and in achieving common interests such as economic development, these areas often find themselves competing for different spaces and goals [1, 2]. In this perspective is the process of 'hybridization' that sees ports striving to create more flexible and adaptable structures to meet the changing needs of the global market. This 'new' approach aimed at continuous and dynamic transformation takes several forms, including, for example, the adoption of digital technologies to optimize port operations, the diversification of functions - including commercial, cultural and/or residential -, and the implementation of sustainable policies to address environmental challenges. These transformations give rise to the concept of 'Port Cities Symbiosis' in which the 'reading' of the territory requires closer interconnection and synergic collaboration between port facilities and cities by investment in infrastructure and services that benefit both the port and the city [3, 4].

In this context the aim of the work is to deepen the issue related to the process of ports hybridization, to address new international challenges in particular. By analyzing some theoretical and real cases of Italian port system authorities - of the Sardinian Sea of the Eastern Adriatic Sea, Ports of Trieste and Monfalcone -, it is proposed to evaluate a synthetic hybridization matrix of ports, within the framework of the broader Port cities symbiosis phenomenon.

The paper is organized as follows: Sect. 2 Related works; Sect. 3 Method and Study Area: Sect. 3.1 Methodology; Sect. 3.2 Study Area; Sect. 4 Results and Discussion: Sect. 4.1 The port of Cagliari and Olbia; Sect. 4.2 The port of Trieste; Sect. 5 Conclusions and Future Developments.

2 Related Works

The port areas emerge as vital hubs for the blue economy. Since ancient times their versatility and the variety of activities involved (industrial, commercial and tourism) reflect a complex network of interconnections that stimulate economic growth, improve the quality of life and preserve the environmental balance of the regions involved [5, 6].

In the second half of the 20th century, an increased interest in understanding the functional structure and evolution of port cities was triggered by changes in the patterns of international maritime trade (delocalisation and re-functionalization of port-city activities) and technological innovations that accelerated transformations, particularly

in the 1980s and 1990s. In this context, at different territorial scales, public and private actors have financed and activated programs and projects aimed at improving the quality of life and relations in the port-city space [7]. These relations have been analyzed since the first decade of the 1900s when the 'American Association of Ports and Harbors' was established in the United States, and subsequently, there have been several studies by authors who have explored and described the development and the relational evolution between port and city from different perspectives: port-city interaction, growth and estrangement, isolation and separation, and port-city integration [8–13]. With reference to the dialogue between port and city, it is worth mentioning the work carried out by Bird J. in 1963 [14] in his 'Anyport Model' in which he emphasized the idea that any location along a coastline could potentially turn into a port, given the right conditions - geographical (sheltered harbor, access to deep water, proximity to transport networks), economic (market demand, industrial and commercial development), and political (regulations and investments that facilitate and/or hinder growth). Consequently, ports, in order to be able to respond to different conditions, must allow their dynamic and flexible nature to emerge and grow.

Historically, ports have always been seen as engines of economic growth and cities as hinterlands supplying labor and resources. However, this traditional dichotomy has often led to conflicts over space and significant impacts on the landscape.

Thus, in the context of growing environmental awareness, increased international competitiveness and new job opportunities, the world's major ports have taken substantial measures to elevate their functional, operational and integrative capabilities by changing perspective [4, 15–18]. The approach adopted is configured through the concept of 'Port Cities Symbiosis' that considers ports and cities no longer as competing entities, but as realities that coexist, thrive and influence each other through the exchange of goods, people and information. The economic success of a port can catalyze urban development, creating job opportunities, attracting investment and promoting a vibrant local economy, and at the same time a thriving city can provide the port with a qualified workforce, infrastructure support and a business-friendly environment [19]. The interdependence between ports and cities therefore offers an opportunity to address economic, environmental and social objectives in a cohesive way, creating a framework for resilient and adaptive urban development. Following these objectives, several working groups and associations are involved in broadening scientific-disciplinary comparisons to improve the port-city relationship in a territorial development perspective.

