The Port - City Relations in the Era of Hybridization

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Abstract. Ports play an important role as interfaces among sea and land, elements of organization of the coastal space, with important influences on the cities and regions they are inserted in. A wide attention and consideration has been put in time by scholars from different disciplines on the relationships between ports and cities on the waterfront, following the different stages of maritimization and the evolution of the roles of ports and cities. In particular, during this evolution, ports become more and more hybrid in their roles and characters, changing continuously their shapes and functions, and, consequently, the relationship they have with their surrounding areas, cities in particular, being the most proximal elements to ports. In research and planning, however, little attention has been put towards dry ports and inner harbors, as the new areas important for ports, hosting vital operations for linking ports and their hinterlands in order to keep quays free for freight handling on the seaside. In this paper we put the attention on the process of hybridization of ports in time, focusing in particular on the new challenges coming out from the evolution of port activities into inner areas and, therefore, observing the interaction these have with peri-urban and peripheral areas. Analyzing some theoretical and real world cases, a matrix of interactions is proposed to evaluate the positive/negative interactions and the correspondence of planning instruments in tackling the issues of the port and city development.

1 Introduction

Ports represent important interfaces in the connections between sea and land, namely between the maritime routes and the terrestrial ones, connecting distant production sites with local, coastal and internal markets.

Their role is multiple in scale, as ports can be relevant nodes in an international, global context, and/or in a national one, but they are relevant at regional levels [1, 2] and, as is the

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main focus of the present paper, also locally, particularly in the city-port relationship [3]. This has evolved in the years, also in terms of the changing role of industrial production and development. Only relatively recently have we witnessed the specialization of port and industrial areas, particularly in the so-called third generation ports [4]. While more recently the requalification and redevelopment of the old waterfronts toward urban uses took place. In the development of ports and of the city-port relationship, the current period of time and stage can be defined as an hybrid one, where a wide application of the concept of hybridization can be observed. Transport modes, in fact, mix in port operations on the shorelines and in the inland terminals. Also, city and port functions mix on waterfronts, but also in more internal and peripheral areas, following urban sprawl and the port-related function of inner relocation. In this we recall a revision of the Anyport model [5, 6], in light of the on-going changes, as well as a reflection on the changes occurred in the MIDAs – Maritime Industrial Development Areas around ports, proposing a method of study and examination of the city-port relations in the evolution of these systems. The occasion is that of reflecting on the overall changing set of relationships that occur between port and its different components and dimensions. This in particular follows the growing needs for efficient urban logistics and for the consequent needs to the new locations necessary from the widespread diffusion and importance of the last mile in the door-to-door urban distribution. In this sense, the new inner harbor spaces deserve particular attention, where logistic functions supporting port activities are mixed and confused with the urban ones, often without proper coordination. Furthermore, operations traditionally carried out in ports now find most efficient locations farther from the shoreline, leaving space on quays for freight movement, management and temporary storage. Pressures are put on waterfronts and peripheries following the evolution of cities and their ports. In Italy, however, the port-city system has specificities given by the proximity of the ports to the cities, what influenced both urban and port planning, with positive and negative externalities [7]. The urban form of several ancient port cities, in fact, was influenced by the location and role of the ports themselves, determining relationships that are still visible today. Port cities holds also a strong identity based on the historical stratification of the union of urban culture and maritime culture and multiculturalism is a strong characterizing component [8]. Port cities are also united by a functional-organizational project that in relation to the different reference scales of the urban and port attractiveness [9]. The port-city relationship, in its complexity, also the sum of the stratification of historical relationships, is at the center of a set of contradictions and problems of contemporary planning, even in the context of global competition. In fact, the city-port relationship intertwines multiple aspects: from its scalar dimension and security to the most suitable funding and planning tools [10]. In this sense, the transformation of port cities and urban waterfronts highlights how the relationship between the city and the port is not conceived without a zoning approach (homogeneous space), but rather of diversity (hybrid space) [11, 12]. In Italy, in particular, the waterfront policy focuses on the regeneration of the city-port contact space, a place immediately behind it that has non-merchant functions.

