The 21st. Century Revolution in 'Smart-Port-Cities'

Review of some European Case Studies

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Abstract:

The role played by maritime transport and ports as 'hubs' of logistic chains determine the growing importance of port cities.

Many economic benefits are associated with well-functioning ports: they lower the cost of trade, attract investments, and generate value added and employment. Moreover, ports are associated with innovation in port-related sectors: nine out of ten world regions with the largest amount of patent applications in shipping are home to one or more large global ports.

Cities concentrate population and production, with environmental, economic, social, and governance challenges: to answer them, strategies must be SMART (Specific, Measurable, Attainable, Relevant and Timely).

Smart ports reduce pollution, embrace automation, while encompassing technological innovations, such as AI, Blockchain, or the 'Digital Twin'. They incorporate **S**hared, **S**ecure and **S**calable infrastructures that enables human possibilities in a **S**mart, **S**afe, and **S**ustainable manner.

The paper summarises the strategies followed by the European port-cities of Amsterdam, Antwerp-Bruges, Barcelona, Havre, Hamburg, Lisbon, Rotterdam, and Turku – in what can be considered a true revolution in the 21st century smart-port cities.

Keywords: Smart-Port Cities. Port-Cities relations. Big Data. Artificial Intelligence. Blockchain. Digital Twin. Internet of Things (IoT). 5G network.

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 port-city relations

Ports and cities are historically linked. However, in the EU, 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 related with innovation in port-related sectors: nine out of ten 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 condition: they are often located in port-cities, but being a port-city is in 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 city'?

Cities are elements in transforming society, with a growing role in development (OECD, 2012, pp. 5). In the near future, its importance should be further increased, given the

concentration of highly qualified workers. It is in the cities that the largest percentage of the qualified, entrepreneurial and creative population is concentrated.

Furthermore, cities attract and sustain large global business and investment networks, generating economies of scale and agglomeration.

The “cities of tomorrow” – using Le Corbusier's expression – are therefore seen as the engines of the economy, as spaces of connectivity, creativity and innovation, and, as service centres, they play an important role in human development.

But cities are also a source of problems and the stage for countless challenges involving private, public and non-governmental organisations.

In order to face the challenges and find solutions, a set of theoretical and technological innovations has been proposed, in which the concept of ‘smart cities’ stands out. This concept – studied and advocated by several international organisations – is a positive approach to current and future urban challenges, to achieve sustainable development in urban areas.

The expression ‘smart cities’ had its origins in the ‘smart growth’ movement (USA, 1990s). ‘Smart’ initiatives identify the relationship between development standards and quality of life, implementing new policies and practices that encourage better housing, transportation, economic growth and environmental quality (Harrison, 2011; McFeeries, 2014; Kamienski et al., 2016).

The strong technological component, introduced at the end of the 20th century, in the area of Information and Communication Technologies (ICTs), increased the potential to address these problems.

However, technology is not enough: in reality, at the centre of the issue, are people.

A smart city, therefore, goes beyond the use of digital technologies to save resources and achieve fewer emissions. It also means interactive municipal management, safer public spaces and meeting the needs of an increasingly aging population.

4. - What is a ‘smart port’?

Ports play a fundamental role at local and national development levels, influencing GDP and Employment. In particular, the literature highlights the importance of ports in regional and local development, that is, in the regions and cities where they are located.

Also remember that port activity is not limited to the movement of goods. It also plays a key role in supply chains, having become a fundamental part of international trade.

The logistic and economic processes of ports must also endorse both the environmental protection of terminal areas and the surrounding space, especially in the current context in which sustainability is one of the main objectives of international, European and national policies.

Smart ports reduce congestion and pollution: they are green, digital, logistically efficient and aim for sustainable development (namely the marine and urban environment).

Thus, a smart port is one that unites economy, climate and people.

They embrace automation, which better connects ports to stakeholders, using automated ships and intelligent systems. They encompass a set of new technologies which, together, constitute a true revolution both in the way ports operate and in their relationship with the cities that are close to them. It can even be argued that a new type of regions is emerging, with new ways of functioning and relationships between different economic activities. And it's most likely that this new type of regions (or territories) becomes the new normality.