The first organization, the Association International Villes et Ports, was set up in 1988 to improve the relationship between cities and ports by establishing and developing dialogue and cooperation. In 2001, RETE, another international non-profit organization, was formally established in 2004 in Venice, thanks to a protocol of agreements between Italian, Portuguese and Spanish ports and cities, who strive 'to improve the relationship of reciprocal collaboration in order to achieve a balanced and qualified development of urban and port areas'. This approach finds a place in the Mediterranean cities and ports with their own 'constitutive specificity' in terms of the organization of the port infrastructure and its relationship with the urban public space. An integrated urban space in which the port becomes an 'urban living room' stimulating the development of a new city identity [20].

3 Method and Study Area

3.1 Methodology

Analyzing the relationships of Italian port cities is a complex issue. The multiple urban areas, ports, waterfronts, semi-peripheries and suburbs create a network of interconnections that requires the integration of different analyses. An essential first step is the analysis of strategic and urban planning tools - Approved (AP), Adopted (AD) or In Progress (IP) - (Fig. 1) [21]. The objective is to observe and assess their capacity to manage land uses (urban and peri-urban) and their consequent effects on urban and port centers in an integrated way. In addition, it is important to examine not only the coordination and interconnection level of urban and port planning tools, but also those related to 'ordinary' industry and transport planning, and special attention must be paid to the 'spontaneous' behavior of logistics operators. Their location in space may be unstructured and follow logistical logics different from the traditional ones, with significant logistical impacts on the territory.

The following methodological approach, complemented by concrete examples, literature research and policy proposals, is configured in Fig. 1 through an analysis matrix that aspires not only to measure the efficiency and effectiveness of policy actions, but also to promote a balanced integration between different strategic and planning tools [22].

The analysis required the review and systematization of the different available documents considered relevant for understanding the pressures and areas of symbiosis in the city-port areas. Planning documents, overview maps and field surveys represented important sources for setting up the matrix related to the different scenarios.

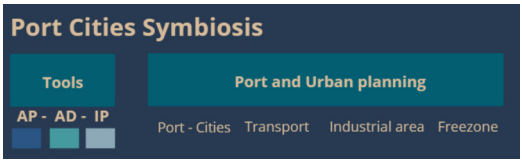

Fig. 1. Port Cities Symbiosis: Analysis matrix. Source: Authors' elaboration

3.2 The Study Area

The port-city relationship in Italy is historically rooted and has evolved over time taking on different forms and configurations. Just to mention a few, the urban structure of Venice, Pisa, Genoa, Naples and Ravenna was born and has been linked to the port infrastructure, creating a cohesive and distinctive urban fabric and an important center of trade and cultural exchange. The dynamic coexistence of these spaces has allowed ports, in their ordinary modernization and redevelopment processes, to integrate their infrastructures and activities more closely with the urban area, favoring new development models linked, for example, to green mobility and environmental sustainability.

The analysis includes the urban-port relations in the city of Trieste (Friuli-Venezia Giulia) whose port is managed by the Port System Authority of the Eastern Adriatic Sea and in the cities of Cagliari and Olbia (Sardinia) where both ports are managed by the Sardinian Sea Port System Authority - other ports managed on the island are Cagliari, Foxi-Sarroch, Olbia, Porto Torres, Golfo Aranci, Oristano, Portoscuso-Portovesme, Arbatax, and for Santa Teresa di Gallura - commercial dock only.

The three cities are characterized as 'central places' that insist on the surrounding territories with their supply of goods and services [22, 23]: a) the Province of Trieste, includes six municipalities, including the homonymous capital, is a compact and densely populated area, with a catchment area of about 240,000 inhabitants; b) the Metropolitan city of Cagliari involves an area of about 400,000 people spread over 17 municipalities; c) the city of Olbia, considered the main gateway to the island, insists on an area involving 26 municipalities - former Province of Olbia-Tempio, now the Eastern part of the Province of Sassari - for a total of 159,000 residents.