The regeneration of the city-port contact aims to make the waterfront accessible with slow and sustainable mobility (walk and bike, local public transport and e-mobility) and attractive with services (museums, refreshment and conference centres, etc.) [2, 13, 14].

The regeneration of the waterfronts has been an important opportunity for urban planning in the - maritime state property - which, although characterized by complex legislation, has opened up replicable scenarios which, however, yet often homogenized by the public space [15, 16]. Furthermore, some research and applications of the last 10 years have demonstrated the important role of the connectivity of ecological networks through green spaces, where port and mobility infrastructures have interrupted the ecological continuity of the coastal system. Green infrastructures, in fact, are able to face a wide range of challenges: from the conservation of biodiversity, adaptation to climate change, support for the blue and green economy [17], improvement of social cohesion and participation integrated into the urban functions of the waterfront [13, 18, 19].

Such elements represent the framework from which the research question originates. The aim of the paper is to investigate port-city relations with particular reference to the transition from specialization to the hybridization of port-city functions, highlighting and proposing methods for analysing the city-port relationship and to address the potential conflicts on land use. The paper is organized as follows. In Sect. 2 Materials and Methods are presented. Section 3 hosts the Methods, where a framework for analysing the port - city relationship in a hybridized environment is proposed. Section 3.2 is focused on two case studies applied to different ports, as the Ports of Cagliari and Trieste (Italy). Results and discussion follow in Sect. 4, and Conclusions and a future research agenda are presented in Sect. 5.

2 Materials

2.1 From Specialization to Regionalization of Ports

The continuous specialization of port functions, over time, has in fact moved the port core away from the urban center and developing port infrastructures and services further away from the urban nucleus unlike in the past. The origin of the specialization of the port and therefore of the relations with the city can be summarized as an initial port site with small quays very close to the city center and warehouses in close proximity. Technological innovation and the progressive growth of the port and naval dimensions, as well as the movement of goods, led to the progressive removal of docks and docks from the city center and in particular from the business centre, with a consequent specialization of the terminals.

Following Bird, as recently resumed in Notteboom [20] a typical port, in its evolution, passes through three major stages as originally proposed in the Anyport model of development. These can be summarized in setting, expansion and specialization [21].

Setting. A port set up is highly related to geographical elements, particularly related to sail ships, and there is a tight relationship with its city and its economy, as a port city is oriented to port-related activities as trading, shipbuilding quays in close proximity of the center, fishing activities, with, in the pre-industrial era, port-related activities based on wholesaling and warehousing. The spatial and social mix of port and urban activities is strong.

Expansion. The city-port relationships evolved dramatically with the exploitation of the industrial revolution, that brought several changes, including the expansion of quays, the growing amount of freight and passengers moved, the increase of ships' size and,

consequently, the need for adequate, bigger warehouses and proper, wider docks, as well as deeper waters to host new ships. The industrial revolution brought industrial activities in close proximity to the waterfront to gain economies of scale and location, helped by the development of railways and a wider integration of the port towards a wider regional area. Maritime Industrial Development Areas (MIDAs) started to be realized [22]. The port expansion started towards external areas in search of deeper waters.

The specialization of port functions is a consequence of the evolution of freights and the growth of volumes handled. Unitization in particular, led to a consequent need to rely on dedicated terminals, that need to be specialized and dedicated to handle differentiated freights, with different techniques for handling, storage and movement. Containers - together with other unitized freight as semi trailers and swap bodies - need wide spaces and dedicated intermodal facilities (i.e., cranes and railways). Ores, grain, petroleum and coal require dedicated warehouses and handling. A closely related element is naval gigantism in all sectors, implying dredging, greater depths, longer and wider quays. Facilities closer to the urban center become rapidly obsolete and their activities need to be moved out from the urban core, in search for wider space for freight management, handling and storage. Older, central, urban obsolete port facilities start to be reconverted towards urban uses (i.e., residential activities, retail, services, urban parks, etc.).

