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PortForward

D1.1 – Harmonized user needs and goals

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0.3	06/11/2018	Working	José Luis Burón (ACCIONA), Fátima Vellisco (ACCIONA), Carlo Paulotto (ACCIONA), Heiko Maly (MAGDEBURG), Olaf Poenicke (FRAUNHOFER), Riccardo di Meglio (APS MTS), Luca Porcaro (MARTE), Alessandra Turi (MARTE), Francisco Barreiro (VIGO), Jorge Martín (APB)	Integrated inputs from ports of Baleares, Magdeburg, Naples/Salerno, Livorno/Piombino, and Vigo. Writing of introduction, common expectations and goals.
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1.0	16/11/18	FINAL	Christian Blobner (FhG/IFF)	Finalization for submission

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Quality Check

Version Reviewed	Date	Reviewer (Partner)	Description
0.4	14/11/2018	MARTE	Review: Inserting: several comments, some suggestions, the introduction of Port of Vigo
0.4	14/11/2018	APB	Global validation

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Abbreviations

AdSP	*Autorità di Sistema Portuale* (Italian Port System Authority)
AIS	Automatic Identification System
APB	*Autoridad Portuaria de Baleares* (Baleares Port Authority)
ARPA	Automatic Radar Plotting Aids
AR	Augmented Reality
BMS	Building Management System
CMMS	Computerized Maintenance Management System
CSR	Corporate Social Responsibility
DPS	Data Processing Centre
ECDIS	Electronic Chart Display and Information System
GIS	Geographical Information System
EO	Electro-Optic
ERP	Enterprise Resource Planning
GMDSS	Global Maritime Distress Safety System
GT	Gross tonnage
HVAC	Heating, Ventilation, Air Conditioning
ICT	Information and Communication Technologies
IoT	Internet of Things
IR	Infrared
KPI	Key Performance Indicator
LPG	Liquefied Petroleum Gas
NAVTEX	Navigational Text Messages
PCS	Port Community System
PM	Particulate Matter
POP	Port Operational Programme
PMP	Port Master Plan
RO-RO	Roll-on/Roll-off
RRS	Remote Radar Site
RTG	Rubber Tyred Gantry
SAMOA	*Sistema de Apoyo Meteorológico y Oceanográfico de la Autoridad Portuaria* (Oceanographic and Meteorological Support System of the Port Authority)
TEU	Twenty-foot Equivalent Unit
TMHG	*TRANSPORTWERK Magdeburger Hafen GmbH* (Magdeburg Port Authority)
VR	Virtual Reality
VTS	Vessel Traffic Service
VTSA	Area VTS
VTSL	Local VTS
WP	Work Package

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Executive Summary

PortForward project proposes a holistic framework that will lead to smarter, greener and more sustainable ports through the implementation of innovative ICT solutions to improve exchange of information flows between port and port community, a tighter integration with different modes of transport and the hinterland/city environment, and the adoption of green technologies to reduce the environmental impact and resource consumption of port operations.

The first step for the development of this framework has been the analysis of the end users expectations and goals, which are in first place the Port Authorities of the ports involved in PortForward project: Baleares, Kristiansand, Livorno/Piombino, Magdeburg, Naples/Salerno, and Vigo, and by extension, the Port Communities of these ports, and of any port that could potentially replicate the PortForward framework.

The analysis of end users expectations and goals has been done through different activities, among which it can be highlighted the organization of technical visits and focus groups/workshops with key stakeholders in each of the PortForward ports, and the analysis of ports' technical documentation. Furthermore, a questionnaire has been launched to retrieve additional feedback from external stakeholders.

The analysis performed in each port includes a synthesis of the port main features (locations, activities, etc.), the identification and classification of key stakeholders, the description of main port processes (port general services, commercial services, etc.), the analysis of hinterland transportation and urban environment, a general description of port ICT-based systems, and economic, environmental, and social expectations of each port.

Main economic expectations and goals expressed by the stakeholders are the increase of efficiency and quality of port operations, risk and cost reduction, timeliness and reliability of port operations, and improved planning of port maintenance activities and of the port public domain.

Main environmental expectations and goals identified are the prevention and reduction of pollution, improved monitoring of carbon footprint and reduction of CO2 emissions, rational use of natural resources, increased renewable energy generation and consumption at port area, compliance with environmental regulations and policies, and increased awareness of port stakeholders about environmental issues.

Lastly, the main social expectations and goals identified include the improvement of working conditions in the port, the socio-economic revitalization of the port region, and the achievement of a positive perception of the port by the society.

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1 Introduction

1.1 Context of this report

This is the first report produced by Work Package 1 (WP1) of PortForward project, "Stakeholder needs and technical requirements", and it corresponds to the first out of four WP1 tasks, T1.1 "Harmonization of end users expectations & goals".

The final objective of WP1 is to produce the technical requirements specification for the development of the PortForward framework, and to define a set of KPIs that will be used for assessment of the technical, business, environmental and social impact of PortForward. The technical requirements specification will be produced in task T1.3 "Technical specifications", while the KPIs will be elaborated in task 1.4 "KPI definition".

Prior to these two tasks, the project needs to complete two preliminary steps:

- Firstly, to analyse the expectations and goals of the end users of the PortForward framework. These are mainly the Port Authorities of the ports involved in the project (Baleares, Kristiansand, Livorno/Piombino, Magdeburg, Naples/Salerno, and Vigo), and by extension, the Port Communities of these ports, and of any other port in Europe that could potentially replicate the concepts that are going to be developed by PortForward.
- Secondly, starting from the outputs of the previous step, to carry out a deep analysis of the use cases that will be developed in each of the ports participating in the project. Based on this use case analysis, it will be possible to develop both the technical requirements specification and the KPIs definition.

The first step is completed within the current task, T1.1, while the second step is being completed within T1.2 "Use case restrictions & requirements".

WP1 outputs will be used by several tasks in other work packages. For instance, WP2 will carry out the design of the PortForward framework architecture based on the technical specification produced in T1.3, and this architecture will in turn guide the technical developments in WP3, WP4, WP5, and WP6. The KPI definition in T1.4 will be used as reference for designing the PortForward Dashboard in T6.4. Besides, the use case validation and impact assessment planned in WP7 will be guided in first place by the use cases analysed in Task 1.2, and will use the KPIs defined in T1.4 for assessing the impact. Figure 1 shows the more direct relationships between the WP1 tasks, and tasks in other PortForward work packages. According to this scheme, Task 1.1 lays the foundations of the rest of WP1 tasks, so it is crucial to carry out a proper analysis of stakeholders' needs and expectations, in order to guarantee the success of the project.

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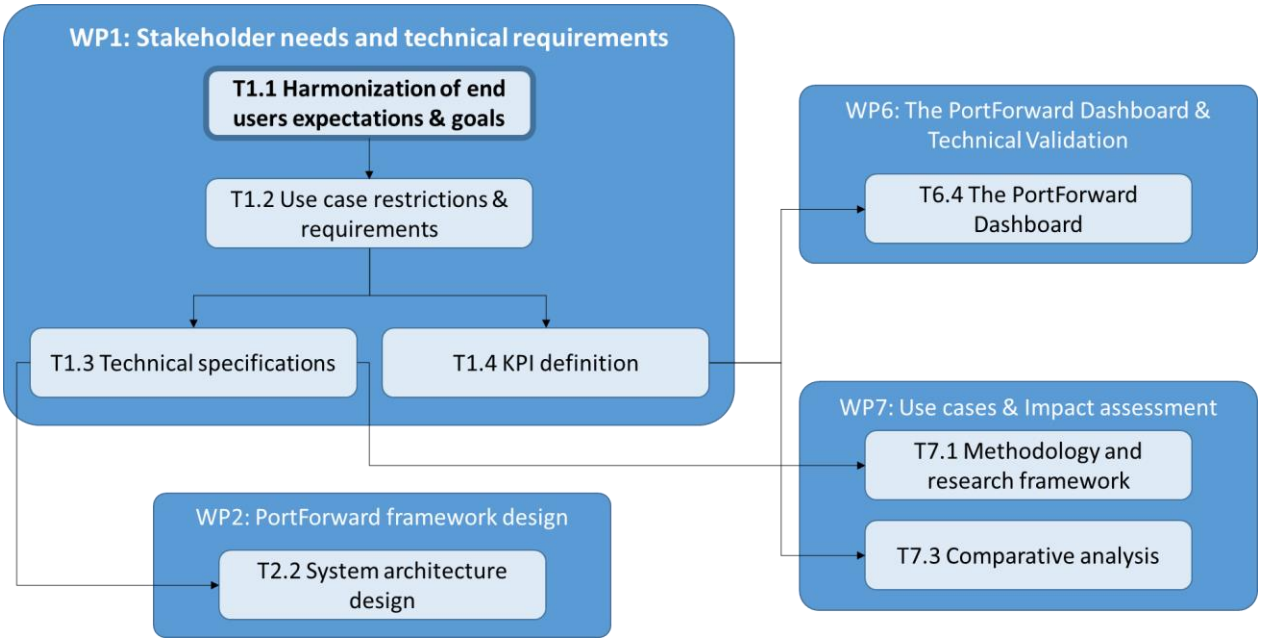

Figure 1 – Direct relationships between WP1 tasks and other PortForward tasks

1.2 The PortForward framework

The outputs of Task 1.1 will ultimately guide the development of the PortForward framework. In its initial conception, this framework will consist of the following components:

- **Sensor layer (IoT-Enabled Port):** in charge of collecting data from the real physical port environment, including port legacy monitoring & control systems, newly deployed sensors, human feedback from the field, city open data, etc. The sensor layer may make use of different communication protocols for transmitting their data.
- **Middleware layer (Connectivity):** in charge of gathering and pre-processing data from the sensor layer, so that these data can be processed and consumed by the upper layers of the framework. The middleware layer will enable integration of and interoperability with heterogeneous data sources.
- **Application layer (PortForward Cloud):** this layer hosts the core functionalities of the PortForward framework. These will consist on one hand on a set of advanced specialized services based on heterogeneous data, namely: a smart logistics platform, a remote management and maintenance platform, a green scheduler for yard operations, a set of AR-based support tools, and an intelligent recommendation system. On top of these specialized services, the application layer will provide a set of transversal tools for data visualization, analysis, and decision-making. These are the Decision Support System, the Virtual Port representation, and the PortForward Dashboard.

According to the description above, Figure 2 shows the structure of the proposed PortForward framework.

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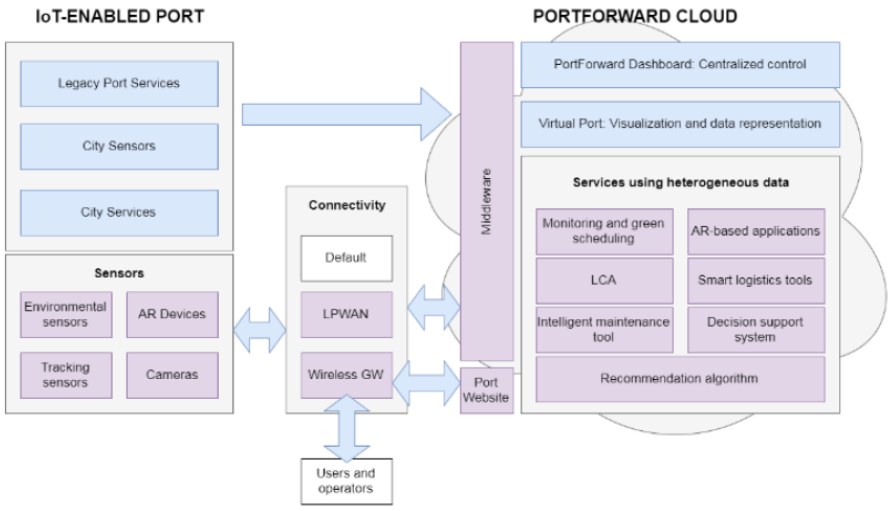

Figure 2 – PortForward framework

1.3 Methodology

According to the WP1 context that has been described in section 1.1, Task 1.1 can be seen as the first step in a standard system requirements engineering process, which has the objective of identifying, analysing, and harmonizing the needs and expectations from target end users, relevant stakeholders, and domain experts. In order to carry out this process, Task 1.1 defined the following supporting activities and tools:

- **Stakeholder focus groups/workshops:** these workshops would be organized with relevant stakeholders of the case study ports, both internal and external to the project. Within the relevant stakeholders, it shall be highlighted the involvement of port city municipalities in order to analyse and identify points for improvement of port-city interactions.
- **Technical port visits:** visits of the ports by the PortForward consortium partners with deeper involvement in each port, in order to carry out an on-the-field analysis of port processes and environment.
- **Documentation analysis:** analysis of technical, business, and regulatory documentation provided by the port end users.
- **Questionnaires:** elaboration of a survey for other relevant port stakeholders who cannot be involved in previous activities, in order to gather additional feedback.

Among these planned activities, the PortForward consortium has focused on the three first three, and their outputs have been used to prepare the current report. A questionnaire for external stakeholders has been elaborated as well, but in order to have enough time to gather a significant amount of answers, the feedback from the questionnaire will be analysed and incorporated into deliverable D1.2, as an additional input for refining stakeholders' expectations and needs, prior to the use cases analysis.

The stakeholder focus groups and the technical port visits have been generally carried out in parallel, i.e. a reduced group of consortium partners (the ones who planned to have a deeper involvement in each port) visited the port, and held a set of meeting with both the port authority, and with other relevant port stakeholders.

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1.4 Structure of the report

This report has been structured into the specific analysis of end user needs and expectations carried out in each case study port. The case studies are the ports of Baleares, Livorno/Piombino, Magdeburg, Naples/Salerno, and Vigo. Kristiansand is not included in this list because although they are a PortForward consortium partner, their role is focused on external stakeholder involvement, and no demonstration/validation activities are planned at their port.

According to this approach, Sections 2 to 6 present the analysis of end users needs and expectations of each specific port. This analysis has been structured similarly for all the case studies:

- **Introduction to the port:** The aim of this section is to provide a short introduction to the port: location, main activities, main figures, etc. Besides, the introduction may include an initial reference to some of the main challenges faced by the port, roadmaps and policies for improving productivity, sustainability, digital transformation, etc., that will be explained with more detail in the following subsections. For the case studies that comprise more than one port (Baleares, Livorno/Piombino, and Naples/Salerno), a specific subsection is included for each port.
- **Identification of the key stakeholders of the port:** The aim of this section is to provide an overview of the key stakeholders of each port. Although each port has been given freedom to structure this section in the most convenient way for them, it was recommended first to identify and describe the role of different stakeholder categories, and then listing/describing the main stakeholders belonging to each category. It was highlighted the importance of including in this analysis the identification of stakeholders external to the port, e.g. those related to hinterland transportation and urban environment.
- **Port Processes description:** The aim of this section is to provide an overview of the main business processes/services of the port, especially those that each port expects to be addressed/optimized through the application of PortForward technologies. Whenever possible, the processes are mapped to the stakeholders described in the previous section, and their description may be supported by some kind of graphical representation such as business process maps. Each port was given freedom to classify its processes in the most convenient way for them. However, as an initial reference, they were provided with a potential classification elaborated according to the Spanish ports law [1]. The main categories explained in this regulation are:
    - *General services:* these are services that are provided to port users without having to ask specifically for them, usually managed directly by the Port Authority, e.g. ordering, coordination and control of port maritime and terrestrial traffic.
    - *Port services:* services aimed at making possible operations associated with maritime traffic, usually licensed by the Port Authority to private entities, e.g. technical-nautical services, passenger services, freights handling, etc.
    - *Commercial services:* activities of commercial nature, not included within the previous category, linked to port activities, usually managed as well by private entities, e.g. consignees acting as intermediaries in representation of ship operators.
    - *Maritime signalling services:* services for installation and management of aid devices to improve safety of navigation and movements of ships in the coast.

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- **Hinterland transportation and urban environment:** this section provides more insight into the relationships/interconnections of the port with its surrounding environment, including on one hand the connection with hinterland transportation (road and rail), and on the other hand, the connection with the urban environment (e.g. analysis of environmental, social, and economic impacts of port activities on the neighbouring cities).
- **Port systems description:** The objective of this section is to provide an overview of the main ICT-related systems and supporting infrastructure (e.g. communication networks) existing in the port. The objective of this section is not to provide many technical details of these systems, as this is more within the scope of WP2, but rather to describe the systems from the point of view of the end users. Therefore, the description tries to identify the existing systems, their main functionalities and goals, their mapping with the port processes and stakeholders previously described, their potential lacks/limitations, and potentials for improvement and interconnection/synergies with other systems, etc. The description includes as well any other system that the port may be planning to deploy within the timeline of PortForward project, as well as plans for deployment of new technologies (e.g. drones, VR/AR, IoT-related systems, etc.).
- **Expectations and goals:** this section provides an overview of the mains expectations and goals of the end users in order to achieve a sustainable "port of the future" vision for the specific case of their port. These expectations and goals are classified according to the three main sustainability axes: economic, environmental, and social. For each expectation/goal, the port shall try to identify the stakeholders, processes, and systems (as described in the previous sections) involved in its achievement. This shall be followed by an assessment of how the PortForward framework can help to fulfil this expectation/goal, i.e. what functionality, new system, and/or new synergy between systems enabled by PortForward will provide the basis for achieving the expectation/goal.

After presenting the different case studies, and based on the information provided by them, Section 7 aims to provide a common picture of the expectations and goals of all the ports involved in PortForward.

Finally, Section 8 summarizes the conclusions and lessons learnt from the activities carried out in Task 1.1, and introduces how the WP1 activities will be continued by Task 1.2 in order to analyse the use cases in each port.

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2 Ports of Baleares

2.1 Port Introduction

The Balearic Islands are an archipelago of Spain placed in the western Mediterranean Sea, near the eastern coast of the Iberian Peninsula. The archipelago is composed by four largest islands: Mallorca, Menorca, Ibiza and Formentera; and minor islands and islets are close to the larger ones, including Cabrera, Dragonera and S'Espalmador.

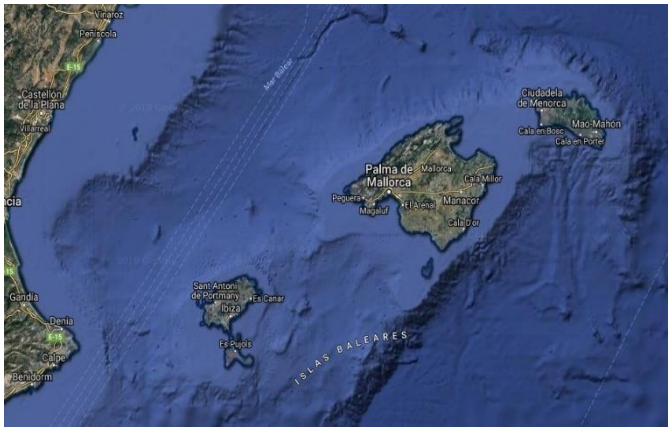

Figure 3 – Balearic Islands

The Balearic Islands have five main ports along their archipelago:

- Port of Palma (located in Mallorca)
- Port of Alcúdia (located in Mallorca)
- Port of Mahón (located in Menorca)
- Port of Ibiza (located in Ibiza)
- Port of La Savina (located in Formentera)

These ports are managed by *Autoridad Portuaria de Baleares* (APB). During the last years, the dynamic of port operations in the Balearic Islands has kept all of its lines of activity, within a socio-economic context of growth. The transhipment of goods has gone forward in parallel with the economic structure.

