

Port Authorities and smartness: the training policies of Spain's smart ports

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Abstract

Artificial Intelligence, Big Data, blockchain, automation, IoT, and 5G represent fundamental knowledge for the evolution of the modern society. The smart label initially found breeding ground in urban settings giving rise to Smart Cities which are capable of efficiently supplying resources and services through the use of technology. The “new” incentives coming from Information Communication Technology (ICT) have over time positively involved other spatial realities as well: Smart Villages, Smart Tourism Destinations, and Smart Ports. The latter spatial context is proposed in all its complexity as it includes various stakeholders, internal and external, and requires constant operational commitment. In order to meet the sustainability goals dictated by international documents (Agenda 2030 and 2050), the operational chain of the port system must adopt an innovative approach capable of improving and optimizing the competitiveness and the active and functional activities of the operators involved. After a brief literature review of the concept of smartness around the port world, this paper aims to highlight the fundamental role played by Spanish Port Authorities to propose training projects that can also educate and make human capital “smart”.

Keywords: Smartness, Training Policies, Human Resources, Spain's Ports

1. Introduction

In the European context there is an ongoing effort to improve spatial balances. In the wake of the main sustainable policy documents carried out in this last decade (Agenda 2030, Agenda 2050, 7th and 8th Action Program, European Green Deal, Next Generation EU) the attention is more focused on the transport, mobility and logistics sector (Holden et al., 2019; Madau and

Battino, 2021). However, the studies related to this market still show clear imbalances between benefits and criticalities related to the goals to be achieved within the green and smart approach of the member States. Dependence on fossil fuels and the resulting significant emission of pollutants are the main negative effects to be reduced by 90% before 2050 to achieve climate neutrality. The Covid-19 pandemic has granted a

relieve by restricting the freedom of movement of people and goods, but at the same time it has stimulated individual transportation, which has partly nullified the efforts made to reduce climate-changing emissions. Confirming this, the data show that road transport is the main polluting “actor” (72%) followed by aviation (14%) and maritime (13%) (Green European Foundation, 2021; Battino and Muñoz Leonisio, 2022).

About 90% of world trade is by sea, and while the shipping method is economical and efficient, in parallel it is also the most polluting due to massive use of fossil fuels (UNCTAD, 2020). There are about 835 seaports and inland ports¹ in this shipping network, which are the growth drivers of this transport sector and the economic and social development of the regions involved (Alop, 2019; Alamoush et al., 2022). Their operation is, therefore, vital for moving goods and people. For this reason, it is crucial to design the development strategies of port areas considering an innovative approach that can improve and optimize the competitiveness and operational activities of the stakeholders. Digitization and automation have improved port operations: workers are required to have less physical strength and new and different requirements related to the use of Information Communication Technologies (ICTs). Several ports worldwide have taken action by digitizing processes. The adoption of a smart port management model through the use of advanced technologies for collaboration, synchronization, automation and analytics enables the port communities to connect with each other and activate synergies with the outside world. The main objective is to improve the quality of governance with a special interest in sustainability and respect for the environment. The level of smartness is not the same for all ports and, depending on the use of smart indicators, different international rankings highlight port peculiarities.

On the basis of these issues related to the use of smart models, the research below consists of four sections: 2. Related works, 3. Organizational commitment and Smart port objectives of Spanish

ports, 4. Practices and Initiatives of Spanish ports which lead toward Smart Port, 5. Conclusions. We will mainly focus on the analysis of Spanish ports, which represent important nodes for international logistics. In fact, as known Spain plays an important role due to its geographical position, both acquiring the Atlantic trades and those coming from the Suez Canal. A privileged position that is the backdrop to the many different performances in the maritime sector where Spain achieves interesting results. Just to mention a last milestone (2022), the Country occupies eighth place in the world ranking of the “Liner Shipping Connectivity Index”, the index that examines a country’s level of access to global transport networks². Specifically, the aim is to highlight the fundamental role played by the Port Authorities in proposing training projects capable of educating and making “smart” human capital as well.

2. Related works

A smartness approach enables the creation of “cohesive” spaces when the smart concept is applied to different spaces to make them more accessible and integrated, and where the role of Information Communication Technologies (ICTs) is essential to activate sustainable development and growth projects. Today we apply the smart concept to cities, rural areas, islands, tourist destinations, and port areas (Murgante and Borruso, 2013; Buhalis and Amaranggana, 2014; Guzal-Dec and Zwolinska-Ligaj, 2018; Ilin et al., 2019; Karvonen et al., 2019; Amaro Garcia and Battino, 2021).

