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Study to Improve the Digitalization of the Spanish Port System Through an Affinity Diagram

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Abstract
Automation, digitalization, technologies that allow interoperability, transparency, decentralization and customer experience define the context of application of the concept 'Ports 4.0' to the logistics-port sector. In the Spanish Port System this is the objective in the near future, already almost present. That is why this study deals with this issue through the Affinity Diagram. This is a method of categorization in which participants classify various concepts into different categories in order to answer a given question. In this case the question is how can the digitalization of the Spanish port system be improved? The main conclusion obtained is that technology alone is not useful to achieve Smart Ports/Ports 4.0. It is necessary that the technology is used in an integrated, open and joint way by all the agents of the port community.

1. Introduction

The digital transformation is of the utmost importance in the business world with significant impact on any of its sectors. This digital transformation within maritime transport is evolving in the ports and the associated logistics (Heilig, Lalla-Ruiz & Voß, 2017). As actors in global supply chains, seaports are particularly affected by technological change. If the trend is towards an open, interactive, highly connected ecosystem of information flows and intelligence, it can be said that in general terms it can be defined as e-ports. On the other hand, as an example, a study carried out by IContainer in 2017 (Rojas, 2018), says: "that only 3% of freight forwarders allow customers to request a quote for transport services through an automated manager and more than 75% of Spanish shipping companies do not include a contact email address on their website.

Due to the high requirements in the logistics sector, e.g. with regard to costs, efficiency, security and sustainability, digital innovation is essential to maintain competitiveness (Heilig, Lalla-Ruiz & Voß, 2017). Europe's ports also need to improve their infrastructure and implement their processes to adapt to these new challenges. However, as in Spain, European ports are committed to simplifying administrative procedures and eliminating customs barriers in the transport of goods. It is necessary to coordinate the sector. Even, it makes possible to implement the latest technological advances, to promote innovation and to train it.

Modern seaports play an important role in ensuring efficient and safe cargo flows in global logistics networks. In addition, ports offer various types of value-added logistics services, for example to facilitate strategies to delay global supply chains (Heilig, Schwarze & Voß, 2017). Digitalization in logistics is the key. Smart Port is a port that bet on technology to improve and modernize maritime transport of goods, with the aim of obtaining greater efficiency (Orive, Santiago, Corral & González-Cancelas, 2020). The efficiency and safety of the related cargo flows depend largely on the associated information flows. Since the beginning of containerization in the 1960s, the adoption of information technology and information systems has become an indispensable success factor for the competitiveness of ports, facilitating communication and decision-making to improve the visibility, productivity, efficiency, and safety of port procedures that are affected by various conditions (Panayides & Song, 2013). In addition, better integration of government agencies to standardize and harmonize information procedures is increasingly important.

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Digitization is taking the maritime industry beyond its traditional boundaries and provides many new opportunities to improve the productivity, efficiency and sustainability of logistics (Cimino, Palumbo, Vaglini, Ferro, Celandroni La Rosa, 2016). The concept of smart ports, for example, aims at adopting modern information technologies to enable better planning and management within and between ports. The most urgent needs of digitization are investments in technology and cooperation to promote information exchange and better coordination and collaboration, often considered an obstacle in highly competitive environments. In addition too new opportunities, important economic problems and issues arise.

Especially the role of ports has changed drastically from their traditional function, connecting sea and land through loading and unloading operations. It has evolutioned to an essential part of the global logistics networks that manage the flow of cargo and offer value-added logistics services in an efficient and effective way (González, González-Cancelas, Serrano & Orive, 2020). In a safe and environmentally friendly way.

Due to their important role in achieving competitive advantage, many information systems and technologies have been adopted in port operations in recent decades. It has allowed more and more electronic transactions to take place (Heilig & Voß, 2017a). Although previous developments have led to a high degree of digitalization and automation, especially in container terminals, there is still considerable potential for improvement.

Europe has been considered a leader in the development of port technologies for many years. Already in 1989 the first shore-to-ship electricity supply was carried out in the Port of Gothenburg. As regards digitalization, in 1993 the Port of Rotterdam offered the first automated terminal in the world (Mu, Wang & Wang, 2020).

New technologies are opening up in the logistics and port transport sector. Port industry is one of the most innovative and a reference in the implementation of technologies associated with the digitalization of processes and management systems to increase efficiency and sustainability (Birtchnell, 2016).

The current phase of the digital transformation is very focused on adopting new digital technologies to better measure, monitor and control port operations, for example, using real-time operational data to predict future events (Heilig, & Voß, 2017b). This may involve advanced pre-processing and data analysis to extract information and knowledge, which can be used in advanced planning and decision support systems. However, the success of digital trans-formation lies not only in the use of advanced technologies and methods, but especially in the adaptation of organizational aspects, according to the idea that "digital technology is a means, not an end".
Digitization is one of the core technologies of the 21st century. The digitization of ports is becoming the direction of development in the future (González-Cancelas, Molina Serrano, Esteban-Infantes, Soler-Flores & Camarero Orive, 2019).

According to scientists of the Fraunhofer Institute, for the implementation of new technologies, industries go through four phases: digitization of analog data, digitization of analog processes, linking systems to processes, and finally the development of a digital business model.

When industries, of whatever sector, implement new technologies, they go through the digitalization of analog data. Next, it links of systems with processes and, finally, it develops of a digital business model. For Fraunhofer, most of the ports are in the second phase (Bierwirth, Kirschstein & Sackmann, 2019).

Among the challenges currently faced by ports are (Heilig, Stahlbock & Voß, 2019):

- Globalization and structural changes: necessary to increase the volume of transport and be competitive
- Demographic change
- Urbanization: the growth of cities creates conflicts with ports, with technology contributing to the flow of transport and efficient operations.
- Sustainability: Ports must also support the development of the region and logistics chains through sustainable ports
- Port Governance
- Information Technology

Today, new technologies allow their implementation at even the smallest steps of the logistic and productive chain (Pournader, Shi, Seuring & Koh, 2019). More and more things can be controlled at a lower cost. However, it is necessary to decide carefully what it is wanted to control, what data and knowledge we need for this and what

benefits can be derived to achieve our objectives at the level of quality, productivity and efficiency. Technology must be a means and not an end in itself (Pournader, Shi, Seuring & Koh, 2019).

In today's world, it is talking about Smart, 4.0, fingering, innovation ... With the means available, it is possible to change the operation of the entire global system. This is inevitable, on the one hand because technological progress cannot be stopped; on the other because the world requires it. The time has come to make (and implement) more sustainable, more future-oriented choices rather than immediate gains (Kersten, Blecker & Ringle, 2017).