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Figure 4 – Main Ports of Balearic Islands

The cruise sector is still growing in Balearic Islands. This activity is generating collective thought in the port of Palma, contributing a diversity of sometimes-disparate points of view. The focus now is no longer on growth but on development. APB have assumed the responsibility of handling the certain impact of cruises in the islands.

Recreational boating is also on the rise and on the way to becoming consolidated, and its focus shall be more oriented towards development rather than growth. There is hardly any room for more moorings in Balearic coasts, so the strategy must be to offer a touristic product with good quality

In addition, it must be mentioned the main industrial activity that Port of Palma has at present: the maintenance of recreational boats, which is in a worldwide leading position. The industrial space in Palma is to be re-organized for the benefit of longer boats, and new spaces are to be developed in Mahón and Alcúdia, still in the phase of tendering.

During last year, the APB undertook a deep digital transformation process in accordance with the 2015-2019 electronic administration strategic plan. As a consequence of such actions, there was an expansion and improvement of the catalogue of procedures available at Electronic Headquarters. APB introduced new electronic document registration functionalities and a 24x7 telematics process system. The electronic identification of the users have been improved as well as the data exchange between Public Administrations in order to eliminate the paperwork and prevent the user from having to provide documentation already possessed by other administrations.

As regards of the internal management, APB improved in the digitalized information systems throughout the last year. Particular mention should be made to the Posidonia port management application.

Throughout last year, the APB intensified its efforts to connect the institution even further with its interest groups and, very significantly, as regards the integration of the port-city interface.

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2.1.1 Palma

The port of Palma is the biggest of the five ports managed by the Port Authority of the Balearic Islands. It is part of the city of Palma de Mallorca. The port is divided into four different areas: the commercial quays, the west quays, the marina docks, and the west breakwater. Despite space limitations placed by its proximity of the city, Palma is one of the most important cruise ports in the Mediterranean. In the following table, the total mooring length available at the port of Palma is broken-down in terms of commercial activities and water depth.

Figure 5 – Port of Palma

Table 1 shows a classification of the total mooring length available at the different quays of the port of Palma. This classification distinguishes between public and private quays and for each one of these categories the different activities carried out at the quay. The same table has been made for the five main ports of Balearic Islands.

Table 1 - Port of Palma. Classification by uses and depths

	l.m. (linear meters) with depth (D)					Total (m.l.)	m.l. with D < 4m
	D ≥ 12	12 > D ≥ 10	10 > D ≥ 8	8 > D ≥ 6	6 > D ≥ 4		
PUBLIC							
COMMERCIAL QUAYS							
General cargo	635	-	-	-	-	635	-
Containerised cargo	-	-	176	-	-	176	-
Ro-Ro berth	-	220	437	120	-	787	-
Solid bulks without special facilities	110	-	-	-	-	110	-
Solid bulks with special facilities	360	-	-	-	-	360	-
Liquid bulks	110	-	-	-	-	110	-
Passengers	465	1.235	1.016	-	-	2.786	612
OTHER QUAYS							
Fish	-	-	-	-	206	206	415
Shipbuilding, repair and breaking up	-	-	-	66	130	196	-

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Sundry	-	-	-	211	-	211	4.732
Total	**1.660**	**1.455**	**1.699**	**407**	**336**	**5.577**	**5.759**
PRIVATE							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	-	-
Containerised cargo	-	-	-	-	-	-	-
Ro-Ro berth	-	-	-	-	-	-	-
Solid bulks without special facilities	-	-	-	-	-	-	-
Solid bulks with special facilities	-	-	-	-	-	-	-
Liquid bulks	140	-	-	-	-	140	-
Passengers	-	-	-	-	-	-	-
OTHER QUAYS							
Fish	-	-	-	-	-	-	-
Shipbuilding, repair and breaking up	-	-	-	1.001	-	1.001	-
Sundry	-	-	-	633	6.357	6.990	5.519
Total	**140**	**0**	**0**	**1.634**	**6.357**	**8.131**	**5.519**

Looking at the Table 2 it is apparent that the main port activity is that related with passenger traffic since Palma is a highly demanded touristic destination. During the last 5 years, an average of 515 cruise vessels have arrived at this port each year.

The second main port activities is that related with Ro-Ro operations to supply the island population with perishable goods moved from the Iberian peninsula on trucks. In 2017, a total of 145 Ro-Ro vessels arrived to Palma.

Table 2 shows that the total quantity of goods moved to the island has steadily increased during the last 5 years.

Table 2 – Port of Palma. Traffic statistics

	Cruise Passengers	Liquid Bulks	Solid Bulks	General Cargo	Total Goods	Containers
Year	**N**	**Tones**	**Tones**	**Tones**	**Tones**	**TEU**
2013	1.245.244	979.267	250.937	6.203.304	7.433.508	54.133
2014	1.336.437	999.374	204.739	6.582.546	7.786.659	56.755
2015	1.703.219	1.072.566	229.291	7.161.161	8.463.018	69.565
2016	1.630.381	1.013.649	296.895	7.688.224	9.003.381	98.304
2017	1.673.210	1.022.151	210.805	8.096.175	9.329.131	90.219

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2.1.2 Alcúdia

The bay of Alcúdia is located on the northern coast of the island of Mallorca. The port has two different areas: a commercial dock and a small craft dock, which is made up of a fishing quay and a marina. The port facilities also include a terminal for unloading coal and terminals for butane gas and propane. In addition, scrap and other recyclable materials are also loaded and shipped to other ports. In the following table, the total mooring length available at the port of Alcúdia is broken-down in terms of commercial activities and water depth.

Figure 6 – Port of Alcúdia

Table 3 shows the most important traffic is Ro-Ro, passengers' remain in the background in Alcúdia.

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Table 3 – Port of Alcúdia. Classification by uses and depths

	l.m. with depth (D)					Total (m.l.)	m.l. with D < 4m
	D ≥ 12	12 > D ≥ 10	10 > D ≥ 8	8 > D ≥ 6	6 > D ≥ 4		
PUBLIC							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	0	-
Containerised cargo	-	-	-	-	-	0	-
Ro-Ro berth	-	-	-	343	175	518	-
Solid bulks without special facilities		-	-	246	-	246	-
Solid bulks with special facilities	-	-	-	-	-	0	-
Liquid bulks	-	-	-	120	-	120	-
Passengers	-	-	-	110	-	110	-
OTHER QUAYS							
Fish	-	-	-	-	-	0	140
Shipbuilding, repair and breaking up	-	-	-	-	-	0	-
Sundry	-	-	-	-	-	0	145
Total	**0**	**0**	**0**	**819**	**175**	**994**	**285**
PRIVATE							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	-	-
Containerised cargo	-	-	-	-	-	-	-
Ro-Ro berth	-	-	-	-	-	-	-
Solid bulks without special facilities	-	-	-	-	-	-	-
Solid bulks with special facilities	-	-	-	-	-	-	-
Liquid bulks	-	-	-	-	-	-	-
Passengers	-	-	-	-	-	-	-
OTHER QUAYS							
Fish	-	-	-	-	-	-	-
Shipbuilding, repair and breaking up	-	-	-	-	-	-	-
Sundry	-	-	-	-	-	-	3.030
Total	**0**	**0**	**0**	**819**	**175**	**994**	**3.315**

Table 4 - Port of Alcúdia. Traffic statistics

	Cruise Passengers	Liquid Bulks	Solid Bulks	General Cargo	Total Goods	Containers
Year	N	Tones	Tones	Tones	Tones	TEU
2013	1.025	46.127	932.651	268.754	1.247.535	452
2014	1.058	48.428	990.624	436.745	1.475.797	775
2015	1.365	54.756	880.565	597.689	1.533.010	2.722
2016	5.901	47.337	1.061.908	703.625	1.814.893	4.133
2017	1.869	52.657	1.248.011	831.492	2.132.160	3.287

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2.1.3 Mahón

Mahón is the capital city of the island of Menorca; this city hosts the most important port of the island. Mahón is located on the eastern coast of the island and it has one of the largest natural harbours in the world, 5km long and up to 900m wide. The water is deep but it remains mostly clear due to it being slightly enclosed.

Figure 7 – Port of Mahón

In the port of Mahón, the most relevant traffic is passengers. The number of passengers have increased considerably in the last two years, although looking to the years before, the figures havehad ups and downs.

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Table 5 - Port of Mahón. Classification by uses and depths

	l.m. with depth (D)					Total (m.l.)	m.l. with D < 4m
	D ≥ 12	12 > D ≥ 10	10 > D ≥ 8	8 > D ≥ 6	6 > D ≥ 4		
PUBLIC							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	-	-
Containerised cargo	-	-	-	143	-	143	-
Ro-Ro berth	-	-	-	200	-	200	-
Solid bulks without special facilities		-	-	-	-		-
Solid bulks with special facilities	-	-	-	200	-	200	-
Liquid bulks	-	-	152	-	-	152	-
Passengers	-	-	898	-	-	898	-
OTHER QUAYS							
Fish	-	-	-	-	120	120	-
Shipbuilding, repair and breaking up	-	-	-	-		-	-
Sundry	-	-	-	-	443	443	3124
Total	**0**	**0**	**1050**	**543**	**563**	**2156**	**3124**
PRIVATE							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	0	-
Containerised cargo	-	-	-	-	-	0	-
Ro-Ro berth	-	-	-	-	-	0	-
Solid bulks without special facilities	-	-	-	-	-	0	-
Solid bulks with special facilities	-	-	-	-	-	0	-
Liquid bulks	-	-	-	-	-	0	-
Passengers	-	-	-	-	-	0	-
OTHER QUAYS							
Fish	-	-	-	-	-	0	-
Shipbuilding, repair and breaking up	-	-	-	-	-	0	-
Sundry	-	-	-	-	3851	3851	48
Total	**-**	**-**	**-**	**-**	**3851**	**3851**	**48**

Table 6 - Port of Mahón. Traffic statistics

	Cruise Passengers	Liquid Bulks	Solid Bulks	General Cargo	Total Goods	Containers
Year	**N**	**Tones**	**Tones**	**Tones**	**Tones**	**TEU**
2013	95.525	154.180	14.365	506.883	675.428	51
2014	79.089	177.166	16.065	545.044	738.275	357
2015	59.193	166.678	23.945	545.122	735.745	3.329
2016	72.165	173.008	14.775	479.375	667.156	5.739
2017	115.104	188.759	23.649	434.128	646.536	6.671

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2.1.4 Ibiza

Ibiza is the third largest island of the Balearic Islands. The Port of Ibiza is placed in the south of the island in the city of Ibiza.

The port consists of the "Botafoc" breakwater, which is used to discharge the fuel needed on the island and for large cruise ships to berth, as well as commercial and passenger quays. It also has several recreational docks with 1,400 moorings for pleasure boats.

Figure 8 – Port of Ibiza

Ibiza has registered a big increase of passengers' number during last five years. Ro-Ro traffic is the second traffic to take into consideration due to cars moved to the island for car rental companies.

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Table 7 - Port of Ibiza. Classification by uses and depths

	l.m. with depth (D)					Total (m.l.)	m.l. with D < 4m
	D ≥ 12	12 > D ≥ 10	10 > D ≥ 8	8 > D ≥ 6	6 > D ≥ 4		
PUBLIC							
COMMERCIAL QUAYS							
General cargo	-	-	-	162	-	162	-
Containerised cargo	-	-	-	-	-	-	-
Ro-Ro berth	-	-	574	298	-	872	-
Solid bulks without special facilities		-	-	-	-		-
Solid bulks with special facilities	-	-	-	200	-	200	-
Liquid bulks	196	-	152	-	-	196	-
Passengers	196	-	574	1161	60	1991	-
OTHER QUAYS							
Fish	-	-	-	-	249	249	-
Shipbuilding, repair and breaking up	-	-	-	-	-	-	-
Sundry	40	-	-	211	-	251	73
Total	**432**	**0**	**1148**	**1833**	**309**	**3723**	**73**
PRIVATE							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	0	-
Containerised cargo	-	-	-	-	-	0	-
Ro-Ro berth	-	-	-	-	-	0	-
Solid bulks without special facilities	-	-	-	-	-	0	-
Solid bulks with special facilities	-	-	-	-	-	0	-
Liquid bulks	-	-	-	-	-	0	-
Passengers	-	-	-	-	-	0	-
OTHER QUAYS							
Fish	-	-	-	-	-	0	-
Shipbuilding, repair and breaking up	-	-	-	-	-	0	-
Sundry	-	-	-	769	60	829	5703
Total	**-**	**-**	**-**	**769**	**60**	**829**	**5703**

Table 8 - Port of Ibiza. Traffic statistics

	Cruise Passengers	Liquid Bulks	Solid Bulks	General Cargo	Total Goods	Containers
Year	N	Tones	Tones	Tones	Tones	TEU
2013	191.814	245.062	101.295	1.514.319	1.860.676	6.749
2014	169.065	222.397	95.189	2.026.243	2.343.829	11.706
2015	193.484	230.756	63.931	2.185.702	2.480.389	13.790
2016	247.348	307.658	156.522	2.440.679	2.908.753	21.898
2017	340.334	289.789	115.084	2.595.313	3.000.186	20.313

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2.1.5 La Savina (Formentera)

The smallest of the Balearic Islands, Formentera also has the smallest port of those managed by APB: La Savina.

Despite this, the port has become essential and vital to the daily life of the island, since it is the only way passengers and good can access Formentera. Over a million people use the port every year. It caters for all needs, and has a 280 metres breakwater with quays for passengers and cargo, and mooring for recreational craft and fishing boats as well as a modern passenger terminal.

Figure 9 – Port of La Savina

La Savina practically have passenger traffic and general cargo for the goods supply to the island.

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Table 9 - Port of La Savina. Classification by uses and depths

	l.m. with depth (D)					Total (m.l.)	m.l. with D < 4m
	D ≥ 12	12 >D ≥ 10	10 > D ≥ 8	8 > D ≥ 6	6 > D ≥ 4		
PUBLIC							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	120	120	-
Containerised cargo	-	-	-	-	-	0	-
Ro-Ro berth	-	-	-	-	-	0	-
Solid bulks without special facilities		-	-	-	-	0	-
Solid bulks with special facilities	-	-	-	-	-	0	-
Liquid bulks	-	-	-	-	-	0	-
Passengers	-	-	-	-	134	134	368
OTHER QUAYS							
Fish	-	-	-	-	-	0	140
Shipbuilding, repair and breaking up	-	-	-	-	-	0	-
Sundry	-	-	-	-	-	0	-
Total	**0**	**0**	**0**	**0**	**254**	**254**	**508**
PRIVATE							
COMMERCIAL QUAYS							
General cargo	-	-	-	-	-	0	-
Containerised cargo	-	-	-	-	-	0	-
Ro-Ro berth	-	-	-	-	-	0	-
Solid bulks without special facilities	-	-	-	-	-	0	-
Solid bulks with special facilities	-	-	-	-	-	0	-
Liquid bulks	-	-	-	-	-	0	-
Passengers	-	-	-	-	-	0	-
OTHER QUAYS							
Fish	-	-	-	-	-	0	-
Shipbuilding, repair and breaking up	-	-	-	-	-	0	-
Sundry	-	-	-	-	-	0	1185
Total	**-**	**-**	**-**	**0**	**0**	**0**	**1185**

Table 10 - Port of La Savina. Traffic statistics

	Cruise Passengers	Liquid Bulks	Solid Bulks	General Cargo	Total Goods	Containers
Year	**N**	**Tones**	**Tones**	**Tones**	**Tones**	**TEU**
2013	1.066	-	10.301	243.704	254.004	184
2014	875	-	12.838	281.472	294.310	177
2015	1.587	-	18.003	240.653	258.657	234
2016	1.634	-	15.541	266.357	282.022	194
2017	0	-	13.101	287.692	300.793	272

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2.2 Stakeholder identification

In order to carry out a proper identification of stakeholders, firstly it is necessary to consider the main types of operations that take place in the APB ports. These are described in more detail later in section 2.3, which includes as well a list of companies in charge of these operations. However, the list below provides a short description of the main commercial services/activities that are supplied, as this will provide a context for identifying the main stakeholders, which are the companies providing these services, or services complementary to the first ones. These main services/activities are:

- *Passenger transport services:* mainly through ferryboats, which usually transport as well vehicles and cargo.
- *Freight transport services:* most of the freight transport is based on Ro-Ro cargo; there is no container cargo traffic. Three main types of Ro-Ro cargo can be considered: cars, trucks with driver, and truck platforms without driver. Besides, there is also a traffic of bulk materials cargo (solids such as grains, sand, gravel, etc. and liquids such as fuels).
- *Moorings management services:* Most of the mooring points in the APB ports are managed through licensing/concessions, although there is a portion of moorings directly managed by the APB (most of them for small vessels, less than 8 m length).
- *Vessels repair/maintenance services:* this is a service focused on recreational boats and specially luxury yachts, with increased relevance in the last years, mainly located in the port of Palma, although with plans of extending it to the ports of Mahón and Alcúdia.
- *Cruise ships services:* this is another service with significant growth in the last years, especially in the ports of Palma and Ibiza.
- *Fishing:* this activity has a decreasing share in the economy of islands. However, the APB still manages several facilities related to the fishing activities in the port.

In addition to the stakeholders related to the commercial services and activities within the port, it is important as well to consider the public stakeholders, which for the case of the APB are:

- The Spanish Port System "*Puertos del Estado"*: this is a central government agency answerable to the Ministry of Public Works, which is responsible for implementing the government's port policy, and is in charge of the coordination and efficiency control of 46 ports of general interest, managed by 28 Port Authorities (being the APB one of them). [2]. Besides, the agency has a representative in the APB board of directors.
- The Balearic Islands regional government: the regional government has the power for appointing the president of the APB, as well as 4 members of the board of directors (of a total of 12-15 members). Besides, they manage the public body Ports IB (*Ports de les Illes Balears*), which manage the ports that are not considered of general interest. There are different cooperation lines between the APB and Ports IB.
- The municipalities affected by the port servicing areas (Palma, Alcúdia, Mahón, Es Castell, Ibiza, and Formentera). On one hand, they are represented in the board of directors of the port authority. This representation can be direct through a representative of the municipality, or indirect through a representative of the *Consell Insular*, an intermediate public administration between the regional government and the municipalities, which encompasses each of the islands. On the other hand, the municipalities are public

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administrations that have to collaborate frequently with the port authority due to the interactions port-city.

- In addition to the mentioned public administrations, there is as well a representation in the board of directors of the Port Authority of the following entities, which are as well important stakeholders to be considered:
  - Chambers of Commerce.
  - Business organizations/associations. For instance, the association currently represented is CAEB (*Confederación de Asociaciones Empresariales de Baleares*).
  - Trade unions.
  - Other economic actors relevant for the port. For instance, the association currently represented is APEAM (*Asociación Provincial de Empresas de Actividades Marítimas*).

Lastly, the following ICT providers shall be mentioned, as they are providing two of the main ICT-related systems used by the port, as described later in detail in section 2.5.