Between “land and sea”, ports traditionally represent the socio-economic development pillars of many different coastal regions: places of defense, border areas, nodes of exchange networks, and production and industrial sites. In Europe, in the more than 1,200 seaports, about 420 million passengers transit each year, 74% of imported and exported goods are handled, and

¹ In addition to these ports, there are about 8,000 smaller ports (Alop, 2019; Alamoush et al., 2022).

² In terms of maritime connectivity, three Spanish ports are ranked among the 25 best in the world: Valencia (20th place), Algeciras (21st place) and Barcelona (23rd place) (<https://www.transportexxi.com/wp-content/uploads/2022/04/TransporteXXI-Spanish-Ports-2022-web.pdf>).

1.5 million workers are employed (www.ec.europa.eu). The growth of port areas has been steady over time. To understand the patterns of their evolution during the United Nations Conference on Trade and Development in 1990 (UNCTAD, 1994, 1999), a theoretical model was proposed considering the strategies adopted at the local level, the services provided and technological information to distinguish first, second, third, fourth and fifth generation³ (Flynn et al., 2011; Kaliszewski, 2018; Karaš, 2020; Battino and Muñoz Leonisio, 2022; Garrido Salsas et al., 2022). The latter, in the era of Industry 4.0, is the result of a major evolutionary process that has made port systems more dependent on new technologies. These innovations contributed to conceive the new Smart Port model (Figure 1; Deloitte, 2017; Jović et al., 2019; Hossain et al., 2019; Peña Zarzuelo, 2021).

Leading ports around the world, in order to improve international competitiveness, reduce environmental impact and improve the workplace, have implemented their functional, operational and integration capabilities with the surrounding area (Karaš, 2020; Molavi et al., 2020; Hirata et al., 2022; Min, 2022).

The basic components of a smart port as suggested by Min (2022, p. 191) are summarized as smart infrastructure (platforms, sensor deployment, business analytics), smart traffic flows (smart container racking system, GIS, aquadrones, trucks, automated gate system), and smart logistics (port community network, green initiatives in the energy sector, global port logistics system) that satisfy current and future needs for economy, efficiency, safety, and environmental compatibility through the use of technological solutions.

The underlying foundation is the ability to have digital systems such as Artificial Intelligence, Big Data, blockchain, automation, IoT, and 5G.

³ 1st generation (before 1960) – mechanic port; 2nd generation (1960-1979) – container port; 3rd generation (1980-1999) – EDI port; 4th generation (2000-2010) – internet port; 5th generation (since 2011) – smart port (Battino and Muñoz Leonisio, 2022).

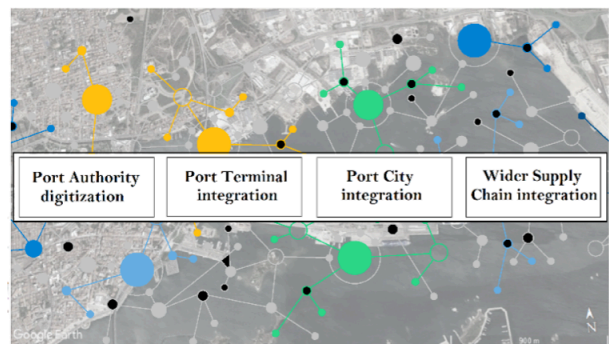


Figure 1. Smart Port's requirements.
Source: own elaboration.

In addition to these technologies, we should remember others that are imperative to take into account in order to adequately support the dynamism and complex functions of harbor ports: fog computing, Radio-frequency Identification (RFID) and Automatic Identification System (AIS) to monitor movements at sea in real time through its detections (Tseng and Liao, 2015; Fernández et al., 2016; Rajabi et al. 2018; Ilin et al., 2019).

Looking at the international rankings of port areas with high levels of smartness we mention Rotterdam, Singapore, Shanghai, Montreal, Amburg, and Barcelona which have adopted demographic, technological, and sustainable drivers capable of propelling business into the future.