Among the new technologies that are part of this revolution - and which is also of a territorial nature - the following stand out: Artificial Intelligence; Big Data; Digital Twin; Internet of Things (IoT); Blockchain; 5G network ('Non-Stop Service'), 'Greentech', Machine Vision, Augmented Reality & Virtual Reality, and Simulation & Emulation Analysis, among others.

Let's take a brief look of the features of each one of them.

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

‘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’ (ETA) systems. For example, they use information from sensors connected to vessels (which provide them in real time) to track vessels and cargo, including texts, audio, videos and others.

A ‘Digital Twin’ (DT) is an accurate virtual representation of an actual or intended physical object, process, or system. The digital replica can be updated using data from its physical counterpart and other sources. It runs simulations to help improve planning and decision-making. A DT for an entire port provides information for making decisions about the position and performance of individual machines, improving the flow and volume of container traffic. It also allows to reduce operating costs, through simulation and assessment of different scenarios. A port's administration can also evaluate the benefits of a particular investment in infrastructure or cargo handling equipment, before committing a single euro.

The Internet of Things (IoT) is a system of ‘things’ incorporated in different technologies, such as sensors. For example, IoT can identify, in detail, what each ship carries. It also allows port authorities to track arriving vessels and monitor cargo in real time. Besides, IoT enables decision-making based on the precise exchange of inputs.

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 consumption, and without being interrupted.

A ‘Green Port’ invests in and encourages sustainable and environmentally friendly operations (‘Greentech’). These ports adopt green technologies and low- and zero-carbon fuels, namely, on the following: green electrical grid to power land-based machines; hydrogen-powered forklifts; and in more efficient electric lighting.

‘Machine Vision’ includes the technologies and methods used to extract information from an image, in an automated way, as opposed to image processing, where the output is another image. The extracted information is used in applications such as automatic inspection and guidance of robots and vehicles or security monitoring, for example.

Augmented Reality (AR) displays virtual fields and scenes based on user space. These spaces are processed with the help of a camera, such as a smartphone. Virtual Reality (VR) consists of presenting a completely new environment, creating new scenarios and new spaces.

‘Simulation’ is a technique used to reproduce or imitate the functioning of a real system or process through a computational model. It is widely used in engineering, medicine and economics.

‘Emulation’ analysis concerns the possibility of reconstructing a system based on understanding how it works, aiming to create a result that is as similar as possible to the original.

All of the technologies mentioned above are therefore fundamental pillars of ‘smart ports’.

5. - 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 smart 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 and intervenes promptly.

As such, a ‘smart port city’ is not just a platform or network, it is also 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 in 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 port 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 port cities are convenient targets for organised criminal groups and can lead to massive losses of information.

6. - European Case-Studies

6.1. – Amsterdam

Amsterdam embarked on 'smart' initiatives with the *I amsterdam*® program aimed, above all, at stimulating social cohesion, in a city where population diversity is very high.

Also noteworthy is the ‘Top City’ program that involved the local authority and large private companies, with three types of initiatives:

- assistance to immigrants;
- develop quality higher education courses (‘Harvard at Amstel’; courses joining both universities and companies in biological sciences);
- launch of an urban marketing plan, to attract investments, events, tourists.

Referring to itself as ‘Smart Port of Amsterdam-Amsterdam Smart City’, investments have been scheduled, of which stand out the development of six main clusters: energy, general cargo and logistics, cruise, agri bulk minerals & recycling, and maritime services & real estate. These clusters are already present, but it is intended to further strengthen them so that they deliver more value.

6.2. - Antwerp-Bruges

Antwerp-Bruges created a port 'digital twin', 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 becomes 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 CO2 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.

6.3. - Barcelona

'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.

Another project is the ‘Container Tracking Application’ (CTA), that allows to identify, in real time, the location of a container in the port, simply by its number and ship scale.

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

'Smart Maritime Traffic Management' was also launched, a solution developed by the Department of Maritime Operations to optimise port traffic and improve safety and sustainability, thanks to detailed information about ships and the activities of different port services.

Also worth mentioning is the ‘Fab Labs’ initiative[1], which creates spaces focused on helping residents produce goods usually sourced from abroad.

But the Barcelona City Council likes to point out that its success is due not only to technology, but above all to 'e-democracy'.

The city achieved an important economic restructuring and job creation thanks to the creation of channels of consultation and public participation, having even received the epithet of ‘Robin of the Data Woods’.