Within these trends, innovation plays a fundamental role. It must be a controlled process, which implies a cultural change, where it is necessary to recreate the flows and processes to generate an open innovation. Innovation must be formalized and incorporated into the culture of the company; ports as an industry-company are not exempt from this process. The management of the R+D+i model associated with innovation must be systematized, verifiable, audited and measurable within the port environment (Philipp, Gerlitz & Moldabekova, 2019). To guarantee the control of innovative activities, control tools must be developed. There is still a long way to go within the port sector to control the management of change from initiatives to projects.

The concept of port 4.0 is linked to the concept of industry 4.0, which is associated with the phenomenon of a fourth industrial revolution that represents a change in industrial development capable of generating important social changes in the coming years (Bilal, Kumar, Cianca & Lindgren, 2018). It is a concept of industry that makes intensive use of the Internet and state-of-the-art technology in order to develop more intelligent and environmentally friendly plants and industrial processes. They involve production chains that are rigorously linked to each other hand to the markets.

World is currently immersed in the fourth industrial revolution or industry 4.0. This technological trend requires moving from electronic ports to interconnected ports. It will produce changes in the models of port governance, not because it is preferred that ports are more public or more private, but because the way to compete and be efficient will be different and it is necessary to adapt the management (Ahokas, Kiiski, Malmsten & Ojala, 2017). All these transformation processes basically need the next six factors for success:

- Reviewing the processes
- Digital skills
- Improve the user experience
- Apply methodologies
- Change the model
- Use technology

The transformation towards Port 4.0 involves measures to enhance logistics efficiency in the area of infrastructure, operations and service provision, the improvement of environmental and energy sustainability, safety and security, as well as the digitization of processes and intellectual platforms (Durán, Córdova & Palominos, 2019).

Ports have always played a key role in the development of society, being a fundamental element in the economic development of different countries and being in a strategic position at world level (Acciaro, Renken & El Khadiri, 2020). The current global changes motivated by new forms of communication, behavioural patterns, innovative technologies, etc. have meant that ports cannot remain at the mercy of these new trends; they must take an active role in this global change, being a major element of the transformation.

A smart solution is one that provides people with improvements in their personal and collective environment in relation to the territory where they live and their surroundings (Cervantes, Jerez, Fierro, Ocaña & Rivero, 2013). A Smart solution is not the same as a digital solution, but ICT is a good way to achieve this purpose.

Port activity is one of the activities most influenced by globalization. It implies the connection of distant and different markets, through complex procedures subject to different legislation in different economic areas. It also involves many of actors with diverse interests (Ducruet, 2016).

Therefore, it seems appropriate to include a factor of uniformity to this process in the port system (Haralambides, 2017). Currently, action programs are being developed in each Port Authority to meet these new objectives, but they do not seem to be carried out in a totally coordinated manner. It seems somewhat incongruous that we are trying to coordinate and synchronize different modes of transport grouped into corridors, chains and networks,

involving all actors, However, that efforts to develop them in ports are not being coordinated in a unique and uniform way. Resources are being used to develop the same systems on an individual basis.

The affinity diagram is a tool that can be used to categorize data, ideas or recommendations that may arise from an event in this case the digitization of Spanish ports. Moreover, it helps focus on the search for possible solutions among the different members of the working group. Once the ideas are grouped together, the working group proceeds to discuss the degree of correspondence of each block of ideas with the main problem or situation. From this discussion, a series of conclusions must be drawn that, at the same time, lead to making one or more consensual decisions.

The main objective of this work is to try to give an answer, by means of an affinity diagram, to how to promote the digitalization of Spanish ports

2. Knowledge status

Industry 4.0 is the name under which the fourth industrial revolution has been coined. If the first one (half of the 18th century) was marked by the steam engine; the second one (beginning of the 20th century), by chain production and electric energy; the third one (second half of the 20th century), by electronics and information technologies; this fourth transformation is characterized by the fusion of the physical industry with the digital world (González-Cancelas, Molina Serrano, Soler-Flores & Camarero Orive, 2020).

The keys to this revolution are as follows:

- DATA: Industry 4.0 carries the promise of intelligent factories that are highly efficient thanks to data. Big Data and advanced analytic can increase manufacturing volume by 20 to 25% and decrease production times by over 45%. To achieve this, it is essential to obtain (production processes need to be obtained automatically), transfer (the information provided at a specific point, must also be available at any other point), process and synthesize, and results (the automation of decision-making from data opens new opportunities for companies) (Santos Martín, González-Cancelas, Molina Serrano & Soler-Flores, 2020).
- THE REAL TIME: The best way to get those numbers when they happen is with the 5G and 6G that are already being tested. 5G networks have the potential to significantly reduce latency (response time), enable ultra-fast uploads and downloads, improve spectrum efficiency and network reliability, and increase the number of devices that can be simultaneously connected to the network, promoting the so-called Internet of Industry. The 5G will allow reactiong in one millisecond against today's 10 milliseconds. Thus, the industry will be able to reach services in real-time (Sánchez-Cambronero, González-Cancelas & Serrano, 2020).
- LEADING TECHNOLOGIES: All the technologies of the Industry 4.0 have a common link: they offer new possibilities to unlock the potential of data. These tools can be classified in four blocks according to their main purpose:
  - *Connectivity:* this group includes the Big Data, the Internet of Things and the cloud. Reducing the costs of sensors and actuators allow for more affordable and powerful data storage, transmission and processing (Alberto Rodrigo, González-Cancelas, Molina Serrano & Camarero Orive, 2020).
  - *Intelligence:* The latest advances in Artificial Intelligence (AI), together with the increase in data availability, are giving rise to new forms of industrial automation. In which, the plant components will be able to organize their work among themselves, without human intervention, to take over the tasks they receive from the superior control units (González-Cancelas, Molina Serrano & Soler-Flores, 2019).
  - *Human-Machine Interaction:* Augmented Reality will provide real-time information to improve decision-making and work procedures. For example, workers will be able to receive repair instructions on how to replace a certain part in a system that requires adjustment. This information can be delivered directly through augmented reality glasses (Marques, Santos, Araújo, Martins, Alves & Dias, 2019).
  - *Conversion from digital to physical*: additive manufacturing allows the creation of different items with the same machine. And without having to go through a subsequent assembly process, one of the most costly industrial phases in the industrial chain. Furthermore, the new robots, which are gaining in security, will be understood as tools to increase human capabilities, not as competitors (Haleem & Javaid, 2019).