In the port sphere, all three areas play an important role as commercial hubs and are part of the cruise ship network, although with different purposes and specialized markets. The three ports welcome 652,300 cruise passengers to their urban waterfront for a total of 331 landings in 2022 [24]. In particular, Trieste is a predominantly international port, serving as a gateway to central Europe; Cagliari focuses on Ro-Ro and ferry traffic for the western Mediterranean; Olbia with about 3 million passengers (2022) is Sardinia's main passenger port - on a national scale it ranks eighth. The three ports are distinguished not only by their specialization but also by their size and different integration with the city.

Sardinian Sea Port System Authority. As mentioned above, the Sardinian Sea System Authority, instituted by Legislative Decree No. 169 of 4 August 2016, has complete management of the island's ports, including Cagliari and Olbia. The policy, planning and coordination actions of the ports under its jurisdiction are based on the three 'Three-Year Operational Plans' (2018–2020; 2021–2023; 2024–2026) in which the primary objective is to contribute to the socio-economic growth of port areas in synergy with urban areas. The projects activated and planned concern not only 'ordinary and extraordinary' activities related to port functions (e.g. quayside infrastructures, seabed maintenance), but also those dedicated to a greater synergy with the urban areas of reference - e.g. the change of use of some spaces for leisure activities, waterfront redevelopment, development of entrepreneurial activities [25].

The Authority's constant efforts on sustainable matrix guidelines such as the ecological, energy and digital transition for the pursuit of socio-economic development integrated with the territory has allowed it to receive awards on a national scale, such as the recent 'Smart Ports Award' (September 2023). In this way, the Authority works to establish a balance and positive relations, from an economic and urban planning point of view, mainly with the Municipal Authority. Therefore, below we highlight peculiarities and projects activated in the two island ports that are on which the study focuses.

Port of Cagliari. The port is divided into three areas [25].

1. The 'Porto Vecchio' is developed on a 333,250 square meter land area (coastal development over 11,000 m including 4,800 m of quay). The port area is delimited by

two external breakwaters (western and eastern breakwaters) and by the Molo Ichnusa (internal breakwater). Three areas are identified between the two breakwaters - Levante Basin, Inner Harbour, Ponente Basin - for a total of around 7 km of waterfront (Fig. 2).
2. 'Porto Canale' is delimited by two converging outer breakwaters, each 2,020 m long, and is configured with five berths for transshipment and Ro-Ro traffic.
3. Porto Foxi' (Municipality of Sarroch) is Cagliari's liquid bulk port.

In 2023, plans are underway to build a new marina in the 'Porto Vecchio' area. Here it is planned to overhaul the berthing system for yachts and private boats and the restyling of the ex-maritime station, which will be converted into a multifunctional center (recreational boating services and tourist hub) and of the additional public spaces.



Fig. 2. The Port of Cagliari. Source: Authors' elaboration [22]

Port of Olbia. The port it is divided into three areas with different functionalities (Fig. 3).

The 'Porto Cocciani' (industrial), which a land area of about 270,000 square meters is located in the industrial area to the north of the city and is used for Ro-Ro traffic and traditional goods - stone material, cement, frozen tuna, cereals and fertilizers; the 'Pontile Isola Bianca' is a commercial area consisting of a strip of land artificially formed for a total of 107,894 square meters - including parking areas for commercial vehicles and semi-trailers - in which there are 11 quays. Ten quays are destined for Ro-Pax ferries for passenger and commercial transport; the 'Porto Interno' (inner harbor), located to the south of the Pontile Isola Bianca, which is reserved for recreational activities.