The 2030 goals highlight the need, particularly in smaller ports, to invest in innovation and research to improve competitiveness and to be part of the Green Deal and Blue Growth strategies. In this context of increasing operations, there is a push for diversification of activities and a different and more intense use of land. Thus, there is a need to give rise to greater synergies between port and city by actively involving all local stakeholders and making sense of sustainability processes that are not only environmental but also social (Deloitte, 2020; Lozano et al., 2020). The historical port-city model, which fell into crisis in the second half of the 20th century due to a strong acceleration of the globalization process,

seems today to see “new” sustainable territorial aggregations reactivated (Vallega, 1996; Hoyle, 1989 and 1996; Hoyle and Pinder, 1992; Musso, 1996; Ducruet, 2005 and 2011). According to the Deloitte report (2020), trends for the ports of the future include Port Authorities devoting more attention to waterfront areas to create a different economic and employment value addition. In addition, it is important to consider automation capacity to make up for the spatial scarcity within a port to increase its productivity.

Being that the technology is growing exponentially and rapidly, Maritime Education Training must also reshape itself quickly and adapt to the changes (Demirel, 2020). Informatization and automation have replaced low-skilled workers in performing routine tasks, but to make next generation port system development competitive, smart tools must be operated by “smart” workers. This is a key element in the future management of these spaces: complementarity between automation and employment increases productivity, earnings, and labor demand (Bottalico et al., 2022). Jobs with a variety of technical, technological, and soft skills essential for planning, managing, and organizing port hubs, terminals, and the transportation and logistics sector are anticipated. According to a study conducted by the Center for Innovation in Transport (CENIT) and sponsored by the Port Authority of Barcelona, 60% of the ports surveyed⁴ already invest in resources for human capital, which is identified as a key strategic pillar for the next decade. What the analysis shows is that the ability to work in teams appears to be the most required skill and, in addition to this, educational institutions must work to train other skills such as interpersonal, intrapersonal and multi-skills. Therefore, the activation of new projects and stronger collaboration between port enterprises and scientific research seems to be the way forward

⁴ New York/New Jersey, Los Angeles, the Italian Ports Association, Sohar, Rotterdam, Gdansk and Barcelona.

for 4.0 growth (Piras et al., 2019; Terziev et al., 2021; Kadakia and Owens, 2021; Guralnick et al., 2021; Garrido and Reyes Díaz, 2022).

Regarding the educational sphere, we would like to mention the recent YEP MED (Youth Employment in Ports of the Mediterranean) project launched in 2020. The project involves seven Mediterranean countries-Spain, Italy, Lebanon, Egypt, Tunisia, France, Jordan-and strives to improve vocational training in ports by motivating in particular the specialized training of young people and women⁵ (<https://www.enicbcmed.eu/projects/yep-med>).

3. Organizational commitment and Smart port objectives of Spanish ports

Spain has around 8,000 km of coastline, which makes it one of the countries with the longest coastline in the EU. This fact, in addition to its geographic location, makes the Spanish Port System (SPS) an axis in the development of the international sea transport and a logistics platform for the South of Europe. The importance of ports as links in the logistics and transport chains is supported by the following data: about 60% of exports and 85% of imports pass through them, which represents 53% of Spanish foreign trade with the European Union and 96% with third countries. In addition, the activity of the state port system contributes close to 20% of the GDP of the transport sector, which represents 1.1% of Spanish GDP. Likewise, it generates direct employment of more than 35,000 jobs and about 110,000 indirectly.

The activity of most of the SPS takes place in the environment of urban centers, influencing in a fundamental way the economic, social and environmental well-being of a large part of the population. Therefore, there is a wide group of a social, economic and administrative nature that are affected or influenced by the activity of the Port Authorities (PAs).

Within the management of human capital, the

⁵ Around 25 training courses have been conducted to date (June 2022) with the participation of more than 1,300 participants from the countries involved (<https://www.enicbcmed.eu/projects/yep-med>).

training of workers has a fundamental role which aims to update the knowledge of employees to new requirements that affect port operations and safety at work. The PAs have intensified their efforts in the prevention of occupational risks in response to an increasingly demanding regulatory framework and a responsibility of social leadership in the port community.

The Spanish State-owned Port System is made up of 46 ports of general interest, managed by 28 PAs coordinated by the State Ports Public Agency, an Organism dependent on the Ministry of Public Promotion (Figure 2). The management model of the SPS is the advanced landlord port model. The PAs are generally owners and providers of space and infrastructure ports, and Port services are carried out by private companies that operate in it through licenses, authorizations or concessions.