2.1. Innovation, digital and smart

A Smart world is possible with innovative and digital solutions. As already mentioned, the pillars are innovations, Smart solutions and organizational empowerment through digitalization (Sánchez & Barleta, 2018).

Innovation in the port sector will require the participation of citizens, the talent of people to improve creativity and the process of creating a model of a certain product and the successive tests made with it, and having tools to manage the change that will take place in the ports.

The smart solutions associated with the port industry 4.0 must bet on simplicity, sustainability, must be focused on efficiency and need to have people and territory in contact.

Organizational empowerment through digitalization requires a review of port processes, which will require the use of digital technology, improving current digital skills (Sánchez & Mouftier, 2016). We must be aware that new roles will appear in the process. This process of digital empowerment is based on:

- Having one's own power of decision.
- Having access to information and resources to make an appropriate decision.
- Having a range of options to choose from.
- Ability to exercise assertiveness in collective decision-making.
- Having positive thinking and the ability to make changes.
- Ability to learn and to enhance their own personal or group power.
- Ability to change perceptions by democratic means
- Improve self-image and overcome stigma
- Participate in a self-initiated process of growth and continuous change.

2.2. The challenge of digitizing innovative and smart ports

The factors to consider for general digitized, innovative and smart ports will be divided into in-ports and out-ports (Sánchez, Palma Barleta & Mouftier, 2017).

The internal factors will be more focused on efficiency and will imply a cultural change, as we could discuss about more:

- The legal position of the public sector: affecting governance and the possibilities to introduce innovation
- Companies and competitiveness: the gap between the industrial processes and the former bureaucratization of the companies and the administration
- The ownership of the port: which complicates its management in a context of necessary interrelation

The external factors will be more focused on growth and will involve new relationships, as we could talk about more prominently:

- Logistics and the industry itself: larger and larger ships that make it more difficult to dock and change schedules, forecasts and operations.
- The economy: globalization and economic tensions as well as the current difficult geopolitical situation.
- Trade: new forms of trade that have broken the traditional mould.

2.3. Available tools

Currently the Big Data and Blockchain are the main tools for creating smart ports as it has already been developed in smart cities (Lee, Aydin, Choi, Lekhavat & Irani, 2018). Data are collected anywhere, at any time. They are a double-edged sword, as they allow users to offer services adapted to them, but at the same time they move in the limit between "data search" and "invasion of privacy". The chain of blocks is already considered for all intents and purposes, an innovation that in a few years will enter our lives (Davarzani, Fahimnia, Bell & Sarkis, 2016).

Clearly, the fact of having a Port 4.0, includes a series of advantages, such as having the goods located at all times, offering a greater possibility of control, which leads to greater efficiency in terms of loading-unloading, storage and future transfer within the Hinterland (Brouer, Karsten & Pisinger, 2016).

Electric vehicles may be used for the movement of cargo, which contributes to reducing local greenhouse gas emissions (Arguedas, Pallotta & Vespe, 2017). In addition, from the point of view of noise and possible spillage of fuel from machinery, the impact that these factors can produce in such a sensitive environment as a port (from the environmental and landscape point of view) is reduced.

It is obvious that ports with a high-level of computer development are more competitive and efficient than those without it. In this way, they are infrastructures that will be able to work with a greater volume of annual traffic. It achieves a greater exchange of merchandise, and with it, greater income for the Ports. In addition, and indirectly, the fact that an area grows commercially generates a "rivalry" effect through which the adjacent areas also wish to grow, thus creating an environment in which development occurs that is positive both for the end consumer (who pays for a certain merchandise) and for our regional area, as it is a key point for the economy of the area. With digitalization, ports are looking for self-matization to make the supply chain more efficient and predictive (Zaman, Pazouki, Norman, Younessi & Coleman, 2017). In addition, intermodality is also being pursued and a more sustainable management is being developed to reduce pollution, gaining flexibility and agility. As it could not be otherwise, Spanish ports have joined the digitalization process. Little by little, the actions carried out in the ports, give them strengths that mark a clear competitiveness.

Based on a systematic review of the literature, Fruth & Teuteberg (Fruth & Teuteberg, 2017) provide an overview of the current state of digitization in maritime logistics, analyse existing problem areas and show the potential for improvement. The results show that it is essential to capture the development potential in order to benefit from the advantages. However, the article concludes that the research is still in its early stages and theoretical and empirical work as well as explanatory approaches for appropriate recommendations for action and restructuring are lacking. This is the most comprehensive article on digitalization literature review to date.

3. Methodology

The affinity diagram is considered one of the 7 new quality tools or also called the seven management and planning tools. It is a tool for categorizing data, information or ideas based on their relationship to each other.

In other words, with this tool you find the "affinity" that exists between the ideas obtained from a session, and from the common characteristics or similarities between them, you group them for review and analysis.

It acts as a catalyst for the sum of ideas, opinions, comments, recommendations and interpretations. They may arise in the face of a given fact or problem, and focuses on the search for a consensus that can satisfy the different members of a team.

The main advantages are:

- Order vs. volume: Organize many ideas and concepts, very useful when you have a large volume of information without order.
- Teamwork: Getting the work groups efforts focused, which allows you to work as a team.
- Understanding: Allows for a more in-depth understanding of a situation or problem.
- Creativity: It is a visual method, which induces the creativity of the group.
- Analysis: Facilitates further analysis.
- In order to carry out this dynamic, more than 12 elements must be available and it is necessary.
- A work space.
- A blackboard or cardboard where the elements of the group can be displayed.
- Sticky notes (post-it) or marker to write down what is mentioned.