Notteboom et al. (2022) [23] and Rodrigue et al. (2020) [24], commenting on the evolution of ports, introduces a further stage, as that of regionalization of ports, coming out from the important changes introduced by unitization - and containerization in particular - with the development of a wide network of satellite terminals and inland terminals connected to the port facilities themselves. This regionalization of ports implies the capacity of a port to transform its surrounding territory, extending the port-related functions to the entire region of influence of the port itself.

2.2 The Hybridization of Ports and Cities

The historical relationship among cities and ports seems living a renewed season in a further hypothesized stage of hybridization. Together with regionalization of ports, cities also have been expanding in other parts of their territories.

Important related changes in transport and logistics, as containerization, globalization, naval gigantism, etc., led to specialization of ports and terminals with a separation of functions and activities and a regionalization of major port systems, that, according to most of the authors cited, occupied an important share of the end of the twentieth century and beginning of the twenty-first century. Further changes are however on-going, in line with the specialization of terminals and regionalization of ports, and such a concept could be defined as Hybridization, to be observed at different scales and according to different points of views.

The growth of specialized maritime traffic then favored the formation of the “inner harbor” and intermodal terminal for freight, including both road and rail modes, and often other areas with sorting and distribution functions. The main function is the decongestion of port areas by storing goods a few - or even hundreds - of kilometers away from the port itself.

This allows to manage efficiently the entire transport cycle, including handling, storage and warehousing, as well as the intermodal break of bulk [25].

Not only ports changed their role and expansion in space and time. The urban areas in their different periods witnessed a process of expansion in space is aimed to gain spaces farther from their original locations, in peripheral and semi-peripheral areas. Such evolution of the city has been studied by authors in the years, leading to theories and models of urban expansion, well known in urban geography theory, that led to phenomena such as suburbanization, disurbanization and/or ri-urbanization [26–34]. In any case cities have been extending their areas in their territories, with phenomena of urban residential - as well as logistic and retail - sprawl and sprinkling. This is very often coupled, at least in Western countries, with ageing and decline of population. The key element and consequence in that is an increased difficulty in meeting the needs of an increasingly dispersed population and to provide central, urban services. Urban density reduction and urban extension represent therefore two sides of the same coin, as the origin of the main spatial challenges connected to cities.

Similarly, ports have been expanding in other 'dry' parts of the territory, as well as playing differentiated roles and functions in the areas not always proximal to quays. These two processes are to-date converging in different parts of the city-port dyad, not only and not always in central locations, but also, and what is even more challenging, in peripheral and semiperipheral areas. The competition for land use is therefore moving out, both from the central city and from the traditional quays of the port, to invest other and different territories, whose social challenges are more and more characterizing and putting at risk a smooth transformation of our cities.

3 Method and Study Area

3.1 Methodology

The methodological proposal fits into this synthetic framework aimed at analyzing the complex relationships involving urban areas, waterfronts, peripheries, semi peripheries, suburbs and port areas. The aforementioned concept of hybridization represents a premise to propose methods, instruments and tools for valuably analyze such relationships.

Such a descriptive overview needs to be integrated by a different set of analysis, implying a survey and methodological organization of the different planning tools - at strategic and urban levels -, together with those related to the organization of the industrial and logistic aspects. Our approach involves the consideration of different aspects as:

- The planning tools available for managing spatially-related aspects;
- Their state of development and/or approval;
- Their spatial dimension (urban, metropolitan);
- Their main realm of application (i.e., industrial, urban, port, etc.).

These elements are summarized in a matrix useful to analyze the co-existence of planning instruments and the level of integration or potential conflicts among different uses of port and urban areas.

The above mentioned approach can be summarized in the matrix as in Fig. 1 (Fig. 1), that can represent in perspective a useful tool for evaluating the urban-port performances [24], together with an overall harmonization of the set of the strategic and planning tools.