In general, the Internet of Things (IoT) was the main ingredient: a network of connected and communicating sensors that feed data into the city's largest sensor network, called Sentilo. One example is air quality and noise detection sensors, used to influence policies at municipal level.

6.4. - Hamburg

In Germany, 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. As such, Hamburg seeks to be a great innovation laboratory to build the future territory, and to promote dialogue between the city and the port.

But the close collaboration between the City-State of Hamburg and its Port Authority will have made it possible to overcome some of the main problems. In a city where life revolves around its port, how smoothly and discreetly can a smart city initiative be implemented?

[1] ‘Fab Labs’ are collaborative manufacturing spaces that aim to facilitate the insertion of inhabitants into the world of technology, without discrimination based on gender, education level, race or religion. The inclusion of women and the training of adults and young people who did not pursue university studies is highlighted. The aim is innovation, collaborative learning and a 'community that enhances the sharing of experiences and knowledge that leverage the creation of new inventions with innovation potential'. The use of digital technologies, together with knowledge shared on a network, makes it possible to measure public interest, as well as their criticisms and suggestions. At ‘Ford Motors’ (creators of this initiative), in just one year, patent applications increased by 50%.

The first step is to break old habits. The Port Authority cannot continue to build roads, railways and canals wherever it wants: instead, each project must improve efficiency on existing routes and thus improve the quality of port services.

As such, the port plans to develop a 'smart' parking management system for trucks and loaders. Another system will collect and analyse traffic information in real time to avoid congestion and detect possible problems. Street lighting controls will be optimised and emissions data will be recorded and evaluated to accurately predict noise, temperature, humidity and air pollution. Key port facilities will be monitored to ensure safe and efficient processes

The Hamburg Ministries of 'Urban Development and Environment' and 'Economic Affairs, Transport and Innovation' initiated the 'Smart Port Energy' project in 2012 and, by 2015, more than 20 smart port projects were already in the development phase.

Combining state-of-the-art digital intelligence with intelligent traffic flow and port logistics energy infrastructures reduces dependence on conventional energy and carbon emissions.

6.5. – Le Havre

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, economic, and civic issues at its heart.

It was evaluated as an innovative proposal to boost entrepreneurship, working with the territory and with the support of public financing: in fact, it received 35 million euros of state support and a territorial investment plan of 241 million euros.

The development issues have been part of this project since its beginning. Its ambition is to provide a true economic transformation, based on harmonious interconnectivity between public institutions and private actors. It was then possible to reach a broad consensus that Havre should, ultimately, ‘attract new entrepreneurs and ‘start-ups’ to enrich and dynamise the ecosystem’.

But, in addition to economic interests, Le Havre also pursues the desire for its inhabitants to take ownership of the port and its activities. This resulted in three areas of ‘ambition’ being defined, namely: (i) innovation; (ii) support for change; and (iii) stakeholders’ meeting.

Since 2017, this project has received an enthusiastic response from various stakeholders. Local authorities and their members (Le Havre Sea Port, international companies, local SMEs, R&D laboratories, higher education institutions) have been combining their experience and know-how to find innovative solutions in several areas: people and goods, energy transition, digital transition, and preservation and respect for the environment.

6.6. - Lisbon

The Port of Lisbon benefits from its location in the city and region of Lisbon, the geographical centre of the country and the largest national consumption market. Its proximity to the major economies of the European Union and strong integration in what is one of the largest markets in the world are also important advantages.

Lisbon is part of the path of the main international trade maritime routes and cruise circuits that pass off the Portuguese coast, which represents enormous potential in terms of attracting international traffic.

The Port of Lisbon faces several challenges, in particular taking into account the need for accelerated development in the face of international competition. It seeks to balance economic development and social and environmental goals, remaining a crucial location for national and international trade and tourism. Furthermore, there is concern about safety: since the implementation of the VTS service, no relevant maritime accidents have occurred in the APL's area of jurisdiction.