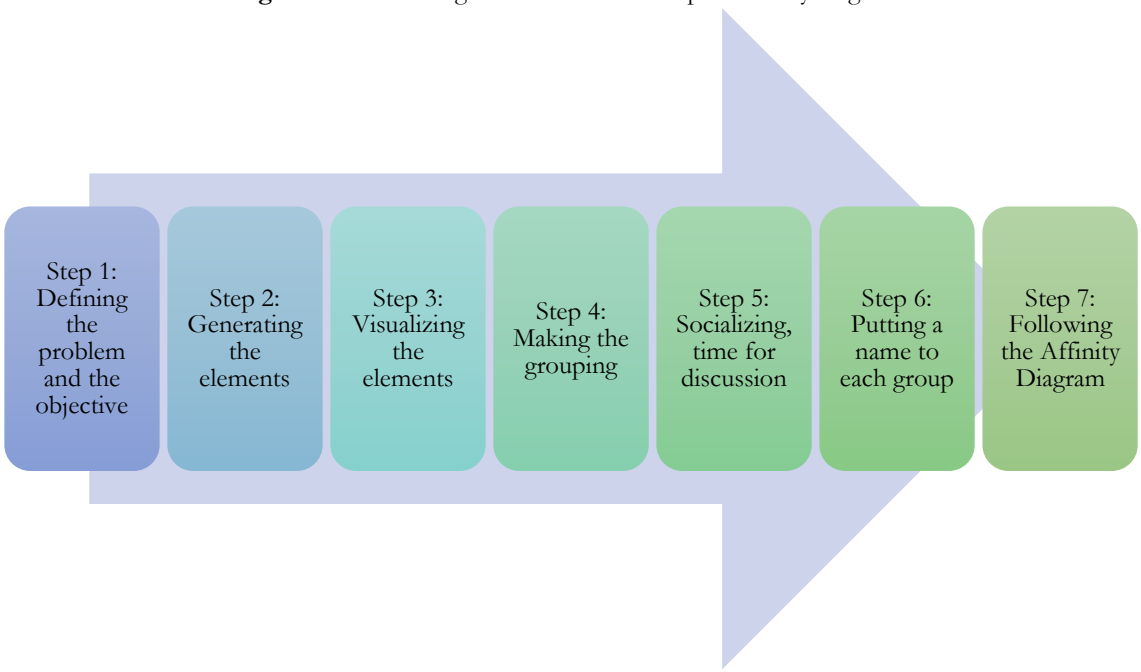
This requires a "leader" to lead the session and interpret the efforts of the attendees and keep the focus on the problem or objective being addressed, and organizers to write on the board, place post-its, etc.

The experts involved in this case the affinity diagram consists of an information gathering technique, based on consultation with experts in an area. It is a very versatile technique. It makes use of the information that comes from both the experience and the knowledge of the participants in a group, usually composed of experts. The starting point for the implementation of this strategy of the affinity diagram has been the existence of a research problem that required the opinion of a group of experts: improve the digitalization of the Spanish port system and whose knowledge on the subject, characteristics and experience were considered a priori as appropriate for the achievement of the objectives of our research. It requires the participation of a larger number of experts than can or should interact in a face-to-face exchange. The leader must always ensure that all the opinions given by the experts are represented. The best source for information should be key experts or informants, who have sufficient expertise in the subject, both knowledge and experience in the content of the consultation. With the expert group

being the source of information, the importance of their proper selection and participation is understood. This is one of the elements that condition their success. In this case, they must have an academic background, special merits, outstanding professional experience, and features that make them stand out in the subject of study. So they have a sufficient knowledge based on the subject to be addressed.

The steps for developing an affinity chart are shown in Figure 1.

Figure 1. Methodological scheme to develop an affinity diagram.



The Affinity Diagram is more than just a grouping of ideas that help to understand the origin of a problem in one of the areas of a company or organization. It works through the hierarchical structuring of the information you have and does not always give the solution to the problem. However, it does help to give you an idea of what it might be causing. That is why it will be taken as a diagnostic basis for the digitalization process of the Spanish Port System. All the ideas that the different experts have of the elements that interact in the port digitalization can be ordered and classified. They can be taken as a starting point to tackle the digitalization of the Spanish ports.

The Affinity Diagram is a method that helps to organize a large amount of information.

Step 1: Defining the problem and the objective

What is the situation or problem to be analyzed? The following is a statement of the problem in the form of a question.

Step 2: Generating the elements

Now, each attendee will begin to generate the ideas they feel are relevant to the problem statement. It is preferable that each one has what to write with and a post-it where to do it; this facilitates the generation of ideas in those assistants who are shy or who have more facility to work on themselves.

Step 3: Visualizing the elements

It receives the ideas from each contributor, and they are placed at random on a surface or on the board. Then, all are placed around the table or in front of the board. For each idea, it is best to place a code or assign an ID. This is vital for the next step.

Step 4: Making the grouping

Silently, each attendee will begin to order the sticky notes as they see fit. The criteria here is to group those elements where you find common characteristics.

- You look for two elements that are related and started forming a column with them.
- You look for more elements that are related to the elements already grouped, if they are not found any more, you start to form another group.
- The above is repeated.
- It is perfectly normal for anyone in the group to take elements that someone else has taken before, and move them to another group.
- If an item is thought to fit into two groups, take a sticky note and write down what you have for that item.
- If there is an item that does not seem to fit into any of the other groups because of its characteristics, it is left alone.

Step 5: Socializing, time for discussion

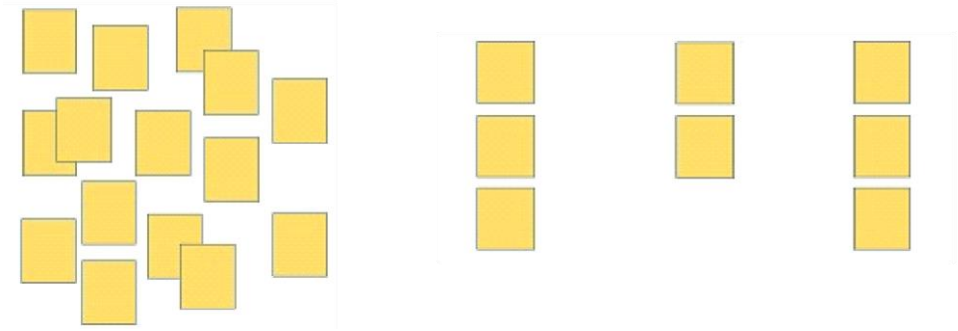
In a group and with the facilitator's moderation, you will discuss as a team the order in which the elements have been arranged. What are the patterns, characteristics and relationships found by the team members so that they have decided to arrange the elements in this way?

In this step, changes are made by decision of the group, for example, by passing a card from one group to another, or by eliminating the elements that say the same thing.

Step 6: Putting a name to each group

In the next step, a title will be assigned that describes each of the grouped elements. You can use a sticky note of a different colour or write on the surface you have been working on (if it is a light board). Once each group has a title, review the affinity diagram with the team. Does everyone agree? (Figure 2)

Figure 2. Affinity diagram´s schedule.



Step 7: Following the Affinity Diagram

With the previous steps done, you already have an understanding of the event or problem being analyzed. This is the main input for decision-making. What to do now?

With the ideas grouped together, the working group proceeds to discuss the degree of correspondence of each block of ideas with the main problem or situation. From this discussion, a series of conclusions must be drawn that, at the same time, lead to making one or more consensual decisions.