The Port of Trieste within the Eastern Adriatic Sea Port System Authority. The port of Trieste is part of the Eastern Adriatic Sea Port System Authority, that includes also the Port of Monfalcone, while integrates also the presence of inner ports and dry



Fig. 3. The Port of Olbia. Source: Authors' elaboration

terminals, as Bagnoli - Fernetti and Cervignano, as well as including the consortium for the industrial development of Trieste area (COSELAG) located in close proximity to the docks of the Port of Trieste, in the Southern part of the port area. The Port of Trieste (Fig. 4) is characterized by interesting dynamics particularly in terms of the maritime - land connections, with a high percentage - 30% - of freight share moved by train towards European inland destinations. Furthermore, a mixed role of hub & gateways functions characterize the port. 35 to 40% of freight traffic is generally transshipped - originating mainly through pendulum routes with Far East Asia, although this share dropped down dramatically at the beginning of 2024, due to the Suez - Bab el Mandeb traffic limitations, while the rest of the traffic is directed towards the port of Trieste's hinterland, at short range - in Friuli Venezia Giulia Region - and at medium and longer ranges - to European destinations.

In the national framework of the Italian System Port Authorities, the Port of Trieste is characterized by being mainly a rail port and the only true international port, with a predominance of international destinations for freight. Pier VII in particular is dedicated to the container movements, while several terminals are nowadays multipurpose ones, hosting a mixed container and ro-ro traffic. Noticeable is also the liquid oil movement, still representing the lion share - more than 70% - in terms of the overall tonnage moved.



Fig. 4. The Port of Trieste. Source: Authors' elaboration [22]

4 Results and Discussion

The recent changes occurring in the port systems are relevant and having consequences on the spatial patterns and balances among the different kinds of uses. Namely, port and urban ones, bringing with them together activities as people and freight movements, residential, services and industrial activities, tend to compete both on the waterfronts and in inner areas for gaining access to the most suitable areas for their exploitation.

The different cases considered are interesting in terms of how peculiar they are in tackling these issues, descending from different urban evolution's histories and port ones.

The analysis applied to the three cases with the aid of the analytical matrixes (Figs. 2, 3, 4). The planning tools were considered, particularly those insisting on the different areas of the port-city. The planning tools are related to urban and port planning, extended also to consider the industrial plans and the mobility ones. The urban/metropolitan scale was also considered, together with the evaluation concerning the presence and operation of Free Zones. The analysis applied to the three cases with the aid of the analytical matrixes. The different stages of adoption of the planning instruments were related to differences in the 'cities and ports' performances in matching and meeting urban and port planning issues [22].

4.1 The Ports of Cagliari and Olbia

As highlighted above, the ports of Cagliari and Olbia belong to the same Port System Authority, although with considerable differences in terms of their performances and characteristics, both from the city and from the port points of view. The characters of accessibility are the most relevant ones. In the case of Sardinia, of course, it has to be

considered that maritime transport - together with air transport - is the only one really connecting high volumes of passengers and freight traffic.

From the urban point of view, Cagliari represents the regional capital and also a metropolitan city with higher order functions and services. Given the presence of a wide urban area, extending to a wide metropolitan city and area, potential pressures and symbiosis are important. In the case of Cagliari, the aspects related to the implementation of the industrial areas are advanced in most of the geographical framework - port, semi-periphery and periphery. The free zone in the port area is also present and available, although not yet fully implemented (Fig. 5).

Cagliari faces a complex challenge. Despite a large metropolitan area, establishing Free Zones – a key development tool for the city and its region – has been slow. The city's substantial population, industries, and service sectors further complicate planning, which currently prioritizes central urban and port infrastructure. Additionally, delays in implementing specialized customs regimes for industrial zones could hinder future progress [22].