Fig. 1. City Port: Analysis matrix

From the planning point of view, we On one side there is the need to organize and analyse the approved (AP), adopted (AD) or in progress (IP) strategic and planning tools to understand to what extent they area able to in terms of their capacity to tackle together the aspects related to the different land uses at urban and peri-urban levels, therefore observing the effects on urban and port centres. Generally speaking, when dealing with If we can observe that strictly urban and port planning tools, these are generally coordinated and interrelated, given the use and habit of having representative of both port authorities and municipalities involved in the planning decisions within the municipal urban plans as well as within the port plan. Thing change this is not always true when we consider transport and industrial planning tools, as well as when we consider the 'spontaneous' behavior of de-facto logistic operators, whose location in space can be non-structured and referred to traditional standard industrial and retail locations, but with logistic-like impacts in space.

The methodology proposed at the basis of the matrix is divided into the following phases:

1. Desk analysis: Assessment of the state of the art of strategic and planning tools - approved (AP), adopted (AD) or in progress (IP);
2. Cartographic analysis Assessment of the main industrial areas/free zones/transport systems;
3. Field survey on the existing logistic and logistic-related activities on the territory;
4. Overlay of the different levels of information

The above mentioned methodology is applied to a sample of Italian cities and ports for a first overview of their characters. In particular in the present research a first set of analysis was focused on the first stage of the analytical framework hereby described.

3.2 The Study Area

In Italy the city-port system has specific characteristics compared to the international context. In particular, Italian ports are associated with urban systems and have developed operational relationships with the territory and with the logistics hubs. However, despite the centrality, functionality and/or specialization especially in the South Italy, ports are affected by the multitude of subjects who have an institutional role in planning-management, which fragments operations - Region, Municipalities, Port System Authorities, etc.

The research started from the local cases of Cagliari and Trieste as examples of port-cities relations, to extract analytical and research points for further evolutions on national and international cases.

These ports were chosen for some similarities characterizing their urban environment but also in terms of the differences that, nonetheless, characterize particularly their port systems. From the urban point of view, both cities hold important administrative roles in their Regions, being the administrative capitals, in this sense also representing hierarchically higher order centres a là Christaller, concentrating a wide set of higher order services, including administration, health, education and, more recently, tourism. Similarly, they have also deindustrialization in common, as a decline of the traditional manufacturing sector, towards an economic system more oriented to services. Also, they both represent the major urban areas at regional level. In the case of Cagliari, a metropolitan area is set, therefore with functions played at a wider level and providing services for a considerable number of citizens and city users (around 400.000 considering the 17 Municipalities). In the case of Trieste, the former Province - now re-established from an administrative point of view but still not yet operational - is limited in the numbers of Municipalities included (six) but at the same time Trieste represents a compact and densely inhabited area, with a catchment area that counts for around 240,000 inhabitants.

From the maritime and port point of view, the port cities of Cagliari Trieste were chosen because of the Northern route with origin from the Suez Canal, the Western and Eastern sides respectively. However, their characteristics as ports are conceptually and functionally rather different one to each other.

These ports, however, present very different cargo and passenger movements (Table 1), as well as different roles in their respective ranges.

Cagliari used to play a role as an important international transshipment port in the Western Mediterranean, before the changes in route choices from shipping companies. Internal demand is mainly served, on the contrary, by other ports (as Olbia) specialized in Ro-Ro, Ferry cargo. The port of Trieste is mainly an international one, with a role of gateway for international destinations within Central Europe, with important synergies with other inner harbours in the European continent. Both ports play an important role in liquid bulk cargo - particularly oil - and in hosting free zones on - at least part of - terminals, whose performances have not been yet fully implemented.

Similarities and differences are also in the passenger traffic. Both cities and ports host cruise ships in proximity of their urban waterfront, with lower figures of cruise passengers in the case of Cagliari, although highly compensated by ferry passenger traffic, and higher ones in the case of Trieste. The competition with other ferry ports in the case of Cagliari on one side, and the presence of Venice in proximity to Trieste on the other side, are all elements to be further considered when observing the two ports.