- Prodevelop: they supply the Posidonia software solution for port operations management.
- IDASA Sistemas: they supply the Computerized Maintenance Management System (CMMS) that is being deployed by the APB (Rosmimam).
- MallorcaWifi.com: they manage the WiFi network that is later described in section 2.5.
- University of Baleares: although not an ICT provider, they are developing for the APB the air quality monitoring system also described in section 2.5.

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2.3 Port Processes description

In order to provide an overview of the main processes and services of the ports of Balearic Islands, a graphical representation of the process map has been created, which is shown in Figure 10.

The process map describes the activities of the stakeholders enumerated in the previous section in a general way, in order to cover the different ports of Balearic Islands.

Figure 10 can be considered more accurate for the case of the port of Palma because it is the port with more activities in its hinterland.

The subsections below provide more details about the different processes, which have been structured according to the classification contained within the Spanish ports law [1].

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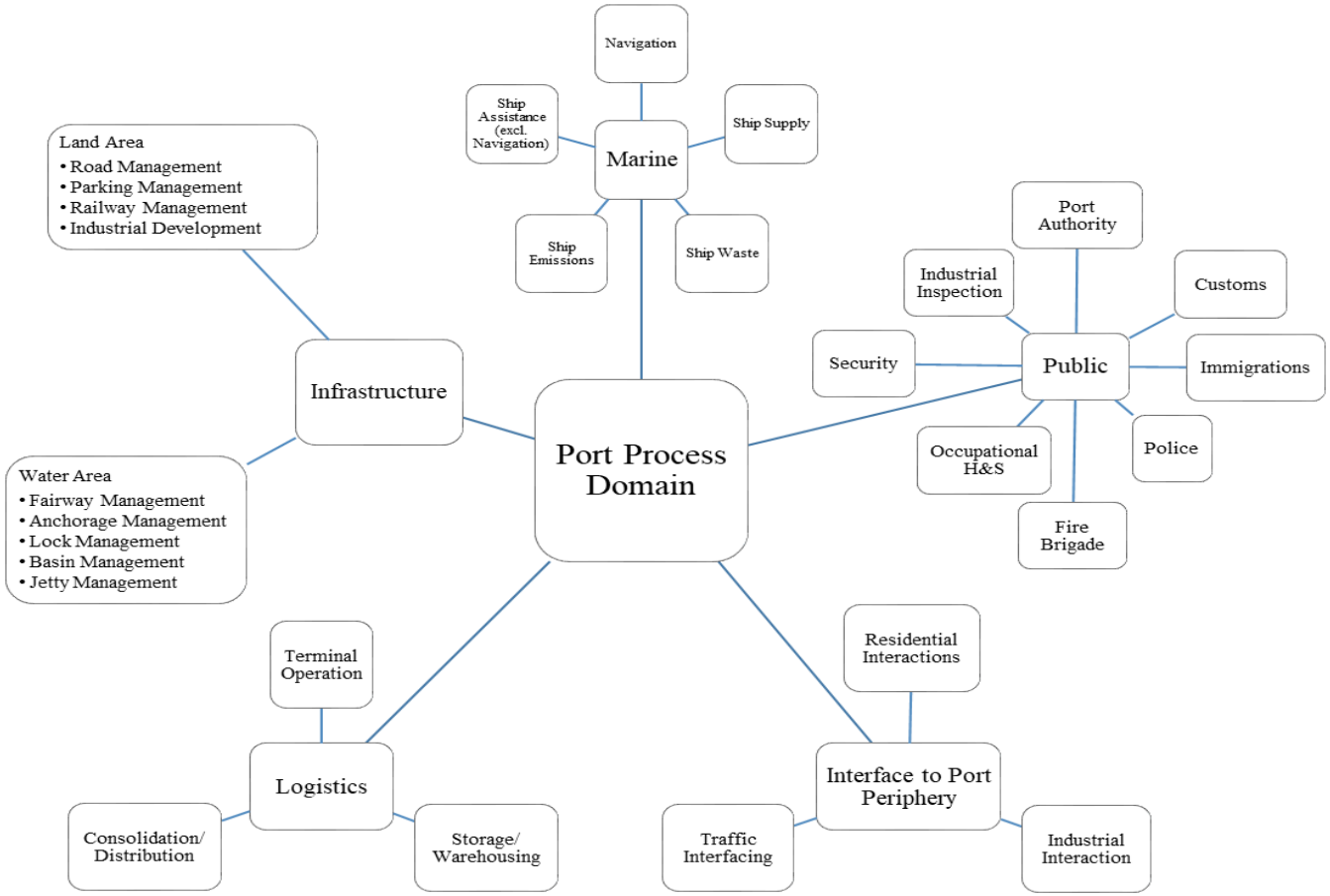

Figure 10 – Balearic Islands Ports Process Map

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As it has been remarked in the introduction, one of the most important cargo traffic in the ports Balearic Islands, especially in port of Palma, is Ro-Ro. Due to this fact, a specific map process for this type of cargo is presented in Figure 11.

The Ro-Ro process can be decomposed in the following operations:

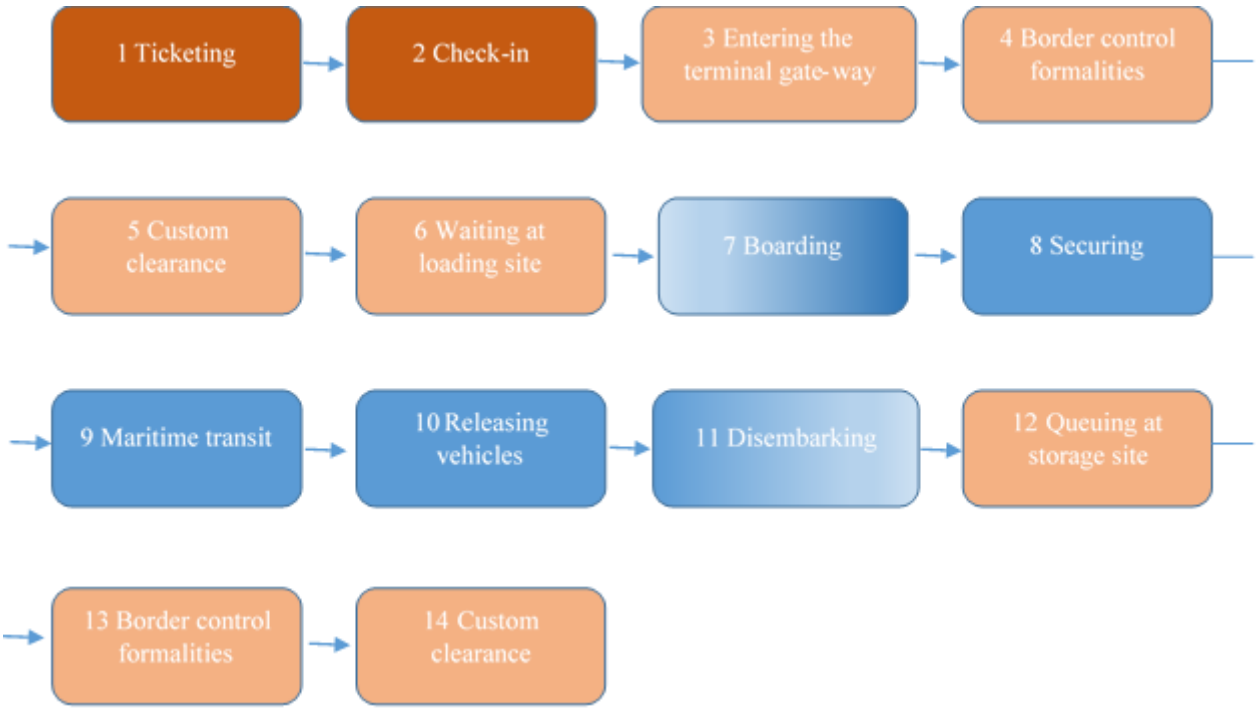

Figure 11 – Ro-Ro Process Breakdown

The operations represented by dark brown rectangles are carried out outside the terminal, while the remaining operations are carried out inside the terminal. Of the latter operations, those represented by light brown rectangles are carried out at the quay-yard, those represented by rectangles coloured in degrading blue are carried out at the quay-side, while those in the blue rectangles are carried out on the ship.

According to this decomposition of the Ro-Ro process, embarking and disembarking the vehicles can be seen as the main process consisting of three sub-processes: 1) vessel process 2) quay-side process 3) quay-yard process. Flows are referred to the information flow and vehicle flow. The flow of information illustrate the information exchange between actors, both internal and external.

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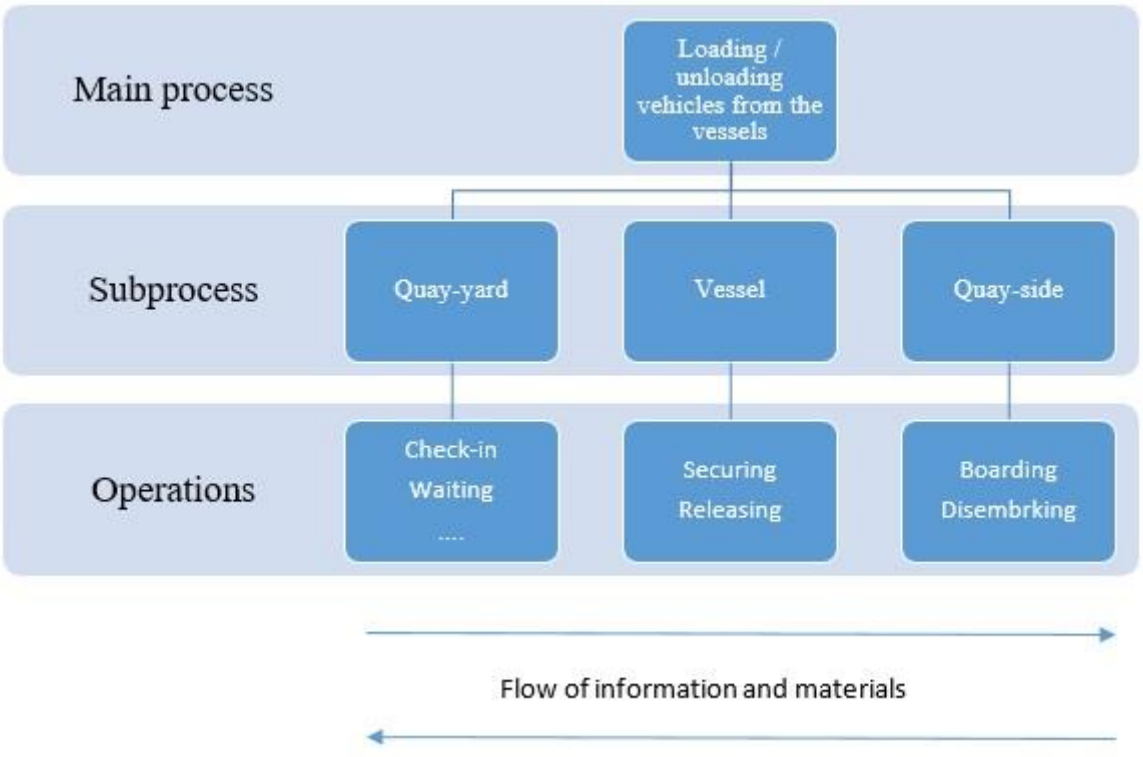

Figure 12 – Ro-Ro Process Hierarchy

2.3.1 General services

General port services are those services that port users benefit from without having to ask for them, as well as those necessary for the fulfilment of the functions of the Port Authorities. These services/processes are managed directly by the APB.

Main general services are:

- The service of ordering, coordination and control of port traffic, both maritime and terrestrial.
- Control, inspection and coordination of operations and activities that require authorization/licenses/concessions.
- The services of signalling, beaconing and other aids to navigation that serve for approximation and access of the vessels to the port, as well as the interior beaconing of the latter.
- The police service in the common areas (this refers specifically to port police services, without prejudice to the powers that correspond to other administrations).
- Lighting in common areas.
- Ordinary cleaning service of common areas of land and water. The cleaning of docks and esplanades following the operations of deposit and handling of freights are not included in this service.

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- Emergency prevention and management services, in the terms established by the civil protection regulations, in collaboration with the competent Administrations on civil protection, prevention and extinction of fires, rescue and fight against pollution.

2.3.2 Port services

Port services are the activities necessary for the operation of the ports aimed at making possible the operations associated with maritime traffic, under conditions of safety, efficiency, regularity, continuity and non-discrimination, and that are developed in the territorial scope of the Port Authorities. These services are usually managed by private entities with the corresponding licenses.

The following port services has been identified in the Ports of Balearic Islands:

- Technical-nautical services
  - Pilotage services

Table 11 - Balearic ports: Pilotages services

PORT	COMPANY NAME
Palma	Corporación de Prácticos de puerto de Palma
Alcúdia	Corporación de Prácticos de Alcúdia
Mahón	Prácticos de Mahón
Ibiza	Corporación de Prácticos del puerto de Ibiza
La Savina	-

  - Port towing services

Table 12 –Balearic ports: Towing services

PORT	COMPANY NAME
Palma	Remolcadores Nosa Terra S.A.
Alcúdia	Remolcadores Nosa Terra S.A.
Mahón	Remolcadores Nosa Terra S.A.
Ibiza	Remolcadores Nosa Terra S.A.
La Savina	-

  - Mooring/unmooring services

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Table 13 – Balearic ports: Mooring services

PORT	COMPANY NAME
Palma	Amarradores del puerto de Palma S.L.
Alcúdia	Servicios portuarios Alcúdia S.L.
Mahón	Astur Menorca
Ibiza	Amarradores y servicios de Ibiza S.L.
La Savina	-

- Passenger services, including:
  - Boarding/landing of passengers

Table 14 – Balearic ports: Boarding/landing of passengers

PORT	COMPANY NAME
Palma	Balearic Handing S.L. Intercruises Shoreside & Port Services S.L.U. Mediterránea 2000 Limpiezas y Servicios S.L.
Alcúdia	Balearia Eurolíneas Marítimas S.A. Balearic Handing S.L. Transmediterránea S.A. Intercruises Shoreside & Port Services S.L.U. Mediterránea 2000 Limpiezas y Servicios S.L.
Mahón	Transmediterránea S.A. Mediterránea 2000 Limpiezas y Servicios S.L.
Ibiza	Baleria Eurolíneas Marítimas S.A. Estaciones y Terminales Marítimas S.L.
La Savina	Balearia Eurolíneas Marítimas S.A. Balearic Handing S.L. Estaciones y Terminales Marítimas S.L.

  - Loading and unloading of luggage and passenger vehicles

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Table 15 – Balearic ports: Luggage and passenger vehicles services

PORT	COMPANY NAME
Palma	Balearia Eurolíneas Marítimas S.A. Transmediterránea S.A. Mediterránea 2000 Limpiezas y Servicios S.L.
Alcúdia	Balearia Eurolíneas Marítimas S.A. Balearic Handing S.L. Transmediterránea S.A. Intercruises Shoreside & Port Services S.L.U. Mediterránea 2000 Limpiezas y Servicios S.L.
Mahón	Transmediterránea S.A. Mediterránea 2000 Limpiezas y Servicios S.L.
Ibiza	Baleria Eurolíneas Marítimas S.A. Balearic Handing S.L. Estaciones y Terminales Marítimas S.L.
La Savina	Balearia Eurolíneas Marítimas S.A. Balearic Handing S.L. Estaciones y Terminales Marítimas S.L.

- Service of reception of waste generated by ships

Table 16 – Reception of waste

PORT	COMPANY NAME
Palma	Urbaser S.A. Serviport Balear S.L. Servmar Balear S.L.
Alcúdia	Urbaser S.A. Serviport Balear S.L. Servmar Balear S.L.
Mahón	Urbaser S.A. Serviport Balear S.L. Servmar Balear S.L.

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Ibiza	Herbusa S.A. Urbaser S.A. Serviport Balear S.L. Servmar Balear S.L.
La Savina	-

- Service of fuel provisioning for the ships

Table 17 – Balearic ports: Fuel provisioning services

PORT	COMPANY NAME
Palma	Compañía Española de Petróleos S.A. Disa Península S.L.U. Galp Energía España S.A.U. Repsol Comercializadora de Productos Petrolíferos S.A. Shell España S.A.
Alcúdia	Galp Energía España S.A.U. Repsol Comercializadora de Productos Petrolíferos S.A.
Mahón	Repsol Comercializadora de Productos Petrolíferos S.A.
Ibiza	Compañía Española de Petróleos S.A. Repsol Comercializadora de Productos Petrolíferos S.A.
La Savina	Petrofor S.L. Repsol Comercializadora de Productos Petrolíferos S.A.

- Freights handling service, including loading, stowage, unloading, maritime transit and the transhipment of goods
    - Service of transhipment of goods

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Table 18 – Balearic Ports. Transhipment of goods service

PORT	COMPANY NAME
Palma	Balearía Eurolíneas Marítimas S.A. Transmediterránea S.A. Hered. De P.J. Pujol Nicolau S.L.
Alcúdia	Transportes Marítimos de Alcúdia
Mahón	Agencia Melia Vives S.L. Federico J. Carmona Tremol S.L.
Ibiza	Balearía Eurolíneas Marítimas S.A. Transmediterránea S.A. Transcoma S.A.
La Savina	-

2.3.3 Commercial services

Commercial services are activities of commercial nature that, not belonging to the category of port services described in the previous section, are linked to port activity. They are usually managed by private entities with the corresponding licenses.

Some examples of commercial services that Balearic Ports provided are:

- The operations of delivery and reception of freights, deposit, removal and transfer of any kind, as well as any others that are not included in the freights handling service, as defined within the Port Services subsection.
- Consignees acting as intermediaries in representation of ship operators.
- Customs offices for declaration/inspection of imported/exported goods.

2.3.4 Maritime signalling services

The purpose of the maritime signalling service managed by port organizations is the installation, maintenance, control and inspection of visual, acoustic, electronic/radio devices, active or passive, designed to improve the safety of navigation and movements of ships in the coast, and, where appropriate, confirm the position of the ships in navigation.

This service excludes the signalling/beaconing for approximation/access of vessels to the port, and the interior beaconing of the latter (which has been previously described as a general port service).

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2.4 Hinterland transportation and urban environment

The relationship between the different APB ports and their surrounding urban environment and hinterland is specific for each port, although there are some commonalities. Due to its size, the most relevant case of study is the Port of Palma. This is a port completely integrated in the urban environment of the city of Palma de Mallorca, covering most of the city coastline, just in front of the old town. Due to its location, the port of Palma has constantly struggled with space limitations, and many areas of the port had to be reclaimed from the sea in the past, such as the water front promenade, which connects the entire port from one end to the other.

Although there are some railway lines in the island of Mallorca, these are not connected with the port and are exclusively devoted to the transportation of passengers, so the transportation of port freights to and from the island rely exclusively on road transport. This is the same case in the rest of APB ports, as the other Balearic Islands have no railway transport at all, and the only transport link between each port and its surrounding hinterland is road transport. It shall be noted that due to the fact of being insular ports, all APB ports are crucial for the supply of all types of goods to the islands, 99% of the supplies to the islands arrive through the APB ports, and only the remaining 1% arrive through air transport.