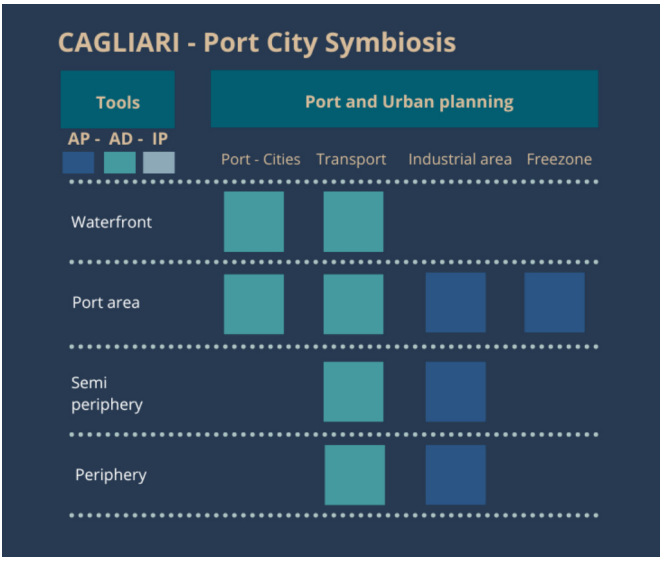

Fig. 5. Cagliari: Analysis matrix. Source: Authors' elaboration

Olbia has been an important port city in the Mediterranean since ancient times. The port favored trade and exchange with other Mediterranean civilizations, contributing to the economic growth of the city and the island's territory. The port-city relationship has not always been harmonious: the port was born and established a conflictual relationship with the city, relegating it to the margins and depriving it of direct contact with the sea, and only in recent decades can it be considered integrated into the urban context. Infrastructure and services help to establish a close relationship with the local community (port services, shipbuilding, yachting, tourism, logistics, etc.). In its role as a passenger gateway in particular, with a constant flow of people it enhances the fruition of the two

areas (urban and port) thus also contributing to the development of the local and regional tourism sector. Following the commitments to achieve Agenda 2030 sustainability goals, in recent years there has been a growing awareness on the importance to develop the port compatible with environmental protection and the wellbeing of residents and guests. In this perspective, for instance, investments and projects are being made in the reconversion of the waterfront and in new redevelopment projects in the port areas that are more open to the city: an area of about 3,500 square meters along the 'Pontile Isola Bianca' will see the creation of spaces equipped with street furniture, greenery, and lighting for leisure enjoyment (Fig. 6).

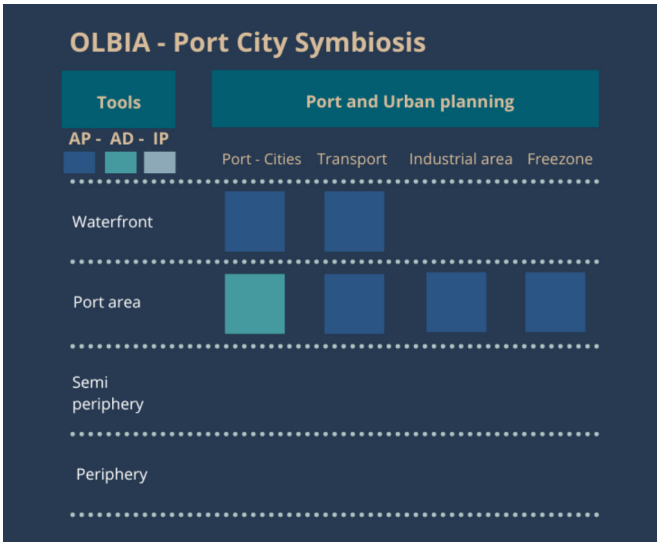

Fig. 6. Olbia: Analysis matrix. Source: Authors' elaboration

4.2 The Port of Trieste

Trieste, encompassing the city and port, holds a set of planning tools applicable across its territory – central core, port zones (including expansions), inner and outer suburbs – nonetheless gap remains. Conventional transportation planning instruments haven't sufficiently tackled the needs of the peripheral areas.

If the previously analyzed ports represent important gateways for a region isolated from other transport systems point of view, in the case of Trieste the maritime - land connections are tightly linked and all the efforts have been put, particularly in more recent times, to make this set of long-range flows be operational and functional. In such a sense, the planning tools were considered particularly for fostering the logistic and transport functions, together with the re-exploitation of the industrial components, after a period of deindustrialization. The overall picture coming out from the observation of the matrix analysis displays an area whose level of maturity of the planning instruments

for the transport, logistics and industry sectors is advanced and presents an important framework for further developing the area. The port masterplan, the integration with industrial planning and a one-of-a-kind jurisdiction of international free port, allowing eased set up of transport and industrial activities, hold potentials for a full exploitation of the area. The development of port-related and extra activities out of the strictly-related port area is not however yet exploited and planned, living room for further planning implementation (Fig. 7).