These considerations are particularly important with reference to the relations occurring among the strictly urban areas and the ones dedicated to port and port-related functions, including the industrial ones.

The Case of Cagliari. The port system of Cagliari consists of two main areas: the historic or old port, which extends over 5,800 m of quays and is dedicated to freight and passenger traffic, including Ro-Ro, passenger and cruise ships (with a dedicated

Table 1. Port movements 2022 (System Authorities and Ports of Trieste and Sardinia – Cagliari)

Port Movements	Liquid and Solid Bulk (ton)	TEU Total	Ro-Ro Unit	Pax	Cruise Pax
East Adriatic Port Authority	61,437,302	879,766	392,337	544,391	532,935
Port of Trieste	57,591,813	877,805	320,337	462,288	437,336
Sardinia Port Authority	43,888,126	140,216	572,521	6,025,499	220,595
Port of Cagliari	30,766,400	140,216	170,457	345,421	151,977

Source: Assoporti, Autorità di Sistema Portuale - Movimenti Portuali
https://www.assoporti.it/media/12508/adsp_movimenti_portuali_annuale_2022.pdf

terminal), the channel port, which extends over 1,600 m and offers five berths for transshipment and Ro-Ro traffic. A dedicated facility is located to the West of the channel port, - in the Municipality of Sarroch - with oil terminals and one huge petrochemical plant, with moorings for seventeen ships, a service of one of the most important national refineries (Fig. 2).

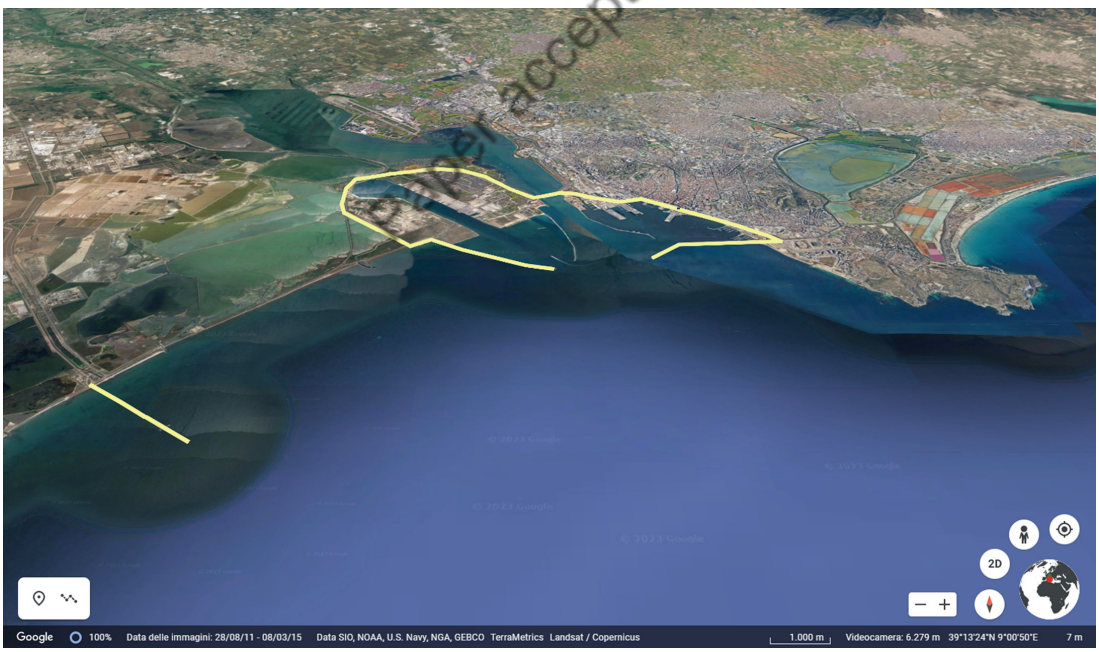

Fig. 2. The Port of Cagliari. https://www.adspmaredisardegna.it/cagliari/

The entire waterfront of Cagliari stretches for about 12 km from the Santa Gilla lagun in Sant'Elia with the new marina under construction (2022). The seafront, with singular places of historical and environmental value that alternate with abandoned spaces or spaces intended for port or industrial activities, is involved overall in the transformation and redevelopment process, animated by multiple public actors. The design theme of the

city-port interface can be summarized as a redefinition of the relationship between the "historical" city and the seafront, with the aim of integrating the sea-city. The goal that everyone agrees is given by the connections of long and short, fast and slow networks.