Each Port Authority chooses its own environmental sustainability policy, along with

digitization and the search for new lines of business, as one of its priority strategic objectives to face the future with guarantees. In this sense, actions in the field of sustainability are addressed from two areas. On the one hand, the improvement of infrastructures and the taking of operational measures that result in the reduction of the environmental impact of port activity and, on the other, the use of innovation and training at the service of sustainability.

The strategic policy of the PA is characterized by the efficiency and quality of services that guarantee economic profitability. At the same time, the participation of the port community and society is considered a tool for progress. Environmental actions have consumed almost 12% of the total investments of the port system in 2020. As shown in Figure 3, climate change and port-city actions take a prominent place on the PAs agenda.

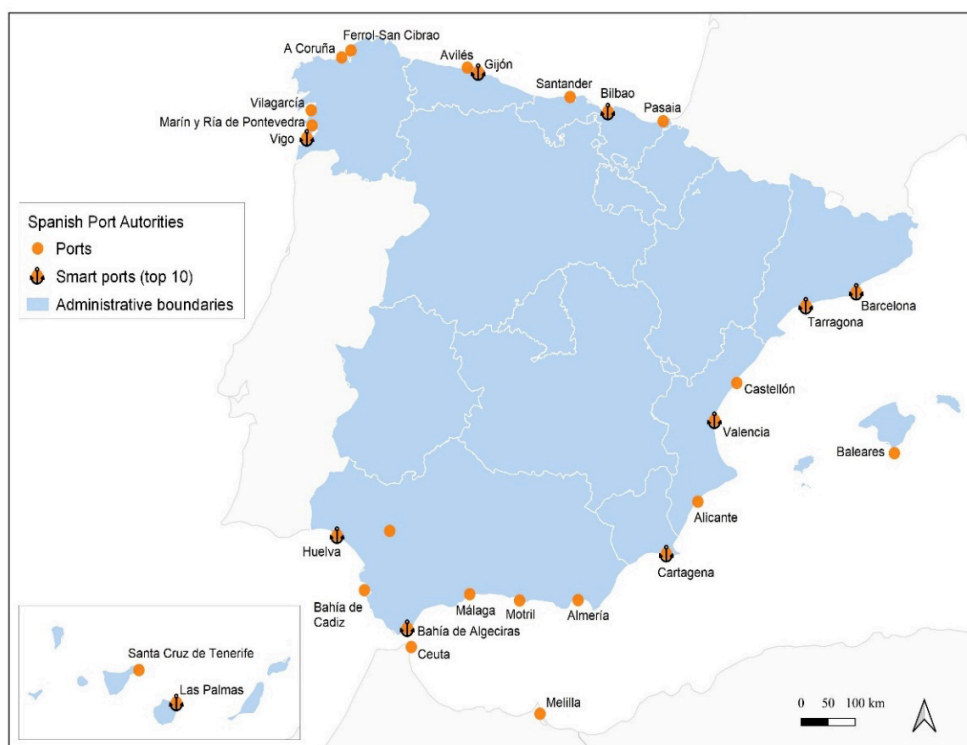


Figure 2. The Spanish Port Authorities system.

Source: own elaboration from Puertos del Estado, 2022 and González et al., 2020.

The SPS reached an investment volume of 380,343 million euros in 2020, focusing mainly on actions to modernize infrastructure and increase port capacity, followed by environmental actions.

Ports are traditionally defined as necessary exchangers between the maritime and land environment. In an economic sense, ports are considered economic units for the provision of services with management autonomy (European Parliament, 1993).

The Law of 27/1992 of November 24 on State Ports and the Merchant Navy calls ports of general interest those ports that meet a series of requirements of interest to the country (strategic, economic importance or essential activities for the territory such as example, the case of island ports).

In recent times, the concept of Smart port has gained strength to refer to a port concept that has managed to improve the efficiency and automation of services through a high use of ICTs together with socially responsible and environmentally sustainable behavior. Its objective is based on satisfying the needs of customers and users without forgetting its responsibility to cities and citizens (Ferretti and Schiavone, 2016; Botti et al., 2017; Yang et al., 2018). From this approach, the port is attributed its development as the backbone of social cohesion, and guarantor of sustainable and safe development. In the labor field, ports are understood as spaces to facilitate the training and qualification of workers in the port community, so that employment can be of quality, subject to gender equality policies and a desirable exercise of social responsibility. corporate.