As previously mentioned, the waterfront promenade (*Avinguda de Gabriel Roca*) links the two ends of the port of Palma, and from these two ends there are links to the West and East highways of the island (Ma-19 and Ma-1 respectively) (see Figure 13), as well as to the ring highway that surrounds the city of Palma, the Ma-20. These three highways articulate the transport across the three municipalities of the Bay of Palma (Palma, Llucmajor, and Calviá), which concentrate 60% of the island population, as well as more than 80% of hotel beds [3], and are therefore the main receptors of the goods supplied to the island.

Besides, there is another important transport axis, the Ma-13, which goes to the north of the island, and can be reached from the previously mentioned ring highway. The Ma-13 links other municipalities with high population density, as shown in Figure 14.

Therefore, from the port it is easy to reach the main highways of the island. However, as can be expected, before they reach these highways, all the trucks and rest of vehicles coming from or going to the port contributes to the intense traffic in *Avinguda de Gabriel Roca*, which has an impact on the city in terms of air pollution and noise.

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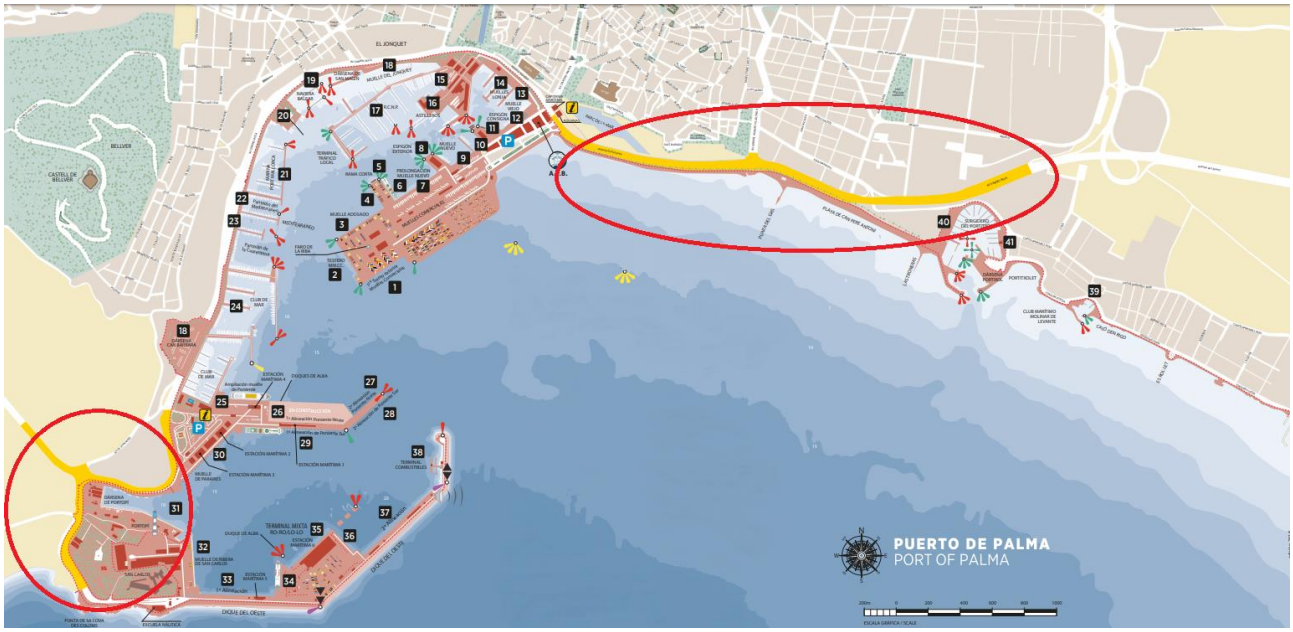

Figure 13 – Main road links in the port of Palma

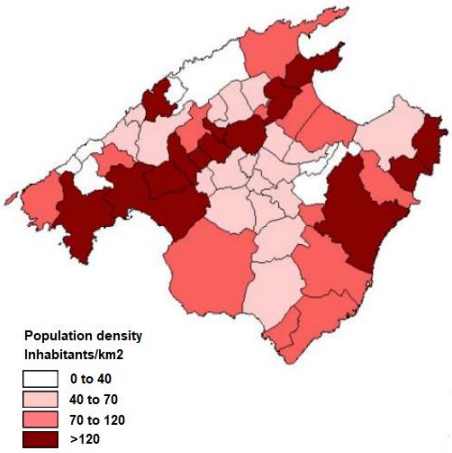

Figure 14 – Distribution of population on the island of Mallorca by municipalities [3]

As it was mentioned in the ports introduction, the growth of the cruise sector in the last years has generated controversy in certain segments of the population of Palma, who have a negative perception of this type of activity. This perception derives both from the potential impact of the cruise ships in terms of air pollution/noise, and from the potential impact of cruise passengers crowds on the urban and economic landscape of the city. In order to handle this impact, the APB is developing projects for air quality monitoring, and for monitoring of people density/people flows in the city (the latter in collaboration with the municipality, a screenshot of this project is displayed in Figure 15). Both projects are explained in more detail in section 2.5.

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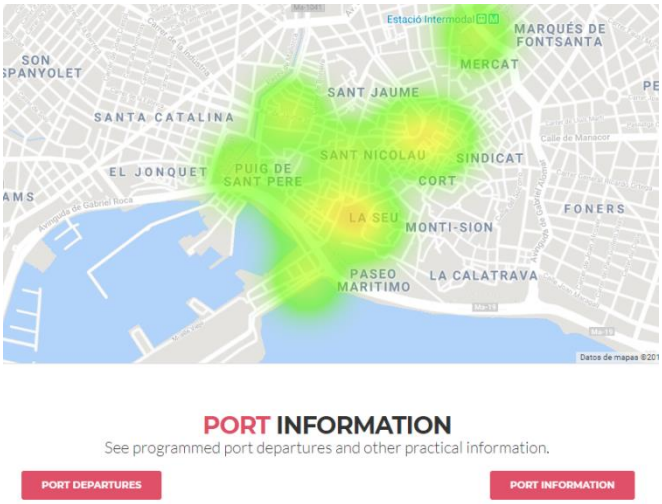

Figure 15 – Crowds monitoring system in the city of Palma

The main transport link of the port of Alcudia with its hinterland is the highway Ma-13, which has been mentioned previously. However, the highway does not reach Alcudia, instead there is a section of about 13 km with a single carriageway in each direction linking the end of the Ma-13 highway with Alcudia. In relation to its activities, the most relevant relationship between the port and the hinterland is the supply of coal to a power plant close to the port, *Es Murterar*, which is one of the main energy generation sites of the island (see location in Figure 16). The coal unloading operations in the port generates an impact on air quality, which can worsen depending on the meteorological conditions. The APB wants to address this problem by controlling the coal unloading operations, which would be postponed in case of adverse meteorological conditions.

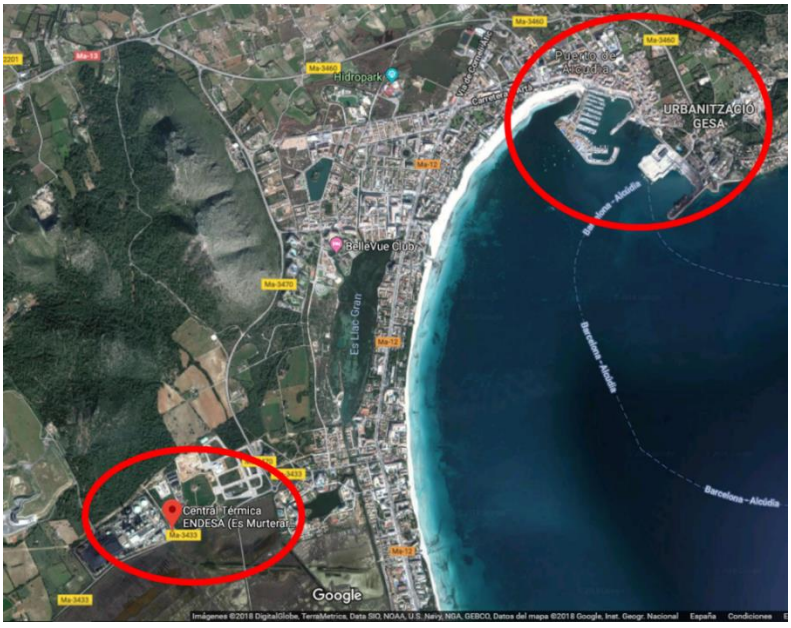

Figure 16 – Location of thermal power plant *Es Murterar* in relation to the Port of Alcudia

In the case of Ibiza, the transport network is composed almost exclusively of roads with a single carriageway in each direction, except for the C-731, that links Ibiza with the city of Sant Antony, and the E-20, which is a ring road in the city of Ibiza that links the city with its airport. The port of Ibiza

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has good connections to the latter through roads and streets that also have two lanes in each direction (see Figure 17). However, it shall be noted that in certain oldest areas of the port the road layout is strongly conditioned by the design of the docks serviced by it, and share the function of access to both the port infrastructure, and the surrounding urban area. This sometimes causes interferences between the areas for loading/unloading operations, and the areas for port and urban access. Besides, the traffic of vessels for passengers and cargo, especially of large ferryboats, originates important concentrations of heavy vehicles, which frequently keep the engine running during more than one hour in order to keep the temperature of their load until the vehicle embarks on the ship. This causes disturbances on the environment in a centric area of the city. This phenomenon is further exacerbated in the morning hours, when the ferryboat traffic overlaps with the traffic supplying the surrounding urban area, and especially in summer, when there are much larger volumes of rolled merchandise [4].

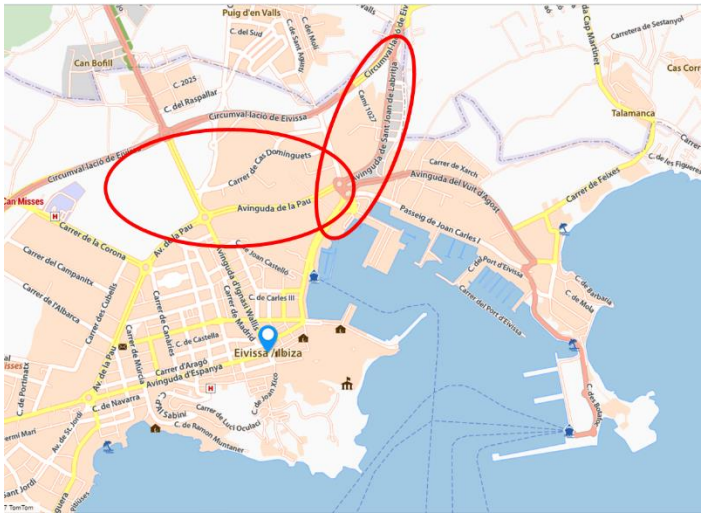

Figure 17 – Connections of the Port of Ibiza with the city ring road

In the port of Ibiza, similar to the case of Palma, there is concern in certain population segments about the potential negative impact of cruise ships on the city and on the island, as the number of these ships has increased dramatically in the last years. This has originated occasional popular protests against cruise ships interference in the city social and cultural life [5]. The APB plans to address this issue in a similar way as in Palma, through air quality and crowds monitoring systems.

Regarding the port of Mahón, as the island of Menorca has a population density considerably lower than Mallorca and Ibiza, it has a less developed road network, with hardly any section with dual carriageway in each direction. However, it shall be highlighted that as this port is located in one of the largest natural harbours in Europe (with a length of more than 6 km), there is a large interface area between the port and the city. Another important aspect is that the activities of the port in the last years have been affected by the growth of another port located in the opposite end of the island, the port of Ciutadella (not managed by the APB), which has been enlarged in recent years. Probably linked to this fact, the port of Mahón has not experimented a significant increase in its activities during the last years (e.g. in No. of tons of total traffic) unlike Palma or Ibiza. This led the APB, together with the municipalities of Mahón and Villacarlos, to prepare in 2016 a document for prioritizing the actions to mitigate the negative trends of the last years, so that the port can become again a main economic and social driver of both the city and the island [6].

Lastly, the port of La Savina is the smallest of all the ports of the APB, and it is crucial for the island of Formentera as it is its only entry point of supplies and for maritime transport connections, which

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are almost exclusively with Ibiza, except for seasonal connections with Denia (in the Iberian Peninsula). That means that to reach Formentera, travellers (both tourists and residents) have to make a stopover in Ibiza. Usually they reach Ibiza by plane, and then arrive in Formentera through the maritime connection. The port of La Savina has practically reached its maximum size and cannot be further enlarged as it is constrained the two natural lagoons of the island and the natural area of Ses Salines. Anyway, tourism virtually collapses the island in the high season, so an enlargement of the port would probably exacerbate the problem [7]. As it could be expected, the transport network in the island is the less developed of all Balearic Islands, consisting of narrow roads and paths, which has influenced on the predominant vehicles in the island, mainly small cars, and above all light vehicles such as motorcycles, bicycles, and quad bikes.

2.5 Port systems description

The Port Authority is currently carrying out a global digitization initiative that is transforming the ecosystem of ICT-related systems used by the port. The main objectives of the initiative are the reduction of paper use in port processes, and the interconnection between different systems.

The main information and monitoring/control systems available at the port are:

- ***Posidonia* Port management system:** Within the mentioned digitization initiative, the port management software *Posidonia* can be considered as the cornerstone, as all other systems in the port shall be able to interoperate with it in order to exchange information. This software has been deployed by other Port Authorities, so it is not a custom development, but specific configurations and integrations with other systems have been carried out according to the needs of Baleares Port Authority. The system encompasses several functionalities, namely:
  - Invoicing services for vessels
  - Management of stopovers. For this functionality, the Posidonia system is interconnected with the AIS (Automatic Identification System) described below.
  - Management of the public domain (i.e. licensing the use of the public domain of the port, e.g. for the organization of specific nautical trade fairs)
  - Management of the moorings under the direct administration of the Port Authority

  Furthermore, *Posidonia* is already integrated with the following systems:
  - Document management system (described below)
  - Electronic site
  - Electronic signature
  - Readings from meters (electricity, water)
- **Document Management System:** This is another important port system that integrates (or is planned to be integrated) with several other systems in the port.
- **Electronic Site:** This is the Port Authority's public web portal, through which port users can carry out different administrative procedures, namely:
  - Tendering processes

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  - Requests/applications
  - Collection of penalties
  - Other administrative procedures
- **ERP (Enterprise Resource Planning):** A standard ERP system used mainly for accounting and billing purposes.
- **SAMOA:** A system developed within the framework of a project co-financed by the Spanish Port System and several Spanish Port Authorities. The acronym stands for *"Sistema de Apoyo Meteorológico y Oceanográfico de la Autoridad Portuaria"* (Oceanographic and Meteorological Support System of the Port Authority), and its aim is to provide each port with oceanographic and meteorological information customized and adapted to its needs. The system consists of advanced instrumentation, prediction systems, and specific modules for exploitation of the information.

- **Fleet Management System:** The Port Authority has around 100 vehicles equipped with a geolocation system, although the information provided by the system is currently scarcely used.
- **Building Management Systems (BMS):** Some port buildings such as the maritime stations are equipped with a KNX-based, BMS which enables automated control of the HVAC systems in those buildings. Besides, this control system is integrated with Posidonia, which allows interactions such as the automated operation of HVAC system when a vessel is going to call at the port.
- **Computerized Maintenance Management System (CMMS):** the Port Authority is currently implementing this system, which allows managing port assets, including its location information, technical features, and maintenance information (including maintenance historic data). The system supports the implementation of corrective and preventive maintenance strategies. The plan is to complete the deployment of this system at all ports in Baleares by March 2019. There are plans to integrate this system with BIM in the future. Besides, it is expected that once a database with maintenance data is populated with enough data, it will be possible to implement predictive maintenance strategies.
- **Port Control Centre:** Each port has its own Port Control Centre, and the architecture differs from one port to another due to the different systems available at each port, and due to different timing of actuations carried out to modernize them. For instance, the Port of Ibiza has a more recent control centre that allows remote tele-operation of the installations, a functionality still pending to be implemented in the port of Palma. In the case of the port of Palma, the operators have several separated screens/control systems, namely:
  - AIS screen for visualizing vessels information and position.
  - Screen for the Posidonia system and other applications.
  - Camera management + video wall.
  - Phone-based control system for activating access barriers to the docks.
  - Fire alert system + Public address system (speaker system)

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- Communication network nodes monitoring system (intrusion detection, smoke/flood detection, loss of connectivity alerts).

- **Lighting control:** The Port Authority is developing different projects for more efficient management of lighting systems.
- **Mooring operations monitoring:** this system is deployed only at the Port of Ibiza.
- **Air quality monitoring system:** an air quality monitoring system has been deployed at the Port of Palma and there are plans to replicating the system in the rest of Balearic ports. The parameters monitored are noise levels, PM levels, other pollutants, and meteorological data. The main aims of this system is the analysis of port operations (e.g. arrival of cruise ships, coal unloading operations, etc.) on air quality and noise in the city.
- **WiFi network and presence monitoring:** a WiFi network deployed by Palma Municipality covers the whole port area (the Port Authority allowed the installation of antennas within the port public domain) as well as other key areas of the city, being the largest free WiFi area in Europe. Based on this deployment, a project has been developed that, through the detection of the WiFi-enabled devices in the network area, is capable to infer the number of people in the area and thus generate heat-maps for visualizing people density in different city areas. The purpose of this is to help visitors to avoid the most crowded areas, and recommend them places to visit based on real time occupation.

The figure below intends to provide an overview of the main port systems and assets, and how they interrelate or could be linked with the ICT systems described above, in order to implement a smart port vision.