The complex network of relationships between the parts and elements of the waterfront and the city offers a progressive redevelopment of empty spaces and abandoned sites, responding to the needs of the metropolitan city. The interface is thus configured to give rise to the different types of relationship between the urban and port systems. In this sense, In Sardinia, a Special Economic Zone (SEZ) was established in 2019 and covers three areas: the Port of Cagliari, the Port of Porto Torres (for total 1700 ha), and the area surrounding the Sardinia International Airport. The SEZ of Cagliari aims to attract foreign investment and promote economic development in the region, focusing on strategic sectors such as logistics, manufacturing, and tourism, offering a wide range of incentives and benefits for companies that invest in the area, including tax breaks, simplified administrative procedures, and access to state-of-the-art infrastructure. Some of the key features of the SEZ of Cagliari include modern infrastructure and strategic location, particularly for companies involved in logistics and transport. Tax incentives are also available, as companies investing in the SEZ area of Cagliari can benefit from a range of tax incentives, including a reduced corporate tax rate of 24% and a full exemption from property tax for up to 15 years; Simplified administrative procedures: The ZES offers streamlined administrative procedures for companies that invest in the area, making it easier to set up and operate a business.

The Case of Trieste. The port of Trieste is located in close proximity to the Northeastern border of Italy with Slovenia, and at the crossroads of the main international routes between the Mediterranean and central Europe. It occupies about 2.3 million square meters, around 1.8 million square meters of free zones. The quays cover a total length of 12 km with 58 operational moorings, and maximum depths of up to 18 m (container terminal - Pier VII in particular), and served by a total length of 70 km of railway tracks.

The Port of Trieste is a unique case on the national scene, especially for the international Free Port regime, sanctioned after the end of the Second World War, and after the long definition of the northeastern border of Italy. This regime, recently regulated in order to adapt to the transformation of national ports within the Port System Authorities, provides in particular for customs relief, and port development as a transit hub and for the development of local economic activity. In particular, the free points of the port of Trieste are considered as a duty-free territory from the custom point of view, with consequences, in particular, linked to simplifications in terms of introduction of goods, storage, processing, deferred payments, as well as relative to the possibility of on-site processing while maintaining the origin, or, on the contrary, according to certain conditions, acquiring the 'made in'. The facilitation of transit functions is also guaranteed by free rail access, with the opening of access for all rail carriers to free points, and the exemption of fixed rights on the movement of vehicles, with the liberalization of the transport of goods in transit. The strong development of the Port of Trieste as the first Italian railway port, as well as the most connected to an international hinterland, and the strong presence of traffic, especially Ro-Ro, are elements that can certainly be connected to this regulatory situation which, in perspective, can orient the port and local economic development towards the definition of free zones. The evolution that has taken place in

recent years, starting from January 2016, has led to a potential changing and changed relationship between the port and neighboring areas or areas linked to the urban context. From that moment, in fact, the free zone regime, up to that moment unchangeable in its locations, was able to be 'moved' and assigned to areas where it could more readily and fully be exploited: in particular, from the Punto Franco Vecchio, a large part, in fact, of port structures dating back to the Austro-Hungarian period, the area of which is now destined for a 'traditional' redevelopment as an urban waterfront, towards other locations, such as the new FreeEste logistics center, part of Interporto Trieste (Fig. 3).

Fig. 3. The Port of Trieste and the two inner ports of Fernetti and Bagnoli https://www.porto.trieste.it/

4 Results and Discussion

The aforementioned framework, as well as previous preliminary research carried on considering a similar topic and city-port relations represent the important framework for analyzing more in depth the areas of conflict or coexistence (Figs. 4 and 5).

