The 21st. Century Revolution in Smart-Port Cities

Review of some European Case Studies

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1. Introduction

The role played by maritime transport, as well as the relevance of port spaces as 'hubs' in global logistics chains determine the growing importance of port cities with repercussions on scientific and political agendas.

Cities concentrate an increasing percentage of the world's population and economic production, with consequent environmental, economic, social, technological, and governance challenges.

It is stated that strategies to address these problems must be SMART (Specific, Measurable, Attainable, Relevant and Timely) i.e., involve knowledge and innovation systems that shape synergies between the different territorial elements. Smart specialisation is key in building innovative territories that aim for sustainable approaches.

2 The Evolution of the port-city relationships

Ports and cities are historically linked. However, the link between port and city growth has become weaker.

In 1972, about 40% of all world port activity took place in Europe, 20% in North America, and 20% in Asia. These shares have dramatically changed: today, more than half of the world port activity takes place in Asia. European ports have presented mixed growth patterns, characterised by stagnation or a combination of stagnation, decline or moderate growth.

There are also different types of port-cities, dependent on port and city sizes, ranging from coastal port towns to world port-cities. In a typical port metropolis, the port function is smaller but still considerable. When the port function is even smaller in a large metropolis, it could be considered a costal metropolis (Stockholm, ex).

Opposite cases also exist, where the port size is relatively larger than the urban size. Examples of these major port-cities are Le Havre or Rotterdam.

Many economic benefits are associated with well-functioning ports: they lower the cost of trade, generate value added and employment, and attract investments. Doubling port efficiency in two countries is found to increase their bilateral trade.

Moreover, ports are associated with innovation in port-related sectors: 9 out of 10 world regions with the largest amount of patent applications in shipping are home to one or more large global ports.

Ports-related research is primarily conducted in port-cities' universities, and not in most other cities.

Ports need to be competitive if cities want to benefit from it. Port related value added and employment is strongly related to urban wealth. Ports can be made more competitive by strengthening their maritime links, port operations and hinterland connections. Local goodwill for port functions is essential and can be earned. Port industries require local employment, but this is relatively marginal in comparison with the wider regional economy in which port operates. Containerisation, automation and economies of scale made port operations and cargo handling increasingly capital and land-intensive, vs. decreasingly labour-intensive.

Maritime services (ship finance, insurance, consultancy) are clearly linked to global firms. For these, urban attractiveness is a most important criterion: they are often located in port-cities, but being a port-city is no way a guarantee for attracting such functions.

The location and attractiveness of multi-office firms in high value-added sectors are more closely following global cities hierarchies than port hierarchies.

Port industries also require local employment, despite the fact that the latest trends (containerisation, automation, economies of scale) have made these sectors increasingly capital-intensive and decreasingly labour-intensive.

3. What is a 'Smart Port'?

The increase in maritime traffic affected ports all over the world. Smart ports reduce congestion and pollution. They embrace automation, which better connects ports to

stakeholders, using automated ships and intelligent systems. They encompass: Big Data; Artificial Intelligence; Blockchain; Digital Twin; Internet of Things (IoT); 5G network.

'Big Data' allows companies to use huge amounts of data, from non-traditional sources, i.e., time-sensitive and not just obtained in the past. It contributes to predictive technologies and 'estimated time of arrival' systems. For example, they use information, in real time, from sensors connected to vessels.

'Artificial Intelligence' allows machines to be programmed to replicate human decision-making (e.g., accurate predictions of port operations). Artificial Intelligence uses 'Big Data' to predict what will happen in global value chains or to create a safer working environment, reducing accidents, thus helping with overall safety.

The Internet of Things (IoT) is a system of 'things' incorporated in different technologies, such as sensors. For example, it can identify what each ship carries or track arriving vessels and monitor cargo in real time.

Blockchain technology stores data that allows logistics companies to track every occurrence in global value chains. This information cannot be deleted. By allowing data to be stored online, it makes possible to restructure decision-making processes. Actors now have access to immutable data, in real time.

5G is a network with a very fast transition speed that can handle a thousand times more traffic than 4G. 5G allows 'Smart Ports' to obtain much more data, transferred in real time, with lower energy consumptiont.

4. Life in a 'Smart Port City'

The vision of a smart city "incorporates the six "s" (Shared, Secure and Scalable infrastructures that enable human possibilities in a manner that is Smart, Safe, and Sustainable).

The management of port cities is complex and must be supported by new tools that combine long-term historical reanalysis of events with real-time data for a quick response.

An example is water management: having a 'digital twin', a system that provides water consumption in real time vs. historical data constitutes a tool that allows territory managers to highlight flaws in the system and intervene promptly.

A port city is not just a platform or network, it is a catalyst for the global economy and development. To be competitive, a port city needs to place more emphasis on a holistic approach, in the context of the UN Sustainable Development Goals.

A 'Smart Port City' is also based on circular economy, aiming to minimise waste. Ports are areas for different businesses and, therefore, it is necessary to study how waste from one industry can be used by another. The concept of the port is that of an energy 'hub', becoming self-sufficient using green energy and supplying it to the hinterland.