The Port Authorities have been assuming greater functions in railway and maritime matters, security and protection, environmental surveillance and the fight against marine pollution. To carry out these functions, the Port Authorities operate with a high degree of economic self-sufficiency and management autonomy, with business profitability criteria, in direct contact with the business port community and with a notable multiplier effect on the productive economy.

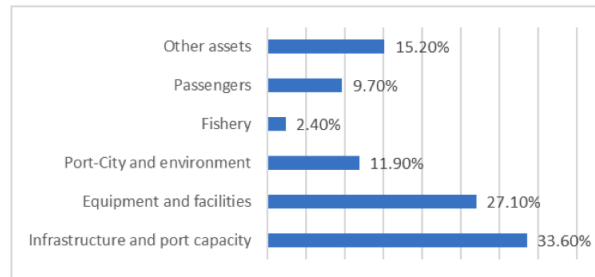


Figure 3. SPS Investments 2020.

Source: Statistical report of SPS.

4. Practices and Initiatives of Spanish ports which lead toward Smart Ports

Climate change currently occupies a prominent place on the agenda of the European Union, an institution that intends to lead the fight against this phenomenon with increasingly demanding measures

This strategy has been adopted by the main ports, which have considerably increased the number of projects and initiatives in order to advance the environmental sustainability of their port facilities. In the case of Spain, it is especially relevant since the country's legislation requires the annual elaboration of a progress report on this matter.

The Spanish PAs have the duty to control compliance with the applicable regulations regarding the environment, handling and storage of dangerous goods, emergency control, firefighting and other threats related to security and transparency in management. Given the growth prospects for maritime transport in the coming years, it is essential to develop strategies aimed at preventing the increase in transport needs from being accompanied by an increase in negative impacts on the environment.

Although the benefits of a smart port are well argued in the literature, the shift towards that consideration is not immediate. It is necessary to establish a set of indicators that gradually measure progress in performance. The first stage in the implementation of a performance system towards the smart port objective is the elaboration of a set of Key Performance Indicators (Min, 2022).

Based on previous literature (Sislian and Cariou, 2016; González Laxe et al., 2017;

González et al., 2020) Smart Port Key Indicators (SPKIs) can be classified into four categories related to performance, environment, energy, and security (Table 1). In addition to the bodies established by law there are different Standard Management System (SMS) to support decision-making, the definition of objectives and their monitoring in PAs.

Table 2 shows the level of implementation of these SMS in the different PAs.

As is observed from the same there is a wide implantation of systems of management of quality and environmental, while the implementation of management excellence standards is still incipient. It is important to highlight that the use of ICTs is considered a transversal objective in the implementation of actions. Based on the development of a global Index, Gonzalez et al. (2020, p. 9) have evaluated the Spanish ports of general interest from an economic efficiency, social, environmental perspective, as well as a measure of the degree of digitization and others. The results of top five are shown in Figure 4.

The Port of Valencia is at the top of the ranking followed by the Port of Barcelona. In a second group are placed the ports of Bilbao, Vigo and Algeciras. In the different aspects analyzed, the port of Valencia has obtained the best score in the environmental and social fields, while Barcelona leads the economic, operational and social aspects. As far as the degree of digitization is concerned, the port area of Algeciras is the most advanced of the ports in the Country.

4.1 Social and Human Resources

Human resource competencies belong to the PAs. They are in charge of the recruitment and training policies of their workers.

The special characteristics of the port industry determine that its market structure is that of a regulated monopoly. The AP maintains control and ownership of the port, while allowing the entry of private initiative in the provision of services.

Description		SPKIs and SMS	
Smart Port Operations	Operational	Operational efficiency	Total cargo moved in relation to seaport equipment
	Economics	Economic efficiency	Investments and returns
	Political & Institutional	Management transparency Private operators (%) Quality private services Quality Management	Open data system Concession area Index ISO 9001 EFQM
	Social	Worker security. Labor inclusion and equality in the workforce	OHSAS 18001 Number of female workers of total workers Gender diversity in the Board of Administration
	Mobility	Optimize the mobility of heavy vehicles. Boost rail traffic	Existence of railway tracks inside the port
Environment	Water consumption management Noise pollution	ISO 14001 EMAS III	
Energy	Renewable Energy Production Energy Management Systems	Use of renewable (wind energy, solar power) ISO 50001	
Safety and security	Actions to improve cybersecurity	International Ship and Port Facility Security (ISPS)	

Table 1. Smart Port Key Performance Indicators. Source: own elaboration.