Finally, the groups and the elements corresponding to the problem are discussed.
companies.

4. Results

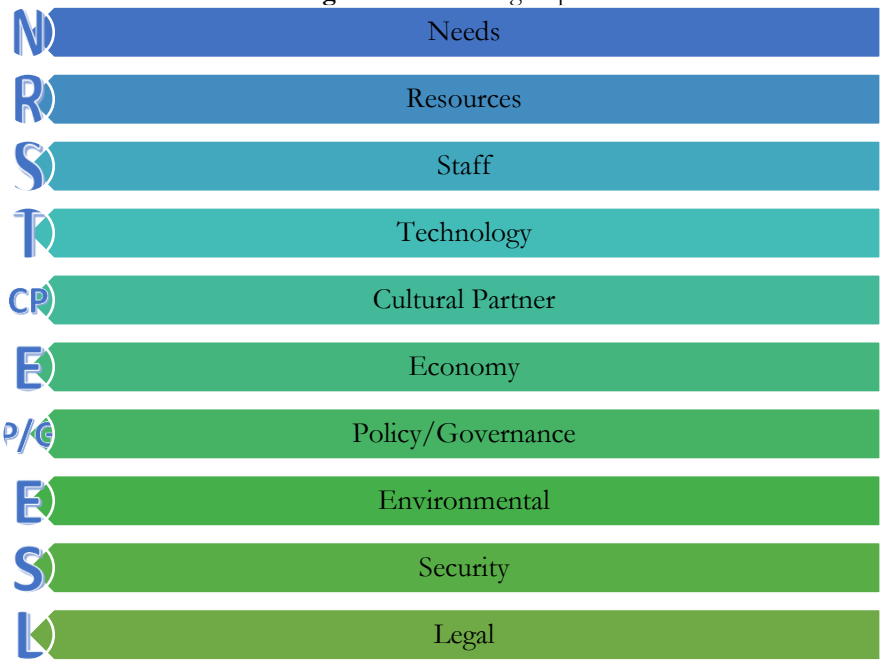
The working group was formed by 22 people related to the Spanish port area, a leader and two coordinators were appointed. The working session took place over the course of a morning in which the members of the team met in person.

One element to take into account when designing an affinity diagram is that the working group must be made up of personnel trained in the subject being discussed. Only in this way is it possible to ensure that the conclusions drawn from the process are truly useful and accurate. For this reason, the creation and selection of the group of experts was much discussed.

The experts who were familiar with the subject of the work included in the post-it the key elements to be taken into account for the digitalization and later on, with the help of the leaders and coordians. These indicators were presented and by consensus they were grouped in different groups.

The groups obtained are shown in Figure 3:

Figure 3. Obtained groups.



Each of these groups encompasses different indicators. The elements included in each of the groups are detailed below.

4.1. Needs

Administrative transformation: Administrative transformation is needed to be able to implement port digitalization. The following paper "The Transition of Croatian Seaports into Smart Ports"emphasizes the cooperation between ports: "Initially, it is necessary to enable system integration and stakeholder connectivity within the seaport, and subsequently connect the seaports with each other. The digital transformation must be accompanied by the administrative transformation (Jovic, Kavran, Aksewntijevic and Tijan; 2019).

Coordination: The challenge that the port and logistics communities have, in order to improve the management mechanisms of the port logistics chain, is to promote the coordination and communication between the different actors of the logistics-port area, and all this goes through collaboration.

However, for the CML Fraunhofer (who explains that technological information is the basis, and digitalization in logistics, the key to the success of Ports 4.0) if the goal is to achieve the development of a digital business model, most ports are in the previous phase, linking systems with processes (Cómo se digitalizan los puertos?; 2017).

Strategy alignment: To achieve this new port business model, it is not enough to have disruptive ideas and the most advanced technology. However, it is also necessary and imperative to align the strategies of the entire port community in order to achieve the common objectives. In addition to a cultural change in the Administration and

a real bureaucratic change that will effectively improve the efficiency of the system. The use of making such investments of money, time and training to implement all these technological changes that make it possible to simplify processes if it can be later found ourselves faced with the rigidity of the Administration.

For example: the inflexibility of Customs timetables and the involvement of so many independent bodies in Customs procedures means that, in the end, even with the best 4.0 advances, logistics chains continue to slow down and therefore negatively affect the global competitiveness of the port community.

Data exchange: Most of the authors point out that the great challenges are precisely: the sharing of information between Port Authorities, the collaboration between ports and the management capacity of stakeholders by Port Authorities (Deloitte Port Services, 2017). The need for cooperation between ports, to really share data and perceptions, is something that has not been explored. This third challenge, driven by a certain form of protectionism by port authorities over their own data, is a major obstacle to the development of a true Smart Port strategy. Finally, the dichotomy between the port authority and the terminal operator adds a level of complexity. Operational implementations cannot be forced by the port authority at terminal level. This could create a port with a highly integrated infrastructure network, but with a lack of superstructure integration. The role of the port authority in a smart port strategy includes development and facilitation for its users. The final level of integration will be the result of the management and identification of stakeholders showing port self-sufficiency.

Economic resources: The development of new technologies opens up a very wide range of possibilities. They require large resources, since, although one of the characteristics of new technologies is their ability to reduce their production costs quickly. Continuously, it is also true that they are increasingly reaching smaller areas that require more massive implementations. Without forgetting its high degree of obsolescence, inherent to its own development.

4.2. Resources

The capital fund Ports 4.0: which Puertos del Estado has launched on behalf of the Spanish port system to encourage innovation in 4.0 technologies in the port sector (within the scope of the 4th industrial revolution). These are subsidies on a competitive basis. The main objective of the Fund is to promote and actively incorporate disruptive or incremental innovation. Innovation is considered as an element of competitiveness, efficiency, sustainability, safety and security in the Spanish port and logistics sector, both public and private, to facilitate its transition to the 4.0 economy. The fund seeks to activate public and private investment in innovation for the transformation and strengthening of the technological capacities of the sector.

Technological development of the Tax Agency: As a resource, we should highlight the technological development of the Tax Agency and its Customs Department, which uses telematic means for the clearance of goods, authorizations for stopovers, etc.

Digital platforms: The Port Authorities have put into operation digital platforms for the electronic transmission of invoices and settlements. Even, it has implemented or is implementing the electronic headquarters, have incorporated ICT in the different processes and operations, which we can include everything within a digitalization process. This gives us an idea that many actors, in this logistics chain, have not started the way to digitalization. The maritime transport sector is being one of the last ones to incorporate the use of new technologies in the management of its processes. Although many initiatives are emerging in Spanish and European ports, I do not know if the technological implementation at operational levels can be considered complete. Except in the large automated terminals, where some of these systems are already applied.