Table 1 presents a list of recent investments carried out in ‘Technology and Innovation’ and ‘Sustainability’:

Table 1 - Port of Lisbon' Recent Investments in 'Technology and Innovation' and 'Sustainability'

Year	Investment	Goals	Equipment	Related Actions
December 2021	Suppliers' electronic invoice	Digitalisation and higher quality of invoicing processes	Electronic Data Interchange (EDI) Technology	---
November 2021	Mobile version of the 'Single Logistics Window'	Greater mobility and productivity. Cost reduction	---	Partnership with 'Associação dos Portos de Portugal'
May 2021	TEJO-LIVE	24/7 service with images and global view between the 25th April Bridge and the port approach area	Webcam installed in the VTS Building, in Algés Webcam installed in Cacilhas	Anyone with the internet monitors the entry and exit of ships, checks weather and sea conditions, watches nautical events, contributes to safety
September 2020	Information Security Systems Certification	---	---	---
2018-19	Vessel Traffic Service (VTS) maritime traffic control	Operational efficiency and maritime safety increase, by reducing waiting times and enabling just-in-time piloting.	Sensors, Radars, Automatic Identification System (AIS), day/night cameras, Radio Direction Finders (RDF), VHF, Navtex Subsystems, weather and marine sensors	Personnel Training Data sharing between the control centre and bar pilots through the Pilot Pro application - Pilot Pro
	ISO/IEC 27001:2013 Standard Certification , international reference for Information Security Systems.	---	---	---

Source: Port of Lisbon site (2024).

The port is still in the process of implementing the following investments and/or initiatives:

- Innovation in Recreational Boating: The Port of Lisbon implemented the first autonomous and 100% sustainable nautical solution in the world.
- Pilot Projects in Recreational Boating, aiming at a more efficient and intelligent management of recreational boating, namely in the supply of water and energy to vessels.

Among the investments linked to the blue economy, led by the Lisbon City Council, the following stand out:

- New Alcântara Railway Station, a partnership with 'Infraestruturas de Portugal' and Lisbon City Council. The investment amount is $200 million euros and should begin operating in 2027.
- Navy Dock: This investment – promoted by the City Council, with a planned amount of 3.5 million euros – should make it possible to further boost this space, next to Terreiro do Paço. The focus is on a regular program of cultural events (concerts, art and artisanal product exhibitions). There will also be a square for large events (7,000 sm.) and a dock equipped for maritime-tourist vessels.

Among the projects developed in partnership by the City Council and the Port Administration, the following stand out:

- The New Lisbon Cruise Terminal, completed in 2017, which includes the new marítime seaport and the Santa Apolónia Cruise Terminal.
- The 'Ocean Campus', a project by a consortium between several entities (Port of Lisbon, Lisbon City Council, Calouste Gulbenkian and Champalimaud Foundations, University of Lisbon, Docapesca, Portuguese Institute of the Sea and Atmosphere) with the aim of creating a blue economy cluster in Lisbon.
- Still within the scope of the 'Ocean Campus', the projected joint investment - the 'Shared Ocean Lab' - stands out. It will create a space for scientific research and innovation, with regard to maritime sciences the blue economy. It is

intended to be an infrastructure for collaboration between business activities and scientific knowledge, enhancing innovation and knowledge transfer.

- The 'Unicorn Factory of the Oceans', with the capacity to transform knowledge into products and companies.

In terms of environmental projects, the set of actions that allowed the return of dolphins to the Tagus River stands out.

6.7. – London

Voted the smartest city in Europe, in 2016, London has the ambition to become the smartest city in the world.

The Mayor of London is advised by the 'SMART London Board', a group of experts who recommend him on how to make the city more efficient, sustainable and liveable. Among the policy measures adopted, the 'Smart City Program' was based on cooperation between members of the Smart London Board. Goals include training ICT professionals and increasing the number of Londoners using digital technologies. The number of technology graduates doubled in just three years.

Hackathons were also held - involving Londoners (one thousand people per district, for a total of 33 thousand) and professionals - in search of problem solving, defining digital inclusion strategies and creating an online research community.

Also worth mentioning is the 'Open Data Strategy' which targets all London residents and traders, through the dissemination of real cases, demonstrating the effectiveness of the use of open data.

Another fundamental aspect is the improvement of air quality, with a series of initiatives such as the modernisation of bus stops with air purifiers or the installation of charging points for electric vehicles. The objective is to reduce, by 60%, carbon emissions, in 2025.

6.8. Rotterdam

The Port of Rotterdam advertises itself as being the largest digitalised project ‘ever’. At 40 km long, it is one of the longest ports in the world.