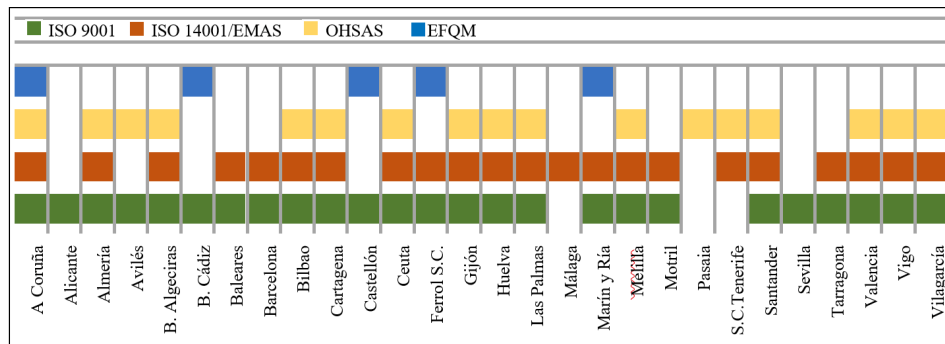


Table 2. Implementation of Quality certifications. Source: own elaboration.

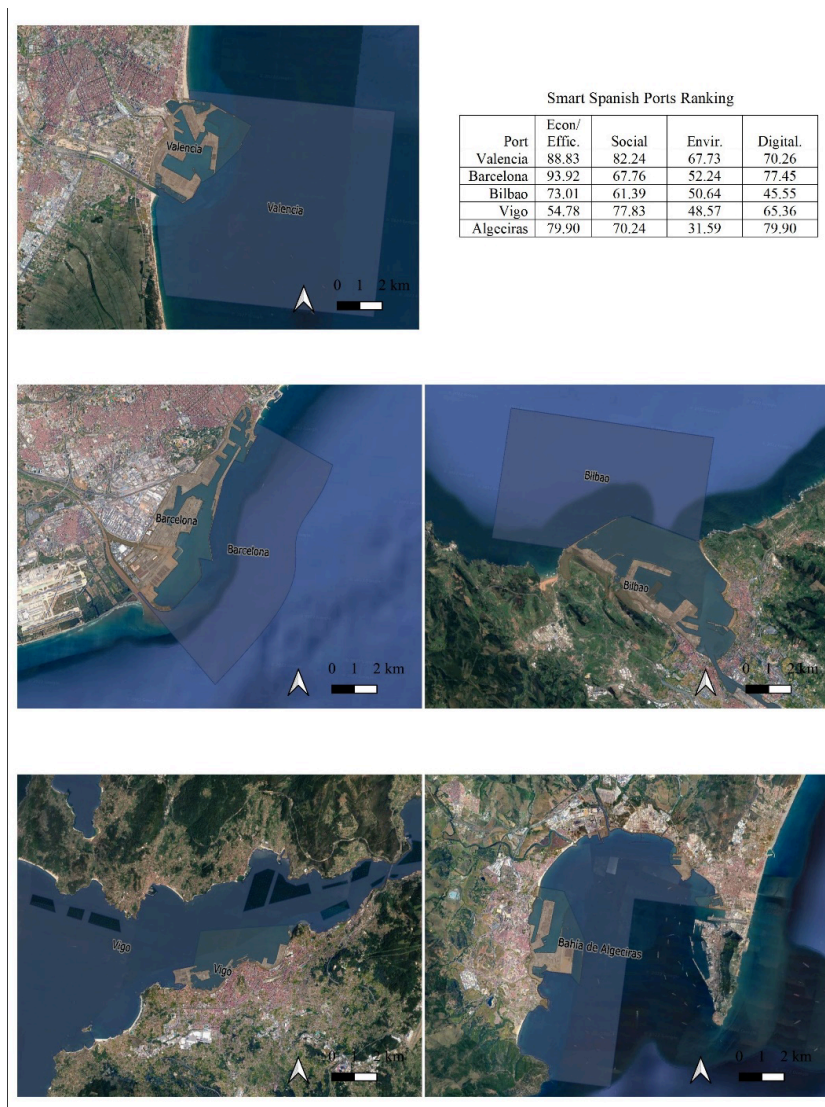


Figure 4. Smart Spanish Ports Ranking. Source: own elaboration from González et al., 2020.