Ad hoc matrices were therefore developed. The first stage of analysis has been followed and applied to the two cases and the analytical matrix was filled for the two cities and ports. In particular, the overall planning tools insisting on the different areas of the port-city dyads were considered, together with the different territorial contexts where these can be applied. The planning tools considered are those connected to urban and port planning, the mobility plans and the industrial ones. Also, the metropolitan level of planning is mentioned, as well as the consideration of the presence and operation of Free Zones (SEZ or similar).

Fig. 4. Cagliari matrix

Fig. 5. Trieste analysis matrix

Considering the different levels of adoption of instruments, it was possible to observe the differences in the cities and ports' performances in terms of the availability of usable planning instruments for fulfilling urban and port planning. In such sense, the city and port of Trieste are at present fitted with a wealth of instruments that can be used and

applied and therefore produce effect over territories, and considering the different levels, as centre, port areas and extensions, semi-periphery and periphery. Only periphery appears still little covered by the ordinary urban planning tools for transport issues.

In the case of Cagliari, the wide presence of a proper metropolitan area and city, as well as delays in the realization and put in operation of the Free Zones in particular, are characterizing the city and the neighbouring area. The presence of a vast area, in terms of population, manufacturing and services, make it more difficult to tackle the aspects related to peripheral and semi-peripheral contexts in particular, with the planning attention still concentrated on central urban and port facilities. At the same time, delays in the full implementation of the industrial component under dedicated custom regimes still seems to represent a potential obstacle to future development.

5 Conclusion and Future Developments

The recent evolutions of ports, between specialization and regionalization, are leading towards a renewed relationship with the cities connected to them and, to a wider extent, to the regions hosting them. The present stage can be considered as that of hybridization, where 'hybrid' situations can be observed in different contexts of the port and of the port-city evolutions. Port-city functions mix in waterfronts on central locations and in peripheral contexts, due to the extension of port-related functions out from the shoreline. Transport and logistic functions mix more and more with industrial ones, thanks, also, to the development of free zones in proximity of port areas. The same terminals, from highly specialized ones, are becoming dedicated to multiple kinds of freights, as the multipurpose platforms capable of hosting both containerized, ro-ro and other freight types. The same ports are being hybridized in their roles, minimizing a conceptual distinction between pure gateways and hubs, with both nodes assuming, more and more, mixed roles.

In some ways, this new stage has brought a city and its port closer than it happened in the recent past, with the port and city economics even closer, as it was in the pre-industrial revolution era, where the port emporium functions were shared with those of the related city. Such a post-specialization stage is leading to a blurring of port and city functions, particularly following two similar processes followed by ports and cities in their expansions out from their original nuclei. Cities in fact have been characterized in the post-war decades by urban sprawls of residential and retail activities out from their centres. Ports have also expanded and occupied portions of land far from their shores, due to the increased need of space on quays and in their proximity for port operations, leaving other functions as warehousing, some multimodal and intermodal transport and logistic operations, custom and document exchange, to dry or inland ports. These twofold expansions towards internal locations.

In conclusion and in perspective, therefore, in addition to greater coordination between the plan initiatives already in place at the urban and logistical-port level, it becomes possible and necessary to map the logistical and distribution nodes, whether linked to the already existing and planned dedicated infrastructures, both those managed by private operators, also for micro-distribution and storage functions, in order to

be able to evaluate the development areas of these activities more precisely and highlight possible interactions and criticalities in urban interactions, including periphery and margin.

There will be the need to apply and map properly the areas of presence and potential interface of the different urban and port uses, particularly in those margin areas where, today, the major challenges are put to ports. These regards surely the quays and the waterfronts, but also, and more and more, those peripheral and semi peripheral areas that, still, are not always adequately considered in the implementation of urban plans. On the contrary they are or can become the realm of the evolution and implementation of transport and logistic-related functions, a situation in which potential conflicts with marginal and, sometimes, deprived communities are located.

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