Simple" Logistics Platform: The Ministry of Transport, Mobility and Urban Agenda is promoting the development of the "Simple" Logistics Platform (Simplification of Processes for the improvement of Logistics) which consists of a platform for the exchange of data by telematic means to facilitate intermodality in the transport of goods. The project, which is currently seeking to extend its functions to land transport, focuses on the development of an open and collaborative technological platform. It will serve as a homogeneous telematic tool to ensure interoperability between the different modes of transport. Even, it enables integrated management of all the data and documents in the multimodal logistics chain, as well as knowledge of the traceability of goods in the different means of transport.

One-stop shop: The new platform, which is based on the one-stop shop system developed by Puertos del Estado in 2015, will allow the reuse of information throughout the logistics and transport chain, based on the principle of

providing unique data only once. On the other hand, it will allow the interconnection between the Public Administration and the different agents of the private logistics sector to facilitate trade and transport, both nationally and internationally. It is expected that the new platform will significantly improve the competitiveness of the sector. It even helps to optimize the transport and distribution flows of goods, generating, at the same time, new business opportunities.

The "Estiba+2022" programme: this programme aims to develop industry 4.0 technologies for the digitalization of Spanish ports by means of highly automated logistics (Smart Digital Ports). Estiba+ 2022 was created to respond to the challenges of optimizing port space, port operation times, transport costs and productivity levels, challenges of maximizing loading and unloading flows, physical limitations, natural resources, and reducing environmental impact and CO2 footprint. Likewise, the aim is to achieve a highly automated port in which all the devices and assets of the ports are connected (Internet of Things) and which also allows interactive operation with the different agents: cranes, lorries and stevedores, as well as advancing in the development of the "Smart Port" concept, linked to that of the cities where they are located (Smart Cities).

DataPorts project: An example of a Blockchain project is the DataPorts project (A Data Platform for the Cognitive Ports of the Future), co-funded by the European Commission through the H2020 programme, coordinated by the Instituto Tecnológico de Informática (ITI) and in which the Valenciaport Foundation participates. The main objective of this project is to take advantage of the large amount of data generated in seaports thanks to digitalization. In other words, with the support of technologies (big data or blockchain), the aim is to create a data market in which all the actors in the port chain participate in an easy, fast and safe way.

TRADELENS Project: In relation to the technological projects applying Blockchain to the supply chain, we should mention the TRADELENS project between IBM and MAERSK, which has already been joined by more than 20 ports (including Valencia, Barcelona, Algeciras and Bilbao) as well as other terminals, shipping companies, transport companies, etc.

4.3. Staff

Lack of training: The lack of training in the port community, anchored in old processes and procedures, together with the high cost of implementation, can be a challenge in the short and medium term for certain links in the chain. All this, without forgetting other essential aspects, such as safety and sustainability. Training is necessary, not only for port personnel, but also for employees of companies linked to the port community. And of course, the port authorities must promote these processes. However, it is not just the port authority that must deal with them, but the companies themselves must keep up to date by means of continuous training processes, in order to develop and improve their digital skills.

New profiles: With all this technological tsunami, new professional profiles will be generated and it will be necessary to adapt the existing ones to the use of technology. The need to implement different training plans to provide new competences and skills to port employees is already emerging in the field of port authorities.

New work methodologies: a work methodology will have to be implemented to obtain new talent and ideas, to manage new initiatives, to guarantee the change from innovation to operation, and to measure and value each step of this process.

Among the aspects that are advised from the social area and in my opinion, the most important in this process of digitalization, are Non-presential work: The convenience of being able to work from home could be accompanied by a continuous control. The hope of being able to workless could be stifled by the possibility of working anywhere and at any time. During the construction of sustainable ports, the creation of job opportunities, workforce development and entrepreneurship will generate a significant improvement in productivity. It also establishes a high degree of economic competitiveness. The increased adoption of online services by customers and users will enable the digital trans-formation of ports to provide new offers based on industry innovation, international business, ICT, etc. In addition, it provides transparency that is increasingly in demand.

4.4. Technology

Solutions: it is essential that this process is included in the Strategic Plan of each Port Authority.

- To face this new challenge, there are Port Authorities that have chosen to hire something already done (with specialized consultants that sell you almost the entire package of a "Smart Port"), tested, although less flexible, to be able to start taking steps almost immediately in this transformation.
- The other option is to use tools with ad hoc solutions. Develop "custom" applications that normally fit better in the organization but have a higher cost of maintenance and lack of integration with other systems on the market.

Tools:

- Internet of Things
- Automation of operations
- Blockchain: has great potential to transform the logistics chain of ports. The port operations represent a specially propitious scenario for the application of the properties of this technology because they are environments of high operational complexity due to the high number of participants, the amount of processes to be carried out and the needs of coordination and supervision of them. The actors involved have to collaborate and trust each other, so that the models that reduce friction and increase trust will again make a valuable contribution. With their correct use, information flows along the logistics chain will be improved, achieving: the automation of processes based on Smart Contracts; the reduction of administrative and customs procedures; the reduction of illicit activities and fraud; and the reduction of transit times. The systems based on blockchain technology will enable the processing of international purchase and sale processes, transport documents, inspection and authentication of goods, as well as customs procedures, in a highly secure environment.
- Artificial Intelligence
- Big Data: Big data and IoT are already being applied to the port terrain through. For example, sensors that collect information from the environment to make forecasts, for example, to help plan navigation according to the tide, etc.
- RFID (radio frequency identification technology), etc. Knowing and handling the information in real-time of the flows of goods, providing it to the different agents involved and the final customer, seems to be a basic objective. The massive collection of data and the great capacities for their analysis that exist today (Bigdata), allow the taking of decisions in a supported and more accurate way, even with the use of tools based on artificial intelligence. This allows loads, routes and processes to be optimized, increasing the reliability of the system.

These systems will generate predictive models that will allow decision-making. Consequently, they increase efficiency.