The high cost of building port infrastructure and the presence of sunk costs make it difficult for ports to operate at optimum capacity. On many occasions there is congestion and increases in waiting times, while in other cases there is excess installed capacity. This fact also conditions the employ needs in a port.

The evolution of the permanent workforce in relation to the activity of the SPS is shown in Figure 5 and Figure 6 respectively.

As can be seen in Figure 6, the trend in recent years has been a gradual reduction in the number of permanent employees. An explanation for this phenomenon can be found in a greater technification of port loading/unloading processes.

At the same time, profitability per employee increases. Figure 7 shows the EBITDA (earnings before interest, taxes, depreciation and amortization) ratio per worker.

This trend is part of a general dynamic in all ports around the world. The search for efficient and economically profitable behaviors urges PAs to incorporate the latest technologies in port performance.

According to the data from the latest Sustainability Report of SPS (2019), the average age of workers under 30 years old is insignificant (0.3%). In general, the PAs have staff distributed more or less evenly between two age groups, from 30 to 50 years old, and those over 50 years old, with exceptional cases such as the Port Authorities of Motril and Huelva, in the that more than 70% of the workforce is between the ages of 30-50, and the Santander and Seville Port Authorities, in which 67.7% and 69.44%, respectively, of the workforce are over 50 years old (Table 3).

In relation to the number of women and men in Government teams, Figure 8 shows that SPS are characterized by a low representation of women in Governance teams. Only the port of Vilagarcía has the same number of men as women, while the ports of Sevilla and Bilbao have just one woman.

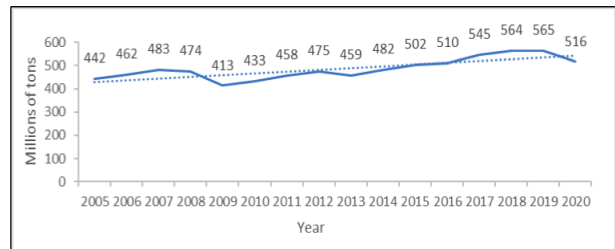


Figure 5. Evolution of total port traffic (millions of tons). Source: Statistical report of SPS.

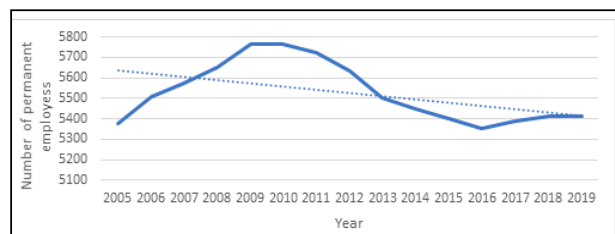


Figure 6. Evolution of total permanent employees. Source: Statistical report of SPS.

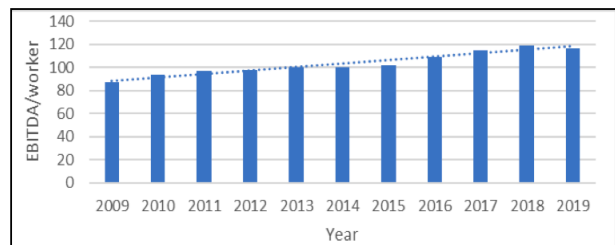


Figure 7. Evolution of the EBITDA ratio generated per worker. Source: own elaboration from Statistical report of SPS.

	Spanish ports Age Structure	
	Under 30 years old	Over 50 years old
Average	0.3%	50.8%
Deviation	1%	12%
Minimum	0%	29%
Maximum	2%	69%
Median	0%	52%
Sample	28	28

Table 3. Spanish ports Age Structure. Source: own elaboration from Sustainability Report of SPS.

With regard to the Spanish case and focusing on the data of the unequal age distribution of Spanish ports, the main conclusion is that there is little generational change and a very low level of hiring of workers under 30 years of age. This contingency determines the need to maintain continuous training plans for workers in order to achieve the effective implementation of the technical processes required by port “smartization”. To be operational, training must be provided in such a way that it is integrated with ordinary activity, flexible, and adapted to the specific needs of each person and each job. In order to achieve these objectives, the port system was equipped with a Virtual Classroom

for training. The employees follow training programs that aim to update the employees’ knowledge of new requirements that occur in port operations.