However, smart cities also have its share of drawbacks, given its early stage of implementation. Deployed technologies often ignore social needs and political changes, creating grey areas. As cities require significant budgets, they often end up favouring the most affluent groups, thus contributing to the increase of social and economic divisions.

One of the biggest risks is still the threat of 'cybercrime', which can wreak havoc on millions of lives. Smart cities are convenient targets for organised criminal groups and can lead to massive losses of information.

5. European Case-Studies

5.1. The 'Smart Cities Marketplace' (SCM)

Created by the merger of two platforms, the 'European Smart Cities and Communities Innovation Partnership Marketplace' and the 'Smart Cities Information System', the SCM is a venture that aims to bring together cities, SME, investors, banks, academics, among other actors.

Its main areas of intervention are: (i) sustainable urban mobility; (ii) sustainable districts and built environment; (iii) integrated processes in energy, information and communication technologies and transport; (iv) focus on the citizen; (v) policy and regulation; (vi) integrated planning and management; (vii) knowledge sharing; (viii) baselines, performance indicators and metrics; (x) open data governance; (xi) standards; (xii) business models, acquisition and financing.

5.2.   The Port Cities of Antwerp-Bruges

Antwerp-Bruges created a 'digital twin' of the port, with sensors, autonomous drones and smart cameras for inspection of oil spills. In the future, 5G will digitally 'copies' the port area, with real-time information. This way, one can analyse, in advance, how the activities will affect not only the port, but also the entire surrounding ecosystem.

More than 600 smart cameras monitor the port, being able to recognise objects, measure cargo traffic and increase general security. Sensors are used to control the door remotely, to monitor the quality of water on the docks or to extend the life of the asphalt. In turn, 3D sonar sensors make unmanned navigation possible. Finally, 'iNoses' identifies harmful gases. All actors have information that they exchange with each other.

But a port is also an open platform for R&D. Together with 'start-ups', 'scale-ups', investment funds, government institutions and academia, it creates an ecosystem that accelerates innovation. The port area become a testing zone, where ideas can be tested safely, in real environment.

As the port concentrates an ecosystem of industrial and logistics companies and know-how in chemical processes, logistics and operations, it becomes a 'hub' for alternative energy flows, seeking a climate-neutral economy.

Industrial and logistics companies ('Air Liquide', BASF, Borealis, ExxonMobil, INEOS, Fluxys, Total) use the port as a 'hub' for alternative energy flows. 'Antwerp@C' is the result of this union investigating the use and storage of carbon capture. The aim is to capture half of the port's CO_2 emissions, by 2030.

It also invests in the hydrogen economy, targeting to build the first hydrogen tug in the world. In this, the gas is used as an energy carrier or as a raw material during the production process, producing or importing green hydrogen.

5.3. Barcelona Port-City

'Power to Ship' to electrify the docks, was one of the Port of Barcelona's main investments, which should allow a 51% reduction in nitrogen oxide and a 25% reduction in suspended particles by 2030. It will also be equipped with an intelligent electrical grid, capable of optimising energy production and consumption.

Barcelona also created 'Virtual Gates', a system to 'know everything' what happens at the container terminals, allowing predictions for 24 to 48 hours, thus improving the efficiency of the logistics chain.

It also launched 'Smart Maritime Traffic Management' to optimise port traffic and improve safety, thanks to detailed information about ships and the different port services-container, simply by its number and ship scale.

5.4. Le Havre Port-City

Winner of the "Territories of Innovation" competition, Le Havre integrates digital transformation in the main components (port, urban, environmental). A dialogue between the city and the port was created, with development,and economic and civic issues at its heart.

Since one of its challenges is the 'valorisation of data and cybersecurity', all systems constantly produce data, which is subsequently processed.

The 'smart-city' of Le Havre also pursues the desire for its inhabitants to take ownership of the port and activities. The 'Le Havre Smart Port-City' project received a territorial investment plan and 2501 million euros of public support.

5.5. Hamburg Port-City

Hamburg was the first to move towards a smart port city, benefiting from the 'first mover' advantage. The port and the city face similar challenges. The analysis of its 'smart-port' and 'smart-city' strategies, illustrates the governance complexity of integrated port cities.

A smart port city must 'attract new entrepreneurs and 'start-ups' to enrich and energise the ecosystem'. Hamburg seeks to be a great innovation laboratory to build the future territory, to promote dialogue between the city and the port.

5.6.   The Port City of Rotterdam

To Rotterdam authorities, fossil fuels will disappear, and vessels will soon resort to 100% automation.

The 'Digital Twin' (DT) was created: the 'Advanced Port Information & Control Assistant' is the brain of this application, with a 3D interface with real-time information. This technology helps port workers to monitor moorings with greater precision, detect accidents more quickly, benefiting safety and traffic flow at the port.

To make the large and complex port area safer, the Port is working with several partners to build a network of autonomous drones. These inspect equipment, in addition to surveillance and monitoring, management of berths and oil spills or detection of floating waste. Furthermore, they help in case of incidents or fires.