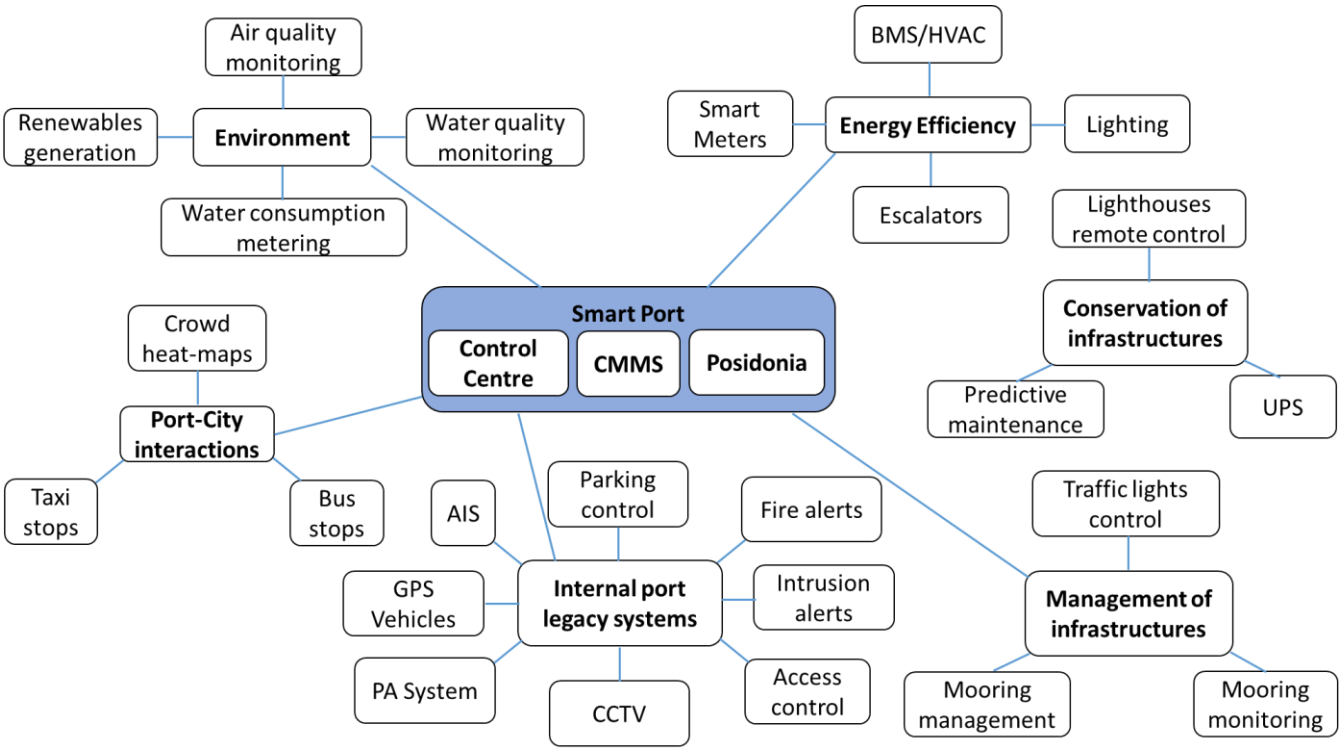

Figure 18 – Map of port assets and ICT systems

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From the information provided, a first conclusion is that the APB is making a huge effort for deploying several systems in order to obtain more insight into its processes and assets, such as the air pollution monitoring system, or to automate their control, such as the KNX-based system for HVAC control in buildings. Another important aspect related to control functionalities is the interest of the APB to be able to operate port assets remotely through from the Control Centre. This concept has been already implemented in the Port of Ibiza, and will be extended to the rest of the ports.

Furthermore, the APB is taking care as well of ensuring interoperability between systems, so that they are able to exchange information among them. In relation to this point, the Posidonia software seems to be destined to be the "central hub" with within all other port systems shall be able to exchange data.

However, in order to make the most from these investments, the APB has two main needs that can be addressed by PortForward:

- The interoperability and integration of data from multiple systems in a single platform has the inherent risk of overflowing platform users with data. Therefore, there is a need of providing these users with a unifying and intelligent interface that allows them to focus each instant on the relevant data and alerts coming from the different systems. This is of particular importance in the case of the ports' control centres, because according to the description provided, operators of these centres have to process the information coming from disparate sources.
- Furthermore, the interoperability and data exchange between the different systems will not provide an added value if it is not complemented with an intelligence layer capable of correlating different data sources and suggesting advanced control functions or support decision-making processes based on those correlations. An example of this would be the intelligent scheduling of coal unloading operations in the port of Alcúdia, which involves the intelligent processing of three different data sources: the air pollution monitoring system, the meteorological data, and the vessels operations data.

2.6 Expectations and goals

The APB approved towards 2016 a modification of its Corporate and Social Responsibility (CSR) policy. This policy is articulated into the main dimensions of sustainability: institutional, social, environmental, and economic.

2.6.1 Economic expectations and goals

In the economic dimension, the main expectations and goals of APB are:

- To manage the port based on criteria of optimization, profitability, efficiency, sustainability, and public service.
- To make responsible investments, looking for social and economic benefits, and protecting the general interest of the APB.
- To manage the public domain of the port according to planning instruments, providing support to private initiative.
- Promoting free competition.
- To encourage private investments.

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2.6.2 Environmental expectations and goals

The environmental dimension is crucial within the CSR policies of the APB. The main expectations and goals in this area are:

- To integrate environmental considerations in port processes related to operational and land planning, design and execution of infrastructures, and surveillance and conservation of the public port domain.
- To protect the heritage and available recourses.
- To protect the marine and port environment, including pollution prevention, and ensuring compliance with regulations and other requirements in all of its areas of influence.
- To make a rational use of the natural resources available, minimizing consumption, applying energy efficiency criteria, and preventing climate change.
- To foster continuous improvement and an adequate environmental performance in all port installations, acting as facilitators in the port community, giving support to the deployment of environmental management systems and creating awareness of port workers, clients and users, so that interest groups perceive APB ports as Green Ports.
- To collaborate with the rest of institutions in the elaboration of regulations supporting the improvement of the environment of the ports and their surrounding areas, within the port capabilities.
- To foster environmental training of APB staff.
- To establish communication and dialog channels with all interest groups, achieving a fluent and efficient communication in environment-related topics.
- To develop studies and research in topics related to port activities and environment protection, collaborating with other organizations.
- To foster that the innovation processes look for solutions that minimize the environmental impact of the port activities in the surrounding environment.

2.6.3 Social expectations and goals

Lastly, in the social dimension, the APB has set the following expectations and goals:

- To support training and professional development of all the people who integrate the institution, fostering work-life balance.
- To promote respect for diversity, favouring adequate conditions for the performance of teams with different capacities.
- To support equal rights of men and women through the deployment of measures agreed upon in an Equality Plan.
- To foster safety and health of all people working in the ports, with the permanent objective of improving the working conditions, reducing accidents at work, and fostering a prevention culture in all port-related companies, according to the commitments contained in the Occupational Hazard Prevention Policy.

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- To facilitate the performance of activities of social interest in the public domain, as long as they are compatible with port activities. In this area, the port public domain hosts every year several social, cultural, sport, and religious events.

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3 Port of Vigo

3.1 Port introduction

The Port of Vigo (APV) is the largest container port in the Atlantic coast of Spain. It is an excellent natural port, located in the northwest of the Iberian Peninsula.

With more than 14,000 ha of harbouring waters, Port of Vigo is sheltered from adverse weather conditions by the Cíes Islands and the Morrazo peninsula, which makes it functional and available 365 days of the year and it is considered a highly safe Port.

The terrestrial surface of the Service Zone of the Port of Vigo reaches an area of 2,572,577 m2 in five municipalities. On the left bank of the Estuary, the Service Zone extends throughout the municipalities of Vigo and Redondela. On the right margin (north), along the municipalities of Vilaboa, Moaña and Cangas. However, most of the infrastructure and port facilities for the transport of goods and passengers and fishing are in the municipality of Vigo.

The port system corresponds to a Landlord management model, in which Port Authorities provide a Port public domain and develop basic infrastructures, leaving to the private enterprises the lending of the Port services.

Port of Vigo is the first port in Europe in fresh fish traffic and the fourth of the Iberian Peninsula in container exports-imports. The container terminal, given in concession to Termavi, has 762 m of berthing line, a depth over 17 m, and a depot area of more than 180,000 m^2.

The main areas of the port are:

- **Dock of Bouzas:** there is the largest port terminal space and industrial facilities in operation in the Port of Vigo, with an area of 862,354 m^2. It is divided into 2 main areas, which are:
    - **The Ro-Ro Terminal**, which is a terminal specializing in general merchandise RO-RO traffic, that is to say, whose operation is carried out by rolling means. It has five fixed ramps and one movable for berthing of ships and an annexed surface of discovered storage of approximately 400,000 m2. The terminal has a direct link by road and highway.
    - **Repair Dock,** in addition to the berthing line available for vessels that have to make repairs afloat, this dock has an area of more than 200,000 m2 for ships dedicated to ship repair and construction, as well as the auxiliary sector of the shipyards, located in its vicinity. In the dock that forms this great dock, also stand the docks of provisioning.
- **Port area of Orillamar:** this is the location of the shipyards. Vigo is considered one of the main nodes of ship manufacturing at an international level. Although in this area of Beiramar there are 6 main shipyards, the sector has 36 tiers distributed on both banks of the estuary. In total, 16 dry docks are located in the port's service area.
- **Fishing port:** is the origin of the seafaring activity of the city, with a land area of 241,238 m^2, it is an economic engine in itself, considered one of the first fish trading ports of fish for human consumption in the world, generates employment in the city of Vigo and its area of influence of 15,000 jobs, in extractive, commercializing, processing, transforming and distributing merchandise activities. The current structure of the Fishing Port includes four docks (unloading, provisioning, stay, repairs, etc.), an area of nurseries, another of

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refrigerators and five fish markets: from Altura, Bajura and Grandes Peces, from Litoral, from Seafood and the Digital Fish Market.

- **Transatlantic:** this is a privileged space of encounter between the city and the more than 200,000 tourists who arrive annually to Vigo thanks to the cruise traffic.
- **Comercio**: its central part is destined to a second cruise terminal, called the "Tinglado del Puerto", to complement the offer of berthing line for cruises and be able to attend multiple scales in the best conditions. This dock, also has spaces enabled for the storage of general merchandise, which facilitates its versatility and its suitability for berthing and operational vessels with general merchandise and project charges.
- **Tranversal:** dock equipped with 3 alignments, where mainly raw granite blocks and other conventional general merchandise such as wood, minerals and salt are handled.
- **Arenal:** divided into two alignments; one of them destined to general merchandise with 292 m; and the other with 231 m, intended for bulk, both liquid and solid. It has several special facilities, as well as 1 warehouse for salt, 1 tank for supplying fuel to ships, and the Border Inspection Post (PIF).
- **Guixar:** it is specialized as a container terminal with a total dedication of its surface, which is granted in concession to the company Termavi. The Guixar terminal has a berthing line of 762 m. and a draft greater than 17 m. These characteristics and its surface area of deposits, which exceeds 180,000 m2, make it the main container terminal in Galicia. More details about this key area of the port are provided below.
- In the remaining public domain, a series of concessions are located, which are mainly refrigeration facilities dedicated to fishing traffic and naval construction and repair facilities, with numerous beaches that are excluded from the port area.

Container terminal management is highly automated and managed by advanced software systems, focusing mainly on the management of 20- and 40-foot containers. Due to the traffic characteristics of the port of Vigo, the Guixar terminal specializes in refrigerated Reefer containers, with more than 1,300 current intakes inside the terminal, although, of course, all types of containers are operated.

Its basic facilities are the five large portainer cranes of different ranges, Feeder, Panamax, Postpanamax and Superpostpanamax. In addition, seven transtainers of 40 t and nine reach stacker of 45 t.

A fundamental value of this Terminal is given by the intermodality provided by the direct access with highway and motorway and the ADIF railway terminal, adjacent to its container yard, being thus effectively connected with north, south and central Spain, as well as with Portugal.

Another key piece of the Port in this area is the Scanner of control and monitoring of containers by X-rays that reinforce the security of the entire Port and its traffic.

The area of the port used for the temporary storage of containers between land and sea transportation is known as the storage yard. Within the yard, containers are stacked on top of each other in stacks within horizontally aligned storage zones. Stacking containers within the terminal is designed to optimise yard capacity and to distribute workload evenly between yard cranes.

Common practice among container terminals is to separate the storage of import, export and empty containers within the yard and minimise stacking heights.

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The Container Terminal showed last year a diesel oil consumption of 678,222 litres, and the total electricity consumed was 577,849 kWh.

Yard Scheduling decisions aim to improve and enhance current management and scheduling processes for three key port areas/assets: the storage yard, the yard cranes and the Internal Movement Vehicles or IMVs.

Yard Space Allocation

The storage yard is one of the most important (and complex) features of a container terminal. At the Port Of Vigo, the container terminal has a storage with a total capacity per year of 350,000 TEU (the average movement of containers in the last years has been around 220,000 TEU). To achieve this figure, additional yard capacity has been created by increasing the maximum stacking heights of containers within stacks to 4/5 levels at the Rubber Tyred Gantry (RTG) lanes, and 5/6 levels at the Fork park (area of the yard dedicated to empty container storage). However, increased lane heights can result in additional yard workload through the creation of unproductive shuffling moves when accessing bottom containers from lanes within container stacks.

Yard Crane Management

Within the industry, there are many different types of yard cranes used to operate the storage yard. Most of the cranes used at APV are RTGs, which are capable of travelling between zones and thus offer great flexibility. The RTGs typically operate areas of the yard allocated to the storage of full containers. Fork parks are operated by specialised Empty Container Handling equipment (called ECHs or Forks). These trade lifting capacity for increased performance and lower purchasing and operating costs.

IMV Scheduling & Deployment

IMVs form an essential link in the flow of containers on the terminal. They shuttle containers between the storage yard and vessel, rail and warehousing operations. The allocation of IMVs needs to be carefully managed. Too many IMVs within an area can result in queuing and congestion, whereas too few can result in crane under-utilisation and thus poor performance.

Figure 19 - Overview of Port of Vigo

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3.2 Stakeholder identification

There is a large group of social, economic and administrative groups that are related to the activity that takes place in the Port of Vigo. It is essential for the Port Authority to identify these groups, characterizing their expectations regarding the Port Authority, assessing the relative importance of each of these groups and defining possible communication or participation frameworks with each one of them.

The main stakeholders in the Port of Vigo are:

- Public Administration:

  ADIF / Aduana de Vigo / Aguas de Galicia / Capitanía Marítima / Consellería de Cultura, Educación e Ordenación Universitaria / Consellería de Economía, Emprego e Industria / Consellería de Medio Ambiente / Consellería do Mar / Diputación de Pontevedra / GAIN / IEO / IGAPE / IGVS / INEGA / Puertos del Estado / Secretaría Xeral para o Deporte/ Inspecc. Sanidad Animal / Inspecc. Sanidad Vegetal / SOIVRE / Turismo de Galicia / Turismo Rías Baixas / Cámara de Comercio / Fundación Deporte Galego / Parque Nacional Illas Atlánticas / Ayuntamientos de Vigo, As Neves y Salvaterra de Miño / AtlantTIC (UVigo) / Atlantic Action Plan Support Team – National Unit for Spain / CZFV

- Principal Customers

  AGAN+ / CONXEMAR / Cofradía Arcade / FUNDAMAR / GAC 7 / ACEMIX / ACLUNAGA / AGARBA / ANFACO – CECOPESCA / ARVI / ASETRANPO / ASIME / Asoc. Provinc. Vendedores y Consignat. De Pescado / GRI Wind Steel Galicia / ATC / ATEIA / Clúster del granito / Logidigal / PYMAR / ACOESPO / ACOPEVI / PSA Peugeot Citroën

  PIF / Gefco / Incargo Galicia / UECC / FUPV / Termavi / Termicar / Transglobal / Vigo Cruise Terminal / Bergé Marítima / E. Durán Shipping / Suardíaz / Kaleido / Liceo Bouzas / Marina Davila / Perez & Cía / Pescanova / Pesquera Ancora / Punta Lagoa / RC Naútico

- Suppliers

  AGEINCO / SAGEP / RENFE / ICSEM / Inova Labs / FEMXA / Infocrucero / INSTRA / Magallanes Renovables / Marexi / Norvento / ABANCA / Escuela de negocios Afundación

- Technology centres, Universities

  AIMEN / CETMAR / CSIC-IIM / INTECMAR / CTAG / Energy Lab / GRADIANT

  Inst. Estudios Vigueses / Inst. Politécnico Marítimo Pesquero / Inst. “Salvador de Madariaga”

  Campus do mar / Facultad Bellas Artes / Universidad Vigo

- Employees

  Autoridad Portuaria, ITF, Rosa dos Ventos, Sindicatos

- Other agents of society

  APIT Galicia / Asociación Taxis / BUXA / Museo ANFACO / Museo do mar / CC A Laxe / MERCACEVI / Ponle cara al turismo / RC Travel / Asociaciones vecinales

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3.3 Port processes description

The Port Authority of Vigo is a public administration with its own legal personality and assets, which is responsible for the administration, management and operation of the Port of Vigo. It depends on the Ministry of Development, through Ports of the State, and from the legal point of view is governed by its specific legislation, by the provisions of the General Budgetary Law that are applicable and by Law 6/1997, of 14 April, Organization and Operation of the General State Administration. Its specific regulations are specified in Royal Legislative Decree 2/2011 of September 5, which approves the Consolidated Text of the Law on Ports of the State and the Merchant Navy.

The management model followed by the Port Authority of Vigo is known as "Landlord Port". The Port Authority provides port space and infrastructure and regulates the operations carried out in the port, but does not provide port or commercial services, which in general are provided by private operators, with means that do not belong to the Port Authority. The Port Authority of Vigo has the competencies defined in article 25 of Royal Legislative Decree 2/2011.

Regarding financing, it should be noted that the Port Authority of Vigo is economically self-sufficient. With its own resources, generated mainly by the application of occupancy, activity and utilization fees, it must face its expenses and investments with a minimum required return, without having to resort to the general budgets of the State.

The port activity shall be developed in a framework of free and fair competition between service operators in ports of general interest.

Following the same approach as in the case of Port of Baleares (since Vigo is also a Spanish port), the port services can be classified according to the categories contained in the Spanish Ports Law [1]:

- General services.
- Port services.
- Commercial services.
- Maritime signalling service.

3.3.1 General services

General port services are those services that port users benefit from without having to apply, as well as those necessary for the fulfilment of the functions of the Port Authorities. The types of general services identified in the Spanish ports law have been already described in section 2.3.1.

The Port Authority of Vigo is responsible for the provision of these general services, notwithstanding that its management can be entrusted to third parties when security is not jeopardized or does not imply the exercise of authority. General services will be provided in accordance with the standards and technical criteria set forth in the Operating and Police Regulations, as well as in the Port Ordinances.

3.3.2 Port services

Port services are the rendering activities that are necessary for the operation of the ports aimed at making possible the operations associated with maritime traffic, under conditions of safety, efficiency, regularity, continuity and non-discrimination, and that are developed in the territorial scope of the Port Authorities.

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The following are considered port services:

- Technical-nautical services: Pilotage Service, port-towing service and mooring and unmooring service.
- Passenger service, which includes: passenger boarding and disembarkation, loading and unloading of luggage, and passenger vehicles.
- Service of reception of waste generated by ships, which includes: the reception of waste and residues of Annexes I, IV, V or VI of MARPOL 73/78.
- Merchandise handling service, consisting of loading, stowing, unloading, unloading, maritime transit and the transhipment of merchandise.

The provision of port services will be carried out by the private initiative, governed by the principle of free competition. It will require obtaining the corresponding license granted by the Port Authority, which can only be granted upon approval of the corresponding Specification of Particular Requirements for the corresponding service.

3.3.3 Commercial services

Commercial services are commercial activities that, not having the character of port services, are linked to port activity. They will be lent in concurrency regime. It will require obtaining authorization from the Port Authority. The provision of the same, must conform to the particular conditions determined by each Port Authority, as well as other regulatory provisions that are applicable.

They are activities of provision of a commercial nature that, not having the character of port services, are linked to the port activity, such as:

- Supply of fuels to ships and other supplies.
- Shipyards and naval repair facilities.
- Services associated with fishing.
- Services to nautical and sports boats. Storage and distribution of merchandise.

3.3.4 Maritime signalling services

The purpose of the maritime signalling service managed by port organizations is the installation, maintenance, control and inspection of visual, acoustic, electronic or radioactive devices, active or passive, designed to improve the safety of navigation and movements of ships in the Spanish littoral sea, and, where appropriate, confirm the position of the ships in navigation.