The Port Administration starts from the premise that, in the future, fossil fuels will disappear and that, soon, vessels will have to resort to 100% automation. Even port containers (where goods are shipped) will all be digitalised.

Rotterdam created the 'Digital Twin' (DT), a computer 'copy' of the port. DT allows to assess, in advance, how different activities will affect not only the port, but also the surrounding ecosystem and the shipping industry. The ‘Digital Twin’ is a digital copy of the port area with real-time information: which ships are in which docks and locks? Are all life jackets hanging in their respective lockers? How much energy are wind turbines producing?

The ‘Advanced Port Information & Control Assistant’ (APICA) is the brain of this application, with a 3D interface with real-time data.

The adoption of a 'SMART PORT' system makes it possible to estimate the economic and social benefits and costs (including those of its main partners), resulting from achieving sustainable growth.

All this technology should help port workers to carry out their work in the most efficient way possible: they can monitor moorings with greater precision or detect incidents more quickly, for example. This should benefit security and traffic flow at the port.

To increase the security of its vast and complex port area, Rotterdam proposes to work with several partners to build a network of autonomous drones.

These drones are used to inspect equipment, in addition to surveillance and monitoring, management of anchorages and oil spills or detection of floating waste. Furthermore, they can also help in the event of incidents or fires.

The Port of Rotterdam also uses technologies to predict what ports will be like over time horizons of up to 80 years from now. The data allows for accurate predictions and projections, which should guarantee competitiveness and efficiency in a maritime sector on the verge of total digitalisation.

6.9. - Turku

The city of Turku (Finland) aims to become a ‘Smart Maritime City’. The construction and completion of a new cruise terminal will free up the area around Turku Castle and the Aura River estuary (Linnanniemi area) for urban development.

Along with these spatial changes that support the physical integration of the city and port, the ultimate goal is the digital integration of the port city's infrastructure.

Digitalisation is already happening, both in the city and the port, with a range of digital solutions available ('end-to-end' trip planning tools, parking or park' n' ride solutions, shared mobility, ex.) to strengthen smart transport and reduce emissions.

With the aim of finding development options for areas that will be released for urban development, an international ideas competition was organized.

The zoning plan for a joint terminal for shipping companies is under preparation under the 'Ferry Terminal Turku' project, and the building is expected to be ready in 2027. The reorganization of the ship terminals is expected to free up the area of land comprising the Castle of Turku, its surroundings, and the west bank of the mouth of the Aura River, which connects the sea and the city.

The History and Future Museum building should also be completed in 2030.

7. - Conclusions

The increase in maritime traffic affected ports all over the world. New ‘smart ports’ technologies are a prerequisite for sustainable development, not only of ports, but also of the municipalities where they are located.

‘Smart-Port-Cities’ are facing both huge opportunities brought by a set of innovative technologies (IoT, Blockchain, Digital Twin, among many others) and significant problems (namely, environmental issues).

These new tools seem to have the potential to address major challenges, due to their capacity to collect and work the huge array of data on multiple topics. Innovation can

be enhanced in vital issues, such as air and water quality, land use management or connection with the hinterland.

Major international agreements such as the UN's 'Sustainable Development Goals' (SDGs) or the EU's 'Circular Economy Agenda' are additional factors that encourage increasing innovation.

It can even be argued that a new type of regions is emerging, with new ways of functioning and relationships between different economic activities and different stakeholders. And it's most likely that this new type of regions (or territories) becomes the new normality.

Territorial governance – with an increasing number of stakeholders – will predictably become more complex.

Over the last few decades, European port cities in particular have faced considerable changes, such as: deindustrialisation, the emergence of democracies in Eastern Europe and the enlargement of the European Union.

Port cities play a crucial role in the European Union's Integrated Maritime Policy (IMP). Here are some relevant aspects:

- Blue Economy - port cities are the centres of maritime economic activities, including transportation, shipbuilding and related jobs. The IMP aims to strengthen the growth of these coastal regions.
- Port-City Integration - effective articulation between port development projects and urban strategic plans is essential. This contributes to the modernization and creation of an urban identity that includes maritime elements.
- Sustainability: IMP seeks to promote the sustainable use of the seas and oceans, considering the environment, fisheries management and employment in port cities.

In short, European 'Smart Port Cities' are key to the success of the EU Integrated Maritime Policy, connecting the sea to urban life and driving sustainable development.