Load targets:

- Improve the management and traceability of maritime goods through end-to-end supply chain digitization. The integration of processes based on these new information technologies can simplify all these procedures, working in coordination and security, in a highly collaborative environment between the different agents.
- Increasing security in the transfer of goods in seaports
- Increase transparency and achieve a secure and reliable exchange of information between the actors in the process, achieving a reduction in operational and administrative costs. The open information, arranged in a clear and reliable way, and in a secure environment. It allows the cooperation between the different agents that intervene in the logistic communities and the optimization of the resources.
- The efficient use and reuse of information is key to the correct flow of data from companies to authorities, as well as to the improvement of the logistics chain and competitiveness.
- In the short-term: from the technological point of view and given that in many companies there is still no awareness of this, it is necessary to
- Make more appropriate investments in security in information systems.
- Increase security and data protection in the sector to avoid manipulation of sensitive systems.
- Implement measures to protect data against unauthorized access and any kind of abuse by cloud-based user systems, access management, device management and data backup.

4.5 Cultural Partner

Cultural change: The keys to obtaining maximum efficiency through digitalization will be based on a cultural change, a new vision of the port sector, especially in terms of innovation:

- A real commitment to port sustainability,
- Governance and new public-private, social and labour relations,
- Reconfiguration of the port map, changes in the world TOP and logistic integration and interaction of geopolitics,
- Technical progress and automation,
- New trade and port activity.

Port-City Synergies: The digitization of ports in relation to the development of Smart Cities allows a synergetic interaction between both institutions, their governors and their citizens. Digital ports are by and for the people, being therefore the key agent in their future development. Better relationship with the city and integration of the citizen: digital platforms allow citizens to learn about the opportunities offered by the port, as well as the creation of wealth that it provides for the whole population. In the same way, the citizen can send suggestions or proposals to the port management that will translate into improvements for the day-to-day life of the citizens, promoting better coexistence between the port and the city.

Socio-cultural factors: The success of the implementation of automated terminals lies in socio-cultural factors. Complete automation will only be achieved through communication and dialogue with the unions, involving them in the project, and providing the necessary information and training.

4.6. Economy

High economic resources: In Spanish ports, in general, the digitalization and environmental aspects are being studied and analyzed, and at different levels of implementation. The need to provide high economic resources is a stumbling block that many companies in these communities cannot face. Among other resources, Ports 4.0 will encourage the creation or consolidation of a network of emerging companies (start-ups), spin-offs or new lines of business in the technological field in existing companies that develop innovative products, services or processes for the port logistics sector with a market orientation.

State funds: From a political point of view and given that the modernization of fleets is necessary and that there are many maritime companies that are hesitant to invest in new technologies due to the high investment costs, some fund should be obtained at a state level to compensate for these investments, thus motivating and promoting maritime companies to accompany this new era of technological change.

Public finances: Lack of budget and resources due to depleted public finances are slowing down public investments. In addition, appropriate and systematic methodologies and metrics for reporting and verifying investment returns are lacking. The financial situation, lack of credit and regulations on financial institutions to reduce exposure to risk by creating a stronger deposit base are limiting available cash flows, slowing investment in port digitization efforts.

4.7. Policy/Governance

Port communities: The interconnection between the digital platforms of the entire logistics chain and the collaborative economy itself, both cases derived from digitalization and PORT 4.0, may require the development of changes or modification of the State's own port governance model. The new model of digitization of the port industry will be the port communities themselves (not only the port authorities as independent), made up of public/private logistics entities associated with a particular port facility. It will jointly and collaboratively develop those strategies to adapt this new digital model to their own reality towards improving the competitiveness of the global port service, supported by the aforementioned technological innovation. As a result of the above, although the opposite would be very favourable for the general interest, it is considered very difficult to think of a possible functioning of the State port system as a block to compete with the ports of Northern Europe. Even more so with the significant heterogeneity in type, characteristics, traffic and size of our ports added to the current scheme of governance, self-sufficiency and competition for all ports just as established in Law 27/92.

Political aspects: The policy context is important for understanding the Smart Ports initiatives, which includes political and institutional elements. The transformation towards digitalization of ports requires the interface of technological elements with political and institutional elements. Under the political dimensions, historically,

interactions between the public and private sectors have been quite complicated. The different means of transport have to maintain a close relationship in order to achieve a global digitization, involving the political and institutional elements in the objective.

4.8. Environmental

The control and optimization of resources: energy, water and waste by means of new technologies add environmental value to port management and the entire logistics chain, allowing to find sustainability objectives, which today are essential for society.

Sustainable ports: The search for a more sustainable port will lead to an improvement in environmental quality and therefore in the quality of life, not only for people, but also for the environment. The intensive use of port land at a 4.0 level will depend entirely on the port's capacity to implement digitalization and ICT throughout the production chain, once again allowing the AI to make significant contributions to the development of logistics nodes. Spanish ports are not yet at the sustainability level of the port of Antwerp in Belgium or the port of Hamburg. However, Spain has many more resources and it is normal to advance more slowly than countries with fewer structures to intervene.

Efficient and predictive supply chain: More sustainable management to reduce pollution, gaining flexibility and agility. Intelligent ports reduce transport costs. Consequently, their connections are much more attractive; they offer a very important competitive advantage with respect to other enclaves. In this context, technology and innovation become key elements to provide real-time information, offer new services from the data flow and digitize processes. The integration with the city and the hinterland-foreland, this would reduce queues and traffic jams. To address these, it would be key to share, merge and analyze data with a view to optimizing processes and performance, for which Big Data would be paramount.

4.9. Security

Security and integrity of the company: to transform to the 4.0 concept. The digitalization of ports makes it possible to adopt systems that increase the efficiency and transparency of the different agents involved and eliminate the need for paper documents, increasing security in general. However, blockchain systems can introduce vulnerabilities or defect regression errors as they become more complex or the information is encrypted. So having a consistent way of managing and administering port security is key to ensuring its functionality and good implementation. Disabling part of the servers that make up the system due to cyberattacks, generating problems in port operations or also affecting some of its customers. The recovery of these systems is slow, leading to great economic losses.

Security and technology: The digitalization at port level increases the security of the different terminals because through the artificial intelligence it is better controlled who enters and leaves the port. All doors and accesses are automatic, and there is an entry system using optical recognition, fingerprints or voice, which makes the port much safer. On the other hand, it allows to have a better control of the loading and unloading processes. In addition, it avoids losing the documentation as everything is digitalized.

Cybersecurity: the digitalization of our new world and the development and progress of technologies show that we are much more vulnerable and sensitive to attack through cyberspace. Today there is something called the Big Data, which is an intangible cloud stored in the air and available to everyone in the world. This can generate big problems since private data (whether personal data, protected data, data managed by administrations) is the engine of the 21st century. Our data is very valuable for all companies. The dependence on technology, both in ports and on marine vessels, is increasing. Crew numbers are decreasing as computer systems are used for navigation, rapid unloading, handling and tracking of goods in ports.