The Port Authorities, as part of the maritime signalling service, are assigned the following functions:

- Approve projects for the execution or modification of maritime signalling devices whose installation and maintenance correspond to the Port Authority.
- Guarantee the effective compliance of the beacons established by Puertos del Estado, so that, in the event that those responsible for their installation and maintenance do not execute them within the established period, they will be executed by the Port Authority at the expense of those.

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- Inform, with binding character, the projects of execution of new devices or modification of the existing ones, whose installation and maintenance correspond to third parties.
- Inspect maritime navigation aids whose installation and maintenance corresponds to third parties and, where appropriate, at their expense, the adoption of measures leading to the restoration of service, including those derived from the exercise of sanctioning power, when appropriate

3.4 Hinterland transportation and urban environment

In the ports converges the transport by sea, highway and railroad, thus enabling integrated chains of maritime-terrestrial transport. The economic efficiency and the environment of these transport chains are conditioned by the efficiency with which the modes of transport are coordinated.

From the perspective of the Port Authority of Vigo, there are different ways of achieving greater integration and coordination between the different modes of transport, as well as improving the environmental efficiency and competitiveness of port transport chains:

- To optimize the mobility of heavy vehicles. For this, the transit times and the stay of the trucks in the port and its surroundings shall be reduced.
- Driven Ro-Ro traffic. The use of maritime transport is promoted as an extension of the road infrastructure, providing an efficient alternative to complete the origin / destination transport relation while reducing the saturation of the great road axes.
- Rail transport in the Port of Vigo has a very low level of implementation. The Port Authority wants to promote the port-rail intermodality, for which it commissioned a study for the design of the possible alternatives of railway connection between the RORO de Bouzas terminal and the general merchandise network.

The distribution and geographical situation of the service area of the Port Authority of Vigo, which runs parallel to the coast, occupying a significant part of the coastline of the five municipalities where it is located, require constant coordination and communication between the Authorities, port and the different political and social stakeholders of these municipalities involved. The good relationship and collaboration seek increased awareness on the part of the citizen social environment of the transcendence of the port activities and their economic, political and social impacts. This policy is developed through programs of visits to the port and promotion of training or sports activities in the port area, among others.

The Port Authority, through institutional agreements or direct cession of shared lands that lack direct utility for the port activities, shows the interest of the port in the city through common spaces of enjoyment for the citizen.

3.5 Port systems description

The Port Authority of Vigo is in the process of implementing a digital platform in order to turn the Port of Vigo into a smart port, with a new management model based on increased efficiency, innovation, and sustainability. The core of this initiative is the “Smart ViPort” project, which aims as well to make of the port an innovation in its socioeconomic environment, and attract as well innovation by the organizations operating in the port [8]. The Smart ViPort platform provides an interface for port users and another for port workers, through which it is possible to monitor port

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services (e.g. cargo handling, mooring operations, port public space management, lighting, energy supplies, etc.) and to optimize energy efficiency. The strategy of the project is based on the following aspects:

- Process digitization as a mechanism to achieve the highest efficiency and effectiveness: reduction of time, improvement of quality, measurement and optimization, and cost reduction.
- Integration of all the actors involved in the processes of the organization, as a mechanism to facilitate participation, collaboration, transparency, delivery and reception service.
- Integration between processes and automation. This allows to enrich and to reduce operational costs.
- Improvement of the security/safety of information, people, goods and environment.

To achieve its goals, the ViPort project defined the following activities:

- To provide users of the port community with information on the status of their goods in the port.
- To centralize and to streamline all port community procedures.
- Real time traceability of goods. Traceability of dangerous goods.
- To work with digitalized documentation in container export processes (e.g. container weighing).
- Storage and distribution of data related to the occupation of terminal areas.
- Entry, loading / unloading and exit of ships.
- Access control of traffic in general, and improvement of road traffic.
- Monitoring and management of energy consumption.
- Online consultation of billing and collection of each user.

With the execution of ViPort project, the Port Authority of Vigo expects to improve its processes in the following way:

- Improvement of internal port services through:
    - Internal process management platform (intranet)
    - Single information repository: statistics, collection accounting, human resources, authorizations, etc.
    - Billing management
    - Geo-positioning of operations, services and resources.
- Improvement of energy management through:
    - Supply networks monitoring: electricity and water.
    - Monitoring of gas consumption, refrigeration systems, and fuels.
    - Consumption optimization.
- Introduction of smart port management concepts, such as:

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- Simulation, optimization and prediction of processes' resources and times.
- Detection of anomalies based on anomalous values and hidden patterns.
- Prediction of future values: analysis of historical variables for future projections.

The ViPort project is currently in its last phase, which is planned to be finished by 2022 [9].

Within the port, it shall be highlighted the advanced ICT-based systems used by the container terminal (Termavi). For instance, the terminal used and integrated camera and GPS positioning system for controlling its operations:

- Entrance/exit of containers is linked through tags to the terminal operations.
- Spreader operations ensures that GPS position corresponds to the one assigned to the container.
- Machine operators receive visual instruction through a screen, with code colours.
- Operation vehicles have also their own GPS antenna for positioning.
- Operation machinery read the container tags.
- Loading/unloading operations are also monitored in the cranes.
- There is a centralized terminal control centre.
- Electronic communications for monitoring container delivery processes.
- Reception and delivery orders are issued in electronic format. The delivery / reception orders are digitized and sent separately to each transport company, by either manually typing each code, or scanning the barcodes.

3.6 Expectations and goals

For achieving the expectations and goals listed in the following subsections, the following improvements in key decision areas of the port can be implemented:

- Yard Space Allocation: Current yard can store up to 350,000 TEU. There are currently 1,300 reef connections. Improved guidance in making strategic decisions about yard layout, container split, etc. has the potential to have a significant impact on reducing both deployment cost and fuel emissions at the same time by affecting the two drivers of these indicators, i.e., equipment performance and travelled distance.
- Yard Crane Management: A significant rate of RTGs' movements are unproductive. Only 67% of an RTG's deployment time is spent to perform container operations. On average, the fleet travels about 10 km around the yard every hour, which consumes energy and reduces operations time. Improved RTG scheduling, enhanced strategies, reduced shuffle level, increased container operation time, and reduced gantry distance could potentially decrease current travel distances by 10% (hence 10% decrease in energy consumption for travels).
- Internal Movement Vehicles (IMV) Scheduling and Deployment: The current emission of CO_2 from container truck traffic was 98,646 Kg CO_2eq. The current fleet of 284 IMVs covers more than 14 million km, and generates 26,500 tons of CO_2. Each day, the Container Terminal receives an average of 550 trucks. Each one travels around 1000 m in the inner of the

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Terminal. An optimized yard scheduling could result in 15% reduction in emissions from IMVs (equivalent to about 2 million KM per year and 4,000 tons of CO_2 for the Port of Vigo).
- More than 5,500 tons of CO2 are generated on a yearly basis by trucks operating in the port.

In addition to the specific port global goals presented in the following subsections, the main expectations and concerns from port stakeholders are:

- Employment creation.
- Innovation in the port.
- Approach of the industry to the city.
- Compliance with legislation.
- Economic self-sufficiency (profitability).
- Elimination of monopolies.
- Improvement in BIP (Border Inspection Posts) operation.
- Simplification of administrative procedures.
- Reduction in the time of operations.
- Cost reduction.
- Improvement of communications with the port.
- Improvements in ports access.
- Port profitability.
- Adapt training to the needs of the sector.
- Improvement of working conditions.
- Improvement of work-life balance.
- Improvement of work tools.
- Tourism associated with cruise traffic.
- Protection of the *Ría de Vigo* (Vigo Estuary).
- Environmental conservation of the port environment.

3.6.1 Economic expectations and goals

Expectations:

- To improve logistic efficiency to enable higher competitiveness of stakeholders operating in the port.

Goals:

- Develop new tools to manage and integrate information in real time to allow better performance and improve decision-making.
- Reduce electricity costs in port operations (mainly in reefer containers).

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- Reduce time in logistic operations.
- Detail efficiency curve in port operations (maximum and optimum capacity).
- Increase transparency (specific information about container location in real time).

3.6.2 Environmental expectations and goals

Expectations:

- To improve the environmental impact of port activities.
- To reduce carbon footprint.

Goals:

- To establish good environmental indicators to quantify impacts properly.
- To integrate all available data to ensure appropriate information in real time.

3.6.3 Social expectations and goals

Expectations:

- To integrate better port with city activities.
- Better management of stakeholder needs

Goals:

- To develop tools to analyse and integrate information related to stakeholders needs.
- To define and measure variables which can affect stakeholders.

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4 Ports of Livorno and Piombino

4.1 Port introduction

Ports of Livorno, Piombino, Elba and Capraia islands have been regrouped in the Port Authority System of Northern Tyrrhenian Sea, established with Law Decree no.169/2016.

The Port System includes therefore two large mainland ports, which handled more than 41 million tons per year (of which 33 million Livorno), and some minor ports, which are indeed relevant for the territorial continuity and touristic/passengers flows.

Please refer to the table below for a global insight of Port System throughput:

Table 19 – Northern Tyrrhenian Sea Port System and Livorno Port throughput

	2016	2017	Δ 2017/2016
AdSP del Mar Tirreno Settentrionale			
Total traffic (ton)	**41.138.919**	**41.070.163**	**-0,2%**
Liquid Bulk	8.406.941	8.893.694	5,8%
Dry Bulk	2.497.878	2.033.946	-18,6%
Containerized Cargo	9.196.116	8.027.301	-12,7%
Ro-Ro	19.009.823	20.409.216	7,4%
Other General Cargo	2.028.161	1.706.006	-15,9%
Vessels Number	**36.341**	**36.128**	**-0,6%**
GT	305.989.539	319.030.137	4,3%
Containers (TEU)	**800.475**	**734.085**	**-8,3%**
Passengers (units)	**9.599.316**	**9.723.851**	**1,3%**
Ferry	8.746.358	8.989.352	2,8%
Cruise	852.958	734.499	-13,9%
Ro-Ro units	**626.160**	**680.226**	**8,6%**
Commercial vehicles (units)	**596.677**	**658.051**	**10,3%**
Port of Livorno			
Total traffic (ton)	**32.815.851**	**33.702.171**	**2,7%**
Liquid Bulk	8.362.816	8.835.225	5,6%
Dry Bulk	831.615	757.048	-9,0%
Containerized Cargo	9.196.116	8.027.301	-12,7%
Ro-Ro	12.413.062	14.420.456	16,2%
Other General Cargo	2.012.242	1.662.141	-17,4%
Vessels Number	**7.211**	**7.429**	**3,0%**
GT	204.663.537	210.609.060	2,9%
Containers (TEU)	**800.475**	**734.085**	**-8,3%**
Passengers (units)	**3.283.841**	**3.217.255**	**-2,0%**
Ferry	2.475.906	2.518.475	1,7%
Cruise	807.935	698.780	-13,5%
Ro-Ro units	**389.961**	**448.357**	**15,0%**
Commercial vehicles (units)	**596.677**	**658.051**	**10,3%**

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Livorno stands out by far as biggest port (ranking fourth in Italy when it comes to global throughput), while Piombino performs mostly a local role, in connection with both Elba, as well as Corsica and Sardinia islands.

The Port Authority System is a public body, with tasks in land planning, concessions awarding and operations control. As public body, under the surveillance of Transport Ministry, has a broader role in connection with port development, innovation and digitalization of port services, notably Services of Economic General Interest. In this respect, it is worth mentioning that all maritime related activities are competence of the National Coast Guard, which is also Harbour Master. In other words, all navigational issues, berth allocation, techno-nautical services are left to the National Coast Guard, which has established its own local office in the port of Livorno.

Port planning and policy making is to be found mostly in the Port Master Plan (PMP) and Port Three year operational program (POP), which are both delivered by the Port Authority.

The PMP sets forth the port layout, highlighting the main development goals and measures towards a more competitive, sustainable and efficient port system. As the port reform has been approved in 2016, there is not a PMP for the whole Port System yet, although the PMPs for the two ports of Livorno (2015) and Piombino (2008) are already in force. The PMP does not detail any project or action in itself, but it puts forward a global strategy and planning of areas, splitting port domain into different traffic categories. From the PMP have been derived the information on energy and electricity needs of the port (questionnaire WP2), as well as the cold ironing facility located within the port of Livorno.

The POP is the main programming document, which sets forth the development goals in the timeframe 2018-2020. With respect to PortForward, the most important ones are:

- Realization of innovation services, to be included in the Port Monitoring Platform called MONICA. These innovative services can be referred both to e-freight, environmental monitoring, intermodal transport, road haulage and security, since MONICA represents the global architecture, that merges all relevant data for port activities.
- Port Community Services. The Port Authority already runs a Port Community System (Tuscan Port Community System), which is provided free of charge to port users. In the next programming period, the PCS will provide dedicated services to hauliers, while all datasets among the operating platforms are bound to be standardized in the Common Infostructural layer provided by MONICA. Consequently, the PCS will be integrated in MONICA.

Broadly speaking, the POP promotes the overcome of separated, poorly-connected platforms and software, through the development of interfaces and interoperability tools to better exploit the existing IT facilities.

The POP implementation for innovative services is earmarked to the Innovation, Development and EU programs Department.

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As long as the traffic flows are concerned, we may point out that the Port System is highly specialized in the Ro-Ro traffic, what puts under pressure port facilities, port access routes and the environment. In the following, the two main commercial ports of the System will be described and analysed.

4.1.1 Livorno

Livorno is a gateway multipurpose port, a feature that is shared with many other middle-sized Italian ports. From the geographical point of view, it lies in the river Arno plain, and it has a rather good availability of open, flat surfaces in comparison with other Italian ports.

The port of Livorno was mainly developed in the 1920s, with several terminals that are located quite far away from maritime access. The most important container terminal results from the widening and deepening of an old inland canal, while many other terminals can be reached only by small vessels, with a maximum draught of -10 metres. For this reason, the navigational issues represent a major challenge for the competitiveness of the port, since the maritime accessibility to quays and operational areas is poor and port users face higher costs in comparison to other near Italian ports. For instance, three tugboats are needed to assist vessels entering the commercial port (see picture below); two pilots (normally the Chief or Deputy Chief pilot and one assistant) steer larger container vessels (up to 9000 TEUs) to make it possible difficult manoeuvring within port waters. Subsequently, technological tools to help navigation can give a relevant contribution to increase safety and to reduce costs associated to ships manoeuvring within port.

Figure 20 – Overview of the port of Livorno

To cope with expected rise in throughput figures, the PMP envisages for the port of Livorno the completion of new terminals, one dedicated to container and one dedicated to Ro-Ro traffic. This

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infrastructure, named Darsena Europa, is projected to be operational as of 2023 (the container terminal only), with a yard surface of 52 hectares and 1200 quays' length. Of course, the completion of Darsena Europa will make it possible to relocate other traffic flows within the existing port area. The PMP as a whole has a projected cost of over 1.3 billion euros, albeit there is no fixed time limit for these investments.

As for port throughput, the port is still behind its peak reached in 2008, although some traffic categories are performing better than before the crisis (notably Ro-Ro), while some others are increasingly marginal (dry bulk). The recovery from the record low has somewhat accelerated in 2015-2016, whereas container flows data have been disappointing, with a reduction of 12.7% between 2017 and 2016 mainly due to lower transhipment figures. It deserves mention that Livorno has also a remarkable passenger traffic, which nonetheless is below the peak value of over 1 million cruise passengers reached in 2012. Monitoring and control needs should be also referred to the passengers' flows as well.

Monitoring of port operations is related to both security, competitiveness and safety goals. The Port Authority has subsequently set forth a Port Monitoring Platform, which is based on common standards and architecture to better integrate data from sensors and other public IT platforms. MONICA is already delivering data on dangerous goods within the port, weather conditions, ships sailing, concessions boundaries and quay length. As such, MONICA is a tool for port planning which is due to gather information in real time form sensors and devices and delivers reports about port activities and vessels' traffic.

4.1.2 Piombino

The port of Piombino is the closest mainland port to Corsica and Sardinia islands. It has been facing a sharp decline in global throughput in last years, mainly due to the crisis affecting the steel plant located in its vicinity. This crisis has resulted in a steady decrease of dry bulk traffic, which has not been balanced by other traffic categories. The government has therefore decided to invest remarkably in port facilities and infrastructures. Planned investments are worth 578 million euros. A new cargo terminal is bound to be operational in coming years, a new quay for cruise ships is already operational and seabed has been lowered to -20 metres. By all evidence, Piombino is currently a passenger port, with some services with islands, which are mixed freight and passengers flows.

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Table 20 – Piombino port throughput

	2016	2017	Δ 2017/2016
Port of Piombino			
Total traffic (ton)	**5.497.731**	**4.787.206**	**-12,9%**
Liquid Bulk	44.125	58.469	32,5%
Dry Bulk	1.666.263	1.276.898	-23,4%
Containerized Cargo	0	0	-
Ro-Ro	3.771.424	3.407.974	-9,6%
Other General Cargo	15.919	43.865	175,6%
Vessels Number	**14.989**	**14.829**	**-1,1%**
GT	55.112.349	59.933.932	8,7%
Containers (TEU)	**0**	**0**	-
Passengers (units)	**3.210.601**	**3.348.772**	**4,3%**
Ferry	3.208.654	3.342.877	4,2%
Cruise	1.947	5.895	202,8%
Ro-Ro units	**142.503**	**138.312**	**-2,9%**
Commercial vehicles (units)	**0**	**0**	-

4.2 Stakeholder identification

The following two groups of stakeholder have been identified insofar:

- Port commercial operators, namely terminals;
- Pilots, in charge of assisting the captain in performing ship's manoeuvring

In addition to this, the University of Pisa has been contacted as key stakeholder for the IT advanced solutions development.

Terminals that have been contacted are:

- Terminal Darsena Toscana
- Lorenzini Terminal

Which are both container terminals.

Other stakeholders are ICT providers, notably the two following companies:

- DBA Lab group spa, Port Community System provider
- DATACH srl, Port monitoring System provider.

Other operators can be contacted as the project PortForward goes further in its implementation of planned of uses cases.

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4.3 Port processes description

4.3.1 General services

The Italian law identifies Services of Economic general Interest, which are provided to port users under concession schemes. For these services, a competition for the market is envisaged, rather than competition in the market. Specific operators, identified by the National Coast Guard, provide Techno-nautical services. Piloting, for instance, is licensed by the Coast guard to skilled officials. Tug boat operate under a concession contract to a single operator.

Other Services, which are land-based, are instead provided by operators granted concession contracts by the Port Authority. We may list here the service for waste collection and treatment, port surveillance, lightning. Based on current legislation, port users are therefore obliged to rely on the incumbent provider, and fees are made public to ensure equal treatment and the full recovery of costs.

4.3.2 Port services

On the contrary, port services are opened to the market. The port authority sets the maximum number of authorized operators, which are given the right to carry on operation on the basis of an activity program. Port services are basically handling, storage and forwarding of goods to the hinterland. Each authorised operator is therefore responsible for carrying on the activity within the area granted in concession, eventually by subcontracting some processes to third undertakings.