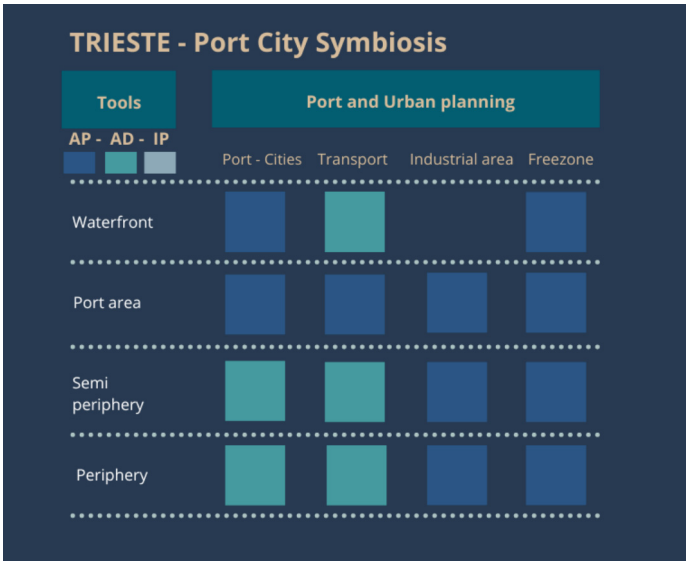

Fig. 7. Trieste: Analysis matrix. Source: Authors' elaboration

5 Conclusions

The port-city symbiosis is a phenomenon that aims to create a relationship of mutual collaboration between port and city. Symbiosis is a phenomenon borrowed from the plant system and consists of a close mutualistic and long-lasting relationship between two organisms of different species that benefit from their interaction.

In this sense, for the port and city symbiosis, the sharing of knowledge and information between the port and the city is fundamental, from port operations and development plans: The city must be informed on how the port operates and what its development plans are for the future, thus allowing us to plan in symbiosis.

The port-city symbiosis is therefore an interdependent relationship between the port and the city of which it is part. In this relationship, the port provides the city with access to the sea and trade routes, while the city provides the port with labor, infrastructure, and services, with economic development created for both parties. The port can create jobs and attract investment, while the city can benefit from increased trade and tourism

and demand for goods and services. Furthermore, the port-city symbiosis can promote environmental sustainability, including through reducing the environmental impact of the port and promoting the circular economy and energy transition.

However, there are also areas of conflict of interest between the port and the city, such as the land use of the waterfront quays which are often used for parking cars, occupying vast central and attractive areas. In this sense, the port-city symbiosis requires multi-level governance to facilitate the creation of a common reference framework for the planning and development of the port and the city, which must include a common vision for the port-city symbiosis, as well as objectives and indicators of measurement.

6 Future Developments

The port-city symbiosis is a desirable alternative to parasitic dynamics, in which one of the two actors exploits the other to its own advantage. Symbiosis can manifest itself both through the development of shared strategic plans that take into account the needs and objectives of both parties and the establishment of consultation tables and multilevel governance bodies. Flexibility and adaptation to changing global and local circumstances are crucial to maintaining a lasting symbiotic relationship.

The port-city symbiosis is not a static model, but a continuously evolving process that requires the active involvement and support of the public and private actors involved. Over the centuries, the relationship between port and city has evolved in parallel with economic, social and technological changes. However, the port-city symbiosis must face the challenge of economic-environmental sustainability, to face global and local challenges.

The development of research on the port-city symbiosis which is constantly evolving, will be oriented towards implementing pilot experiences capable of: overcoming regulatory barriers and facilitating the adoption of symbiotic management models capable of innovating to improve its efficiency, security, sustainability and life quality [26–28].

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