Unfortunately, these systems are also very vulnerable to cyber threats. Each hack can cost ship owner´s millions of dollars, and in some circumstances could even ruin the national economy. Researchers have discovered security holes in key ship technologies: in GPS, the marine Automatic Identification System (AIS), and the Electronic Chart Display and Information System (ECDIS). Another problem is that if there is a vulnerable device on board, most of the crew is not prepared to deal with such a situation. For example, hacking a GPS could send the boat on a different route and still have it appear on its correct route. This could lead to a collision and a delay in the delivery of the goods.

4.10. Legal

Data logging: From a legal point of view, this is where more work and shape should be done since the use of AIS (Automatic Identification System) and RFID technologies requires the automated registration of personal data in some applications. All such data transmission should be encrypted and regulated, otherwise the privacy of, for example, crew members would be exposed. Privacy and data protection restrictions should therefore be reviewed and reliable and political framework conditions should be re-established, especially in the course of digitization and automation in the maritime logistics chain, so that seaports can continue to function as logistics centres.

Disparity in legislation and scope: Inconsistency in national and regional rules and regulations related to policies cannot help to broaden the initiatives of intelligent cities. The use of "big data" and the massive use of data has legal implications that are controlled by the different administrations of each country, community or region. Changes in legislation, regulations, privacy laws, the impossibility of storing personal data and future changes in legislation may mean that this digital transformation may not be as useful as previously thought. In the end, the usefulness of this digitalization will be mainly conditioned by the country that places the greatest restrictions on the storage and use of this data. There is no point in ports and ships having a lot of information if its use is not allowed in the country of destination.

5. Conclusion

Currently, Spanish ports are in a medium to high position of digitalization, and continue to update and innovate, to be increasingly competitive in this market. In spite of this, there is still a long way to go in digitalization. Amongst the road still to be travelled is the immediate conversion to digital, intelligent and green ports. It optimizes existing infrastructures with capacity bonuses thanks to intelligent space management and, to this end, integrate technologies such as the cloud, big data or sensorization, which have already been mentioned. In this way, and working together with the port community, ports must promote the creation of more efficient logistics platforms. So they must encourage coordination and communication between the different actors in the logistics-port field. The mere existence of this technological offer does not in itself guarantee that a community will be "smarter". The experience of various port communities at both the national and international level shows that the result or impact produced by the introduction of these technological changes is not homogeneous. Technology matters a great deal, but the key factor in the success stories is intelligent governance, or what they now call "smart governance".

Again, it is clear that technology alone is not useful to achieve Smart Ports/Ports 4.0., it needs to be used in an integrated, open and joint manner by all actors in the port community.

Based on most of the current processes, the change introduced by Blockchain must be gradual and progressive. Being aware of the benefits that the referred technology can bring to the port and logistic communities, demanding strategies where more cooperation and information is shared, we have to be aware that this change is not going to be easy since it has to be accompanied by a cultural and social change.

Unlike the traditional model based on a government (Port Authority) that defines the environment of the activities carried out by all port operators, intelligent governance should be characterized by:

- Decentralization. Abandoning the model of a large administration by displacing the leading role in decision-making to the set of actors integrated in an electronic administration and hyperconnected
- Participation. Relations with the administration must be fluid, fast and interactive.
- Transparency. Through open data platforms make available to all members of the community information and data.
- Efficiency. Horizontal communication and availability of information is the basis for better management and anticipates and allows for rapid resolution of potential inefficiencies.
- Sustainability. Enhance the role that new technologies can play in intelligent energy management, environmental protection, waste disposal, ...
- Innovation. The promotion of the entrepreneurial ecosystem, the interaction with universities and research centres and the stimulation of R&D projects must be the axes of this new governance
- Collaboration. Both at the level between administrations and between companies and public-private partnerships.
- Security. To guarantee not only physical security but also the protection of data and information affecting privacy.

There are still growth opportunities in the concept of the logistics network, which requires if or if a change in the governance model. The public sector must make the bureaucracy. It is part of the logistics network with its institutions, more flexible. Another situation that must be improved is the integration of the network for small transporters, because if what is sought is maximum efficiency of the network as an integral system. It is necessary that all the actors "connect" to the network, many of which are SMEs, which eventually requires them to make important investments. However, to participate in an increasingly interconnected sector this becomes imperative, there the State must play the role of promoting the integration of these small actors in the logistics network, in addition to encouraging the generation of innovation.

The main benefit of smart port transformation is to join a larger network of equally digitized sites, i.e. a network of smart ports, which can be connected together to form an integrated network of systems, all working in unison to interchange data and improve the efficiency of their collective operations. This will form a system of port co-community and will be key for exchanging data from one point to another, and where the benefits of advanced technological solutions such as IoT, AI, blockchain, etc. can be obtained. Connecting one port community system with another, which is what will form the basis of a global logistics chain, i.e. an Intelligent Port Network, which optimizes transport modes and allows all participants to benefit from lower costs and faster delivery speeds, which will increase competitiveness and drive farther innovation.

Spanish ports, through their Port Authorities, have launched to a lesser or greater extent to implement in their strategic plans and annual business plans the relevant objectives related to port digitalization. Each one starting from very different positions and that there is a unification of criteria and a common calendar. Every Port Authority, given the growing importance of digitization to become more competitive, in addition to having business plans, strategic plans, etc., should have an innovation plan based on a very long-term planned model.

The objective to achieve will be to digitalize the whole environment, generating changes and improvements in the automation of processes. Moreover, it will be speeding up transactions and procedures with reliability and traceability, connecting all the actors in the logistics chain, making use of applications and solutions based on technologies such as big data, automatons, drones, artificial intelligence as well as the use of the internet of things.

Therefore, a possible step to follow would be to have an innovation plan in each port authority:

- That has a strong technological base.
- That respects the principles of sustainability (economic, social and environmental).
- That it takes into account internal and external sources, counting on the whole community of the Port, being totally collaborative.
- That it takes into account the current and future demand, as well as being aligned with the strategy established in each port.

In most of the port authorities, or at least in the medium and small ones, there is a wide development field in the transformation towards smart ports. I believe that technologies could be implemented at a reasonable cost to improve the port-city relationship by introducing information panels, moving towards intelligent lighting systems, sustainable mobility, or digitalised signage systems, all of which are energies efficient and based on renewable energies.

Equally significantly, environmental data collection or access control, alarm alert management or environmental quality sensing should be improved by integrating intelligent counting data, sensor grids or video image management. For access management, licence plate readers or people/vehicle counters, when they become widespread, will improve security in port areas and speed up entry and exit at controls.

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