The services provided to passengers include the security and ticket checks at gates, car rental and luggage storage, as well as the restaurant and cafeteria. Parking slots are located outside port area and, since the port of Livorno is not home port of cruise services, this is not an issue for the passenger traffic, which is by far a transit traffic.

4.3.3 Commercial services

Other business than those that are defined as port operators can access the port and perform commercial services. We can quote the following services:

- Road haulage
- Shunting and railway transport;
- Shipbuilding and repair.

The above-mentioned operators do not carry on an activity during the basic port core processes (ship arrival or departure, cargo or passenger loading or unloading, goods storage), but they are nonetheless crucial for the smooth connections with the hinterland.

4.3.4 Maritime signalling services

Port's lighthouse, beaconing and other supports to navigation are competence of the Italian Navy, which is a different administration than the Port Authority. The Port Authority is however cooperating with competent bodies for ensuring safer navigation within port waters. For instance, it will provide a photonic radar through a Horizon2020 funded project, ROBORDER.

Please refer to the map below for the list of maritime signalling services within the port of Livorno:

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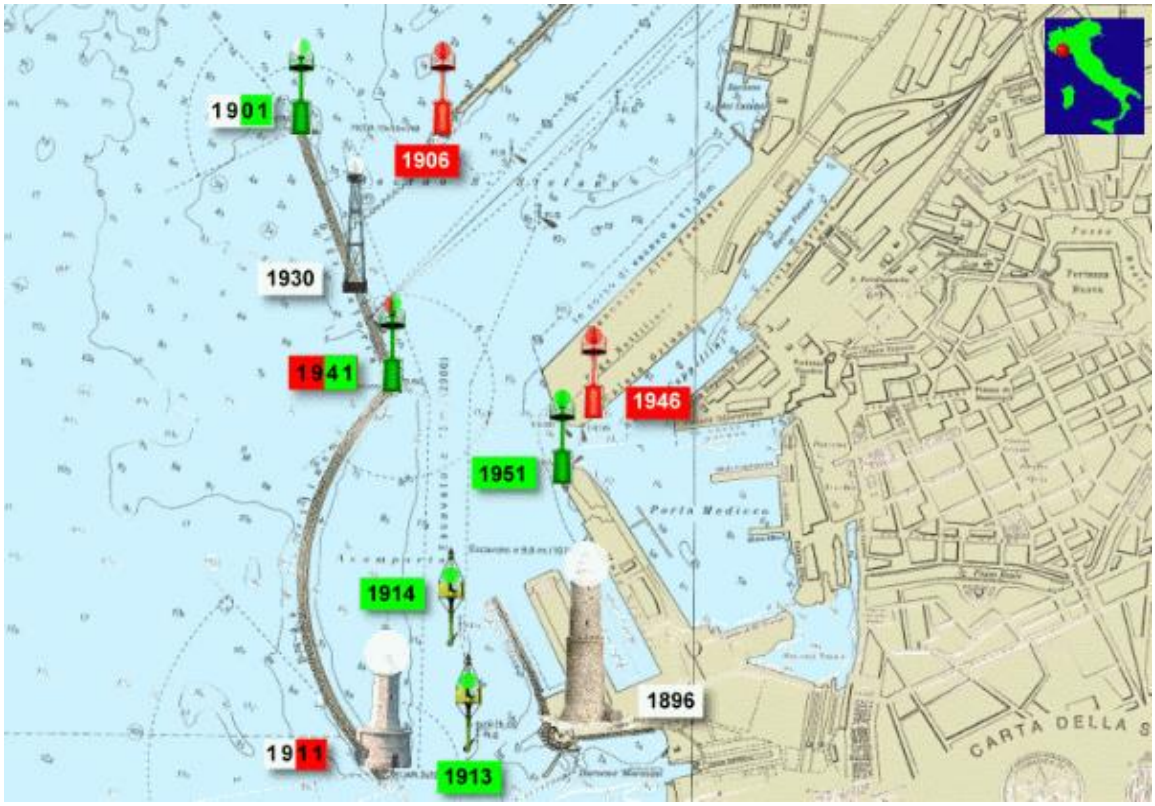

Figure 21 – Map of maritime signalling services in the port of Livorno, source Italian Navy

The port lighthouse (no. 1896 in the map) has a reach of 24 nautical miles, and an optic ORQ4 with a period of 20 seconds. The light stands 52 metres above the sea level. The light no. 1911 has a reach of 10 nautical miles, a period of 3 seconds and is 20 metres high above the sea level.

4.4 Hinterland transportation and urban environment

Port connections are managed by competent authorities, namely the Railway infrastructure manager (Rete Ferroviaria Italiana), the AVR as for the expressway Pisa- Firenze-Livorno and ANAS in relation to the road network.

We may quote the following hinterland transportation key points:

- Direct electrified railway connection from Terminal Darsena Toscana (TDT), the biggest container terminal: two tracks, 1.5 kilometres length;
- Marshalling yard within the Calambrone freight station, with direct link to the main line Genova Roma, serving all other terminals through shunting operations. It should be borne in mind that shunting is quite slow and requires minimum two hours. Port Authority is only responsible for the rail port network, which is nevertheless some 80 kilometres length (including some dismissed stretches).
- Direct linkages of Darsena Toscana terminals to the expressway Firenze-Pisa-Livorno, a two carriages way. This road is a toll free connection to Firenze, and from there to the

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relevant markets of Bologna, Veneto region and Lombardia. The port has no motorway direct connection.

- Mixed urban and port traffic, as better detailed in the map beneath. This is an issue especially when it comes to terminal gates, which are located within the city areas.

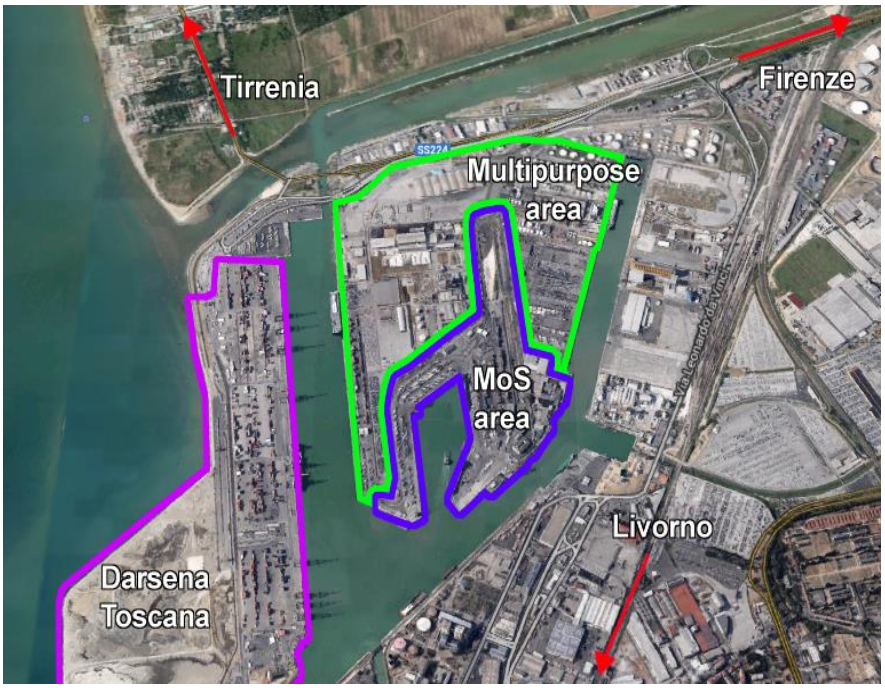

Figure 22 – Port layout and main related routes

4.5 Port systems description

We may list the following main ICT systems:

- The Port Community System (PCS), which is a platform provided free to the port users in order to manage the whole cargo related process within the port. It enables the digitalization of export and import information coming from cargo manifests, shipping documents, customs bills, delivery orders, gate systems, etc. TPCS interacts with the Customs Agency and other public bodies.
- The Port Monitoring system, called MONICA, which is provided free to whom it may have an interest at stake. It delivers statistics, real time monitoring of operations, 3D rendering of the port, ships' timely localisation, real-time management of dangerous goods information as Emergency data sheets, authorizations, risks management, etc. MONICA is a standard platform, which can be improved through specific modules. Sensors are connected to MONICA. We have Cameras, one air pollution sensor, the weather conditions sensor. Other sensors are bound to be purchased and set in the port. For instance, we plan to put bathymetric sensors, in order to have real time data on the seabed of the port. Additional sensors will be set to detect noise pollution. Through an OneM2M solution MONICA in interfaced to these sensors and gather data to release alerts and forecasts on critical environmental and operational conditions.

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- The GTS3, which manages the smooth and paperless access and exit of trucks through port gates. The GTS interoperates with the PCS.

4.6 Expectations and goals

4.6.1 Economic expectations and goals

As pointed out in the project proposal, the port infrastructure in Livorno is a given asset, which sometimes dates back to the 16th century. As logistic processes develops further, it becomes necessary to improve control and management of highly standardized operations. Moreover, the port hosts some important hazardous goods storages, notably Liquefied petroleum gas (LPG) and oil products, thus resulting in a major need for enhanced control of risky operations.

The existing bottlenecks on one hand pose a threat to the port competitiveness. On the other hand, they give the opportunity to exploit technological means to assist operations and control hazards of port and port related activities. We may list the following economic expectations:

- Reduction of risks, especially related to navigation and hazardous goods handled and stored in the port;
- Reduction of costs as result of stricter control on operations;
- Better and timely planning of maintenance and infrastructural upgrade of the port.

As goals, we may consider that the port faces remarkable costs when it comes to navigation, logistic processes in quite old facilities and difficult interconnections with the hinterland. IT tools are therefore expected to contribute to the achievement of the following goals:

- Higher price competitiveness for techno-nautical services, through enhanced management of operations; for a middle-sized vessels between 40,000 to 50,000 GT, navigation costs are up to 4,950 euros, due to complex operations;
- Lower insurance costs for activities performed in the port;
- Tailored and on-time maintenance, through better knowledge of actual conditions of port infrastructures;
- Attraction of additional investments, also in the field of logistics 4.0, for the training of personnel and the improvement of port facilities and equipment as result of IT steered innovative processes;

As the port represents an important share of economic throughput at local level (at national level port related activities have been estimated around 0.2% of Italian GDP, source IRPET), the aforementioned goals are also crucial for the local welfare and employment.

Key stakeholders are therefore port and logistic undertakings, techno-nautical service providers (pilots, tug boats operator, moorer), public administrations involved in port activities, namely:

- Customs agency,
- National Coast Guard,
- Police,
- Fire brigade,

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- Phytosanitary and health office.

All the above mentioned stakeholders are port related operators and represent "cost items" of the logistic chain as a whole. Customers of the port are on the contrary shippers and manufacturers, who eventually decide whether to call a port. These players are unlikely to be involved in a project as Port Forward is, but they are nonetheless price and time sensitive and are increasingly less linked to the port, as globalization of trade is moving forward.

The project can contribute to have a clearer view of processes, cost control and assessment, especially through the port performance dashboard and the envisaged port monitoring solutions. The IoT middleware is interesting for the port as this infrastructure is a huge producer of data and it is needed for enhancing the communication among sensors, platforms and users. Due to the importance of hinterland interconnections, the envisaged Multi-modal track-and-trace device is deemed useful to e-freight surveillance along port access routes. All these solutions should in fact be not limited to the port area only, but they ought to have a broader scope and benefit the whole logistic chain.

4.6.2 Environmental expectations and goals

The aforementioned Port Reform Law calls for a Sustainability and Energy plan for the infrastructure to be made by Port Authorities. As this Plan has not been yet approved, we can refer to the goals highlighted in the National Strategic Plan for Ports and logistics:

- Increase the sustainability of port operations through the deployment of alternative fuels and modal shift;
- Enhanced monitoring of pollutant emissions by the port and main sources;
- Raise awareness of operators to environmental issues and means to tackle emissions and reduce impact of port activities;
- Increase knowledge of carbon footprint of the port, both as for maritime operations and inland operations.

Although no one expects the port of Livorno to be 100% sustainable, stakeholders are interested in verifying and assessing the steady path towards a greener port. Monitoring can contribute to better control if and how the port is succeeding in becoming more sustainable.

In this respect, key stakeholders to be addressed are:

- Agenzia Regionale Protezione Ambientale (ARPAT), Regional Agency for the environmental protection;
- Istituto Superiore Protezione Ambientale (ISPRA), National Institute for Environmental protection);
- The concessionaire for waste collection;
- Ship owner, regarding ships' emissions;
- Citizens, and local committees against port related pollution;

And port undertakings. These stakeholders are sometimes data collectors and producers (the citizens themselves, when for instance it comes to noise complaint), or the core actors taking action and to achieve a greener port.

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In relation to the project PortForward, the Green scheduling is the most important achievement in this domain, even if the port of Livorno will be not committed to that task. More in general, efficient logistic processes result in smaller environmental impact and the objectives of WP4 are relevant in the light of a greener port.

4.6.3 Social expectations and goals

Livorno and its surroundings are a quite not-innovative region. The Innovation scoreboard of the European Commission lists Tuscany as a moderate innovative region. Projects as Port Forward, along with other innovation actions, are therefore called to increase also the awareness of the public for the importance of continuous innovation and research.

Innovation in ports has been sometimes linked to job losses and increased automatisation of processes. Stakeholders are hence interested in how innovation processes can improve competitiveness and strengthen the strategic positioning of the port without reducing job opportunities. Goals can be subsequently identified as follows:

- Move the region towards the raking of strong innovator;
- Strengthen the strategic positioning of the port and keep the actual employment levels;
- Enhance new business development opportunities;
- Boost cooperation among research centres, public administrations and local businesses.

It deserves mention that the public expects innovation to take place, although it is not considered a priority both in term of financial resources as well as dedicated workforce. It could be meaningful in the PortForward perspective to point out in the port performance dashboard the role of innovation in giving value to port activities and to define the “innovative” port.

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5 Ports of Naples and Salerno

5.1 Port introduction

The ports of Naples and Salerno, together with that of Castellammare di Stabia, are part of the Campania port system. The governing body of the system is the "Autorità di Sistema Portuale (AdSP) del Mar Tirreno Centrale" (Port System Authority). The Port System Authority is a body with legal personality under public law and administrative autonomy. It has financial, budgetary and administrative functions.

The asset and financial management of the AdSP is governed by an accounting regulation approved by the Ministry of Infrastructure and Transport, while the main planning tool of the public authority is the "Piano Operativo Triennale (POT)". The main tasks of the AdSP are to guide, plan, coordinate, promote and control port operations, such as loading, unloading, transhipment, storage, movement in general of goods and any other material, carried out within the port. It controls and entrusts to port users, for consideration, activities aimed at the provision of services of general interest (i.e. technical-nautical services).

The AdSP is also responsible for the ordinary and extraordinary maintenance of the common parts in the port area, including that for the maintenance of the seabed. In addition, an important innovation introduced by the port reform law (2016) assigns to the AdSP the task of promoting forms of connection with the logistic systems inland and interports. Therefore, the role of the AdSP is both to enforce what it itself has provided for in the POT for the development of the port, and to manage the space to maximize the economic and social opportunities of the port itself.

The Naples-Salerno system represents in the south of Italy one of the three main port systems to look at with particular attention. In fact, this system is seen as a single large *multipurpose port system*, justified by a large demographic basin with a high population density. Moreover, there is the presence of important productive poles composed by some big companies and by systems of small and medium enterprises that extend in Campania and in some areas of Basilicata, Puglia and lower Lazio.

The two ports operate both in the container market and in certain general cargo sectors, such as the automotive sector. Excellent result as far as the commercial traffic of the containers is concerned, expressed in "Teu". According to the data 2015, the "Autorità di Sistema Portuale del Mar Tirreno Centrale" turns out to be fourth in the national classification, with little less than 800.000 units (*source: www.porto.napoli.it*).

At present, the ports of Naples and Salerno are lagging behind in terms of infrastructures, especially in terms of seabed maintenance, and therefore also in terms of handling capacity, last mile connections, as well as a limited supply of technological services and competitive ancillary services. These ports have draughts and quays that are not suitable to meet market demand in the perspective of development in the coming years.

5.1.1 Naples

The port of Naples, located in the middle of the Mediterranean Sea, along the ideal route between Suez and Gibraltar, is one of the main ports of call in commercial traffic and shows constant increases in passenger traffic.

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It extends for about 5.600 m along the stretch of coast that flanks the historic centre of Naples. It measures a total of about 4.400.000 m2, of which about 2.700.000 m2 of water surface and about 1.700.000 m2 of land areas. The latter are used for different purposes (passengers, shipbuilding, and commercial activity in its components of freight traffic, oil, containers, cruise traffic, ship repair industry and yachting), and have a total of 14 piers (Figure 23 - *source: www.porto.napoli.it*).

Figure 23 - Overview of the port of Naples

The port of Naples has many functions and represents, in terms of turnover and direct employment, a primary industrial reality of the Campania Region. From the tourist area of the port, located in the historic centre of Naples, depart connections with hydrofoils and ferries to the islands of the Gulf and Sorrento. The traffic of hydrofoils has been separated from that of ferries, from the pier "Beverello" and "Mergellina" depart in fact hydrofoils, while from "Calata Porta di Massa" depart ferries.

The "Stazione Marittima", on the other hand, hosts the cruise ships and is managed by the company "Terminal Napoli S.p.A". The company is made up of the main cruise companies: Costa Crociere, MSC, Royal Caribbean and Alilauro S.p.A. In the local traffic sector (< 20 miles), the port of Naples is the leader, representing 50% of Italian traffic. It is also a fundamental hub for the transport of goods and passengers to the major islands (Sicily and Sardinia). If the maritime transport in the Mediterranean Sea foresees a growth rate, for year, between 7% and 9%, the port of Naples in the last 4 years shows a strong increase in the local traffic sector. There are peaks of absolute excellence in the "Autostrade del Mare" sector, whose lines to Sicily represent 49% of the entire sector throughout Italy. Shipbuilding and ship repair represent another important industrial sector for the port's activities, which continues to invest to ensure capacity and high quality standards in the works.

In order to confirm its important position at national and international level, all the functions already present need to be strengthened; this presupposes the development of passenger traffic, containerised goods and Ro-Ro goods. In addition, some of the works need to be completed in the short term. This

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refers in particular to the completion of the "Nuova Darsena di Levante" for the handling of containers, the new road and rail link and the maintenance of the seabed.

However, there are important limits to the development of the port itself because, at present, commercial traffics containers, passengers and goods (Ro-Pax and Ro-Ro) are devoid of a rational organization of spaces and dedicated infrastructure, as well as technical-nautical services, scattered over the port territory and without adequate space dedicated to land and sea. Significant obstacles to the development of freight traffic are also due to the condition of the railway line and the connection between the port and the motorway network.

The reopening of the rail link between the port of Naples and the interports of Nola and Marcianise in the Campania Region is essential for the competitiveness and development of the port itself. This is the objective of the agreement recently signed by the President of the "AdSP del Mar Tirreno Centrale" and the General Manager of "Rete Ferroviaria Italiana (RFI)". The agreement will allow the AdSP to select, through a call for tenders, the railway company that will manage the connections from the port of Naples to the interports of Nola and Marcianise.