On the other hand, a possible institutional response to the low presence of women could be the establishment of an action plan with gender equality objectives that would include access to employment, reconciliation of work and family life, training, promotion, and equitable remuneration. For each of these areas it could be possible to establish a set of objectives, actions and monitoring indicators.

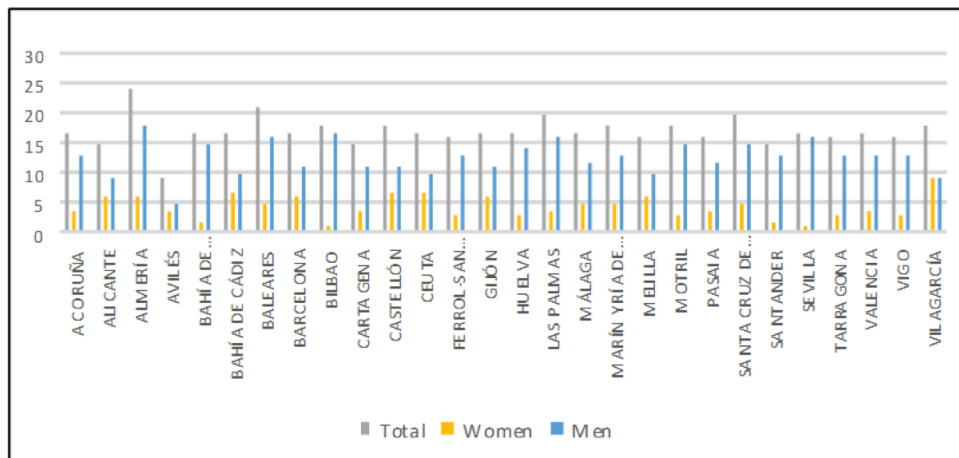


Figure 8. Number of men and women in Spanish ports Governance teams.
Source: own elaboration from Sustainability Report of SPS.

5. Conclusions

In the current port environment, the concession of certain services to private operators is one of the most common practices for Port Authorities to optimize the use of port resources. The challenge facing SPS consists in combining public management with the efficiency criteria of private companies. The modern definition of port competition covers not only what happens between intra-port companies, but also extends to all the actors involved in the organization of the logistics chain. Port competitiveness is defined in the literature as the ability of a port to offer similar

services more effectively and efficiently than the rest of its competitors. Each operator involved aims to achieve maximum performance in the exercise of their activity, either in terms of added value in the handling of their merchandise or profit in the case of port investors. It is evident that, in a competitive environment, port operators and Public Administrations must establish adequate practices of action in order to achieve sustained success in attracting more clients, or greater potential to the port.

At the same time, the expansion of a port often generates conflicts between the interested parties, and the governments are in charge of

reconciling private and public interests based on social welfare. In most cases the ports of SPS are located on highly valued coastal land with multiple alternative uses. The construction of new port terminals is often opposed to the creation of residential areas, commercial or recreational parks and other tourist or service industries.

With regard to the case study, Spanish PAs are progressing towards their digital transformation. This is a long-term process that includes sustainability, decarbonization, alternative energy sources, the use of geographic information systems and training. Achieving the smart target is therefore necessary, but can represent a significant cost, especially for small and medium-sized ports. Therefore, the creation of new collaborative relationships between different players (local, national and international) is a further pillar of the smart approach. In this context, we would like to mention the support given by the Spanish PAs to ports through the “Port 4.0 Fund” program (https://www.ports40.es/static/ports_40).

The main objective of the Fund is to foster innovation by stimulating the creation of new business projects or the consolidation of existing ones. During this last five-year period, about 60 project ideas have been selected and funded (180 applications in total). Actions, ideas, projects and strategies seem to highlight an active and dynamic port system. The future also sees direct investment in training: a radical overhaul of human capital will be necessary, starting with the idea, for example, of creating a “dedicated” degree to qualify workers in this sector.

The recent pandemic caused by coronavirus (COVID 19) has confirmed the importance of maritime transport as a key sector for maintaining the continuity of essential supplies and has accelerated the digitization of business processes. The pandemic has also highlighted the absence of contingency plans for emergency situations and the need to establish action protocols to avoid situations like the current ones. In this context, in order to implement the digitization process, Port Authorities will have to make significant investments in information technology solutions, in the reorganization of internal activities according to the rules of the digital world and, also, in the retraining of

experts and personnel. This last effort seems to have to follow the most current “educational models” related to the paradigm of online and lifelong learning.

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