5.1.2 Salerno

The port of Salerno is located in a particularly favourable geographical position for commercial traffic in the Mediterranean, as well as having an efficient network of connections with the hinterland (central and southern Italy). These characteristics therefore allow the port to serve the maritime traffic of large areas of the Mediterranean, playing a key role in the Italian maritime economy. The strong and easy interaction between the port and the hinterland - road and motorway connection networks - is an important aspect that favours and simplifies the import and export activities, determining in fact a traffic trend in constant growth in the last decade.

In 2010, the Port Authority of Salerno obtained the validation of the technical-functional adaptation of the "Port Development Plan" to adapt the port of Salerno to the dimensional values of the latest ships, more spacious but also more ecological. In this respect, the port of Salerno is the absolute forerunner for all Italian ports. Therefore, following recent infrastructural interventions, the port, in its current configuration, offers the possibility of accommodating even large ships.

The port has a total area of 1.700.000 m^2 of which 500.000 m^2 consists of land areas, 250.000 m^2 for storage and handling, and 250.000 m^2 for traffic roads and service areas. The port area consists of two ports:

- *commercial port*, which is located in the west of the city;
- *tourist port*, located about half a mile east of the first.

The commercial area extends from the border with the Municipality of Vietri sul Mare (Salerno) to the beginning of pier "3 Gennaio". It is divided into three operational macro-areas, as shown in Figure 24 below (*source: www.porto.salerno.it*):

- Terminal A (pier Ligea/ Molo 3 Gennaio) which has a surface area of 37.143 m^2 and handles various goods;
- Terminal B (Molo Trapezio), which occupies 120.975 m^2 and handles goods in containers;
- Terminal C (Banchina Rossa/Molo di Ponente), which handles Ro-Ro traffic and the "Autostrade del Mare", and occupies a surface area of 80.500 m^2.

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Figure 24 - Overview of the port of Salerno

The main terminal operators operating in the port are:

- **Salerno Container Terminale S.p.A.** (Gallozzi group), which operates at Molo Trapezio;
- **Gruppo Amoruso Giuseppe S.p.A.**, which deals with:
    a) handling of: steel products (raw materials and semi-finished products), intended in particular for FCA (Fiat Chrysler Automobiles) which, through its main suppliers, picks up the steel material used as the main raw material for the construction of cars in the Pomigliano d'Arco, Cassino and Melfi plants; full and empty containers;
    b) unloading and storage of exotic fruit stored in the storage area of the terminal, consisting of a warehouse with four refrigerated cells (under the temporary customs storage procedure).
- **Salerno Auto Terminal S.r.l.**, a company that belongs to the Grimaldi group. Since summer 2012, FCA as the hub (central and exclusive point for collection, sorting and distribution) has chosen the port of Salerno for the new 500L produced in the plants near Belgrade. Salerno Auto Terminal (SAT) and Grimaldi Euromed manage the transport of cars, rolling stock (new and used) semi-trailers and, in very small quantities, containers (the latter only on Ro-Ro ships). The main processes they deal with are embarkation, disembarkation, logistics (movement within the port and from the port) and transhipment.

Since 2001, the port of Salerno has been included in the new maritime transport system of short sea shipping called "Autostrade del Mare". In recent years, this traffic (rolling stocks and passengers) has undergone high growth rates, thanks to the implementation of new regular lines Ro-Ro and Ro-Pax. The following "Autostrade del Mare" lines are active for the port of Salerno (Figure 25 - *source: www.ramspa.it*):

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Linee regolari RO-RO e RO/Pax		
Destinazione	**Armatore**	**Frequenza**
Valencia **	Grimaldi Lines	Trisettimanale
Tunisi	Grimaldi Lines	Bisettimanale
Malta *	Grimaldi Lines	Settimanale
Tripoli *	Grimaldi Lines	Settimanale
Messina	Caronte&Tourist	2 volte al giorno
Augusta	Grimaldi Holding	Trisettimanale
Cagliari **	Grimaldi Lines	Trisettimanale
Catania	Grimaldi Lines	Trisettimanale
Palermo	Grimaldi Lines	Bisettimanale

Figure 25 - "Autostrade del Mare" lines active

For the port of Salerno is essential to complete the construction of the new road link, in tunnel, between the Port and the motorway junction (intervention called "Salerno Porta Ovest"). Even for the port of Salerno is highly desirable integration with areas behind the port. These areas must be sufficiently close to the port or located in the districts of origin/destination of goods, as well as with the interports of Campania Region.

According to what is indicated in the "POT 2017-2019", the planned interventions include the implementation of "port security" infrastructures, through the execution of civil works, the installation of technological systems aimed at controlling the access of people and vehicles to the port entrances, and the construction of the "Centrale Operativa di Security".

5.2 Stakeholder identification

With specific reference to the context of the "AdSP del Mar Tirreno Centrale", it is possible to identify all the stakeholders within the Port Authority, namely those who are directly part of its organisation (shareholders, managers, employees and trade unions). The group of external stakeholders stands out from these, consisting of:

a. economic subjects that invest directly in the port area (concessionaires, shipping agents, carriers, suppliers of port services, etc.);

b. enterprises or institutions located in the port area and/or hinterland (shipping agents, multimodal transport operators);

c. cruise and ferry passengers;

d. public bodies and regulators;

e. local community and social interest groups.

The following is a more detailed categorisation of both internal and external stakeholders, in order to identify them more specifically.

- S*hareholder*: public and/or private entities holding shares in the Port Authority, or entitled to appoint the board of directors or managers.

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- *Financial Community*: financial and credit institutions that provide financial resources to support investment decisions and port development (equipment, infrastructure, dredging, etc.).
- *Workers and trade unions*: trade unions and persons working at administrative and operational level in the Port Authority, in public institutions (customs, coastguard, etc.), in concessionary companies, in working groups and in companies linked to the port (shippers, shipping agencies, etc.).
- *Dealers*: terminal operators who have at least one concession in the port, or other dealers connected to warehouses, industrial areas, logistics platforms, shopping centres or commercial areas.
- *Port user*: shipping agents, shipping agencies, shipping brokers, hauliers, railway companies, logistics operators, etc.
- *Shipping companies*: shipping lines (containers, Ro-Ro, cruise lines, etc.) and non-scheduled transport operators (liquid bulk, solid bulk, etc.).
- *Passengers*: people who use the port facilities for tourism (cruise and yachting) and travel (ferry).
- *Port service providers*: pilots, mooring and stevedoring operators, customs, coast guards, etc.
- *Local communities and social interest groups*: persons and organisations located near port areas and directly or indirectly affected by port operations and businesses. This category also includes those persons or groups of persons interested in environmental and social problems.
- *Regulators*: police and public institutions that determine the institutional framework and governance mechanisms.

The stakeholder identification will be concretise in port-specific stakeholder list.

5.3 Port processes description

5.3.1 General services

With reference to the port of Naples, there is no data needed to describe the services of signalling, beaconing and other aids to navigation that serve for approximation and access of the vessels to the port, as well as the interior beaconing of the latter.

Recently instead, the port of Salerno presented to the institutions and port operators the implementations carried out in the framework of the "Habitat Project", which concerns the monitoring of last mile vessel traffic.

The project aims to monitor the port traffic of all ships, combining all the technologies currently in use in the port, in any weather condition and at any time. Inside the port has been set up a virtual control tower and two simulators "real time", immersed in a 3D scenario with images of the port of Salerno. These features are available on both fixed and mobile devices, such as tablets or smartphones, to support the activities of the various port operators. The global "Habitat" system consists of the following three subsystems:

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1) **Sensor system (cooperating and non-cooperating sensors):**
    - Network of newly developed "mini radar sensors" with low environmental impact, based on "software defined radio" technology;
    - Electro-Optic (EO) and Infrared (IR) sensor network for optimisation of detection and tracking phases in conjunction with the mini radar network;
    - Telemetric laser sensors located on the quays to facilitate docking manoeuvres.
2) **System "Ad Hoc Network Layer"** for the interconnection of sensors and for the transmission of data from and to a control room on land and from the latter to devices on board vessels.
3) **System "Mediation Layer & Data Fusion"** for the implementation of applications for the control and support of navigation in port waters:
    - "*Blue Port Awareness*": subsystem for the real-time visualization of the outline dimensions of each ship 24/24 hours and in all marine weather conditions;
    - "*Docking Facilitator*": subsystem to support the pilot during the docking phase of ships through a network of telemetric laser sensors;
    - "*Training & Exercise*": simulation system to innovate the training and exercise processes of pilots and port traffic workers.

The data obtained from the various sensors are transmitted, via the network infrastructure, to the block that provides for the data fusion operations.

5.3.2 Port services

In 2015 the Ministry of Infrastructure and Transport has merged the "Corporation of Pilots of Naples" and the "Corporation of Pilots of Castellammare di Stabia" in the "Corporation of Pilots of the Gulf of Naples". The Corporation has its legal and operational headquarters in the port of Naples and other operational offices in the ports of Castellammare di Stabia and Torre Annunziata. Over the years, the Naples pilots have been equipped to withstand the increasing traffic with appropriate electronic equipment, ready to guarantee radio assistance to all those ships that do not require the presence of the pilot on board but only assistance in V.H.F.

In June 2000, the "Torre Piloti" was inaugurated in Naples, which still remains one of the few in Italy today; it has a sighting room at 35 meters above sea level and is located in a strategic point of the port to allow the control of all movements of the vessels, both in the port and in the Gulf itself. It is equipped with advanced equipment to assist navigation in order to provide maximum assistance and safety, using radar, GIS cartography, AIS, weather station, thus being able to provide all the information necessary for proper navigation.

The mooring group of the port of Naples, instead, was established on May 21, 1946 by Decree of the Port Authority of Naples. As indicated in the executive regulation currently in force, the execution of the operations of mooring, unmooring and handling of the ships in arrival and departure is reserved to the "Group of Moors and Battellieri of the port of Naples". It is only exceptionally allowed for ships of small tonnage, however not exceeding 500 T.L.S., that the service is carried out by the same personnel on board. Provided that this is possible without creating obstacles and difficulties to traffic

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and without compromising port security. It is strictly forbidden to use persons not belonging to the "Gruppo Ormeggiatori e Battellieri del Porto di Napoli" for the aforementioned service.

5.3.3 Commercial services

Commercial services are services that provide activities of a commercial nature, which are not classified as port services per se, but are related to port activities. In addition to the port services described above, the following commercial services are provided in the ports of Naples and Salerno:

- Repair, washing, fumigation and operations of extraordinary maintenance of containers;
- Balancing of goods;
- Counting, separation, marking, sampling, measurement of goods;
- Handling of goods and containers with shuttle vehicles;
- Repair and reconstruction of packaging in general;
- Filling and emptying containers.

5.3.4 Maritime signalling services

In the ports of Naples and Salerno, in order to implement the level of maritime safety in its three distinct aspects, sustainable development, safety and security, it was necessary to introduce tools for the control and monitoring of maritime traffic. These instruments were introduced to prevent or reduce the risks of accidents, dangers to human life at sea, to navigation and to the marine environment.

The "AdSP del Mar Tirreno Centrale" uses the VTS (Vessel Traffic Service), a maritime traffic monitoring system that does not constrain routes or speed, but is aimed at evading dangerous circumstances and organizing the manoeuvres of vessels (sometimes with dangerous cargo), in times of heavy traffic. The VTS system provides position information on ships in a given geographical area by collecting, on the one hand, data from on-board AIS systems and, on the other hand, by collecting position data obtained from radar systems for traffic control. By combining these two information flows, the VTS generates a cryptographic protocol that allows secure communication from the source to the recipient over TCP/IP networks, thus providing all the data of the vehicles present in the monitored area.

A VTS system consists of a centre for data collection and presentation and one or more remote sites containing the following sensors: Radar, VHF Radio, Weather, AIS, Direction Finder, Electro-optical. The Italian system consists of a central VTS (VTC), 8 Area VTS (VTSA), 23 Local VTS (VTSL), 31 remote radar sites (RRS) and 3 mobile VTSL units (*source: www.guardiacostiera.gov.it*).

The most important benefits obtained from the use of such a technology are:

- the prevention of maritime accidents due to collision, impact and grounding;
- the reduction of the risk for the safety of passengers and crews;
- the prevention of the spillage into the sea of polluting loads;
- the safety of port, territorial and personal infrastructures;

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- the optimization of the use of resources available for surveillance and intervention, especially preventive, for the control of water.

The VTS is enriched by an automatic identification system, called AIS (Automatic Identification System). It is an international system of data exchange between ships and coastal stations. It consists of a VHF band radio device that acquires, receives and transmits information about a ship and its cargo, the port of departure, as well as its position, course and speed. Initially considered as an apparatus to evade or reduce the risk of collisions between ships, over time it has become a system for monitoring vessel traffic and, thanks to the constant and perpetual updating of information sent and received, has proved to be a key tool in the search and rescue at sea.

5.4 Hinterland transportation and urban environment

Campania Region suffers from the infrastructural delay that characterizes Southern Italy, although unlike other regions it has a dense network of roads and motorways as well as railway lines.

Naples

The current connections between the port of Naples and the external road network are as follows:

- at an urban level, through the "Immacolatella", "Pisacane", "Carmine" and "S. Erasmo" gates, which give access, with in/out junctions, to via Cristoforo Colombo - via Marina - via Reggia di Portici, namely on the urban route that, following the coastal arch, extends from Piazza Municipio to Rione Principe di Piemonte;
- at the level of great road network, through the "Bausan" gate, which gives access to the motorway link with the "A3 Naples – Salerno".

The greatest concentration of traffic, with a strong component of a heavy commercial type, is through the "Bausan" gate, which also collects a substantial part of the through-flows to the ferry terminal and that flow through the gate of the "Carmine" and through the "Immacolatella".

The eastern port area, currently used to a marginal extent, lacks a real connection, both with the areas inside the port and with the outside. However, all the traffic flows generated by the port activities of the eastern sector are forcibly introduced on the urban road network.

Salerno

In the port of Salerno the gates open to vehicular transit are those of the "Molo di Ponente", "Molo Manfredi" and "Molo Trapezio". From the port gates you can directly access the viaduct, which leads to the A3 motorway "Napoli-Salerno-Reggio Calabria", and then to the "Salerno-Avellino" motorway. In addition, there is a road axis, tangential of Salerno, that connects, avoiding the city centre, the motorway junction with the municipality of Pontecagnano, and that crosses the entire industrial area of Salerno.

An ad hoc railway company has been set up between the port of Salerno and the interporto of Nola, the "Interporto Servizi Cargo". It is the intermodal operator but also the authorized and certified railway company. Interporto Servizi Cargo and Grimaldi Lines have established an operational collaboration to develop intermodal traffic from all over Europe and from Northern Italy to Sicily, Tunisia and Libya and vice versa. The Grimaldi Group is a conglomerate of companies linked to the logistics business with a main-focus on shipping. The agreement allows operators to use all means of transport: ship, road, train, taking full advantage of the potential of the "Motorways of the Sea",

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putting in close connection two logistics nodes in southern Italy, such as the port of Salerno and the Interporto di Nola.

There is a direct motorway connection between the port of Salerno and the interporto of Nola, as shown in Figure 26 (*source: our processing by Google Maps).* The section is about 55 km long, more than 95% of which is covered by the "A30 Caserta-Salerno" motorway, which runs along two lanes (in both directions) until the junction with the "Salerno-Avellino" link (for the first 15 km from Salerno) and three lanes from the junction to Caserta. The Interporto can be reached via the "A30" exit at Nola and a small stretch along the "7bis state road".

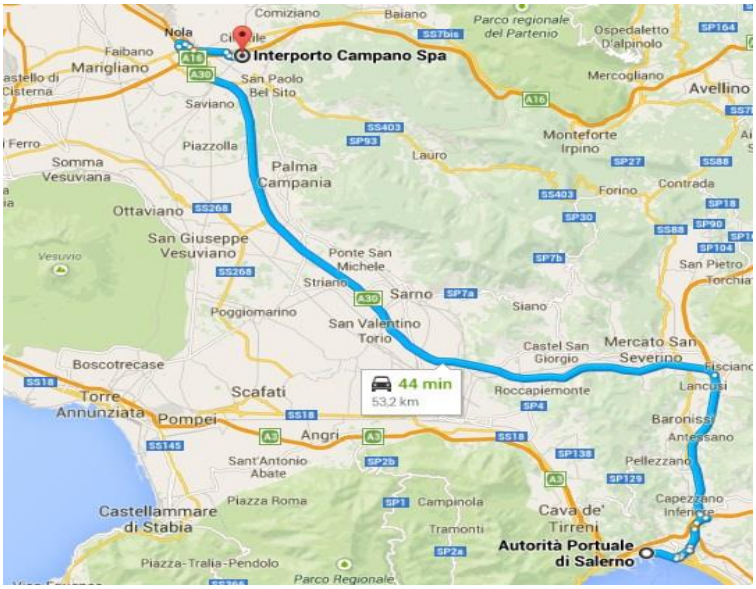

Figure 26 - Motorway section "Port of Salerno - Interporto di Nola"

5.5 Port systems description

At the AdSP operates the "Sportello Unico Amministrativo" (SUA) that, for all administrative and authorization procedures concerning the economic activities, with the exception of those relating to the counter customs and controls and security, has a unique function of front office with respect to the subjects appointed to operate in port.

At the moment, however, for the port of Naples, it has not been possible yet to prrrovide an overview of the main "ICT-related" systems and supporting infrastructure (e.g. communication networks) existing in the port. A working group with ICT manager of port of Naples and two MARTE components have been defined, so the information will be retrieved in a later stage of the project.

In the port of Salerno, instead, a Data Processing Centre (DPC) acts as a "control centre" for the interconnection of sensors and for data transmission. A telecommunications infrastructure based on the combination of the paradigms Wireless Sensor Networking and Ad-Hoc/Mesh Networking has been designed for sending and receiving information. The "control centre" has two functions:

1) it acts as a point of collection of data coming from sensor systems and as a place where their processing takes place;
2) it exposes services and interfaces to different types of clients:
   a. operational room of the Harbourmaster's Office;

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b. control room of the shipping companies;

c. training & exercise systems;

d. on-board terminals, dedicated and/or general purpose, fixed and/or mobile (dedicated terminals, smartphones, tablets, notebooks, etc.) operating in aid of legacy systems to support navigation or in their place on vessels that do not have them.

Below a list of the current navigation assistance systems in the port of Salerno:

1) ARPA (Automatic Radar Plotting Aids): it is a system capable of improving standard practices to avoid collisions at sea. It also provides a forecast of future situations developed based on computer processing of current situation data.
2) ECDIS (Electronic Chart Display and Information System): a system that generates a digital display of the nautical chart with the inclusion, within the same screen, of a series of objects and features that make navigation easier and safer.
3) NAVTEX (Navigational Text Messages): An automatic system that transmits mid-frequency warnings and navigation and weather bulletins. It is also used for the transmission of urgent information for the safety of ships.
4) GMDSS (Global Maritime Distress Safety System): it is an internationally recognised set of communication procedures, equipment and protocols used to enhance safety at sea and facilitate the rescue of ships in distress.

Salerno Container Terminal (SAT) is equipped with the COSMOS software system for a complete management of the containers, starting from the initial contact with the shipping company, up to the control of the position of the container inside the storage area. It consists of a central database with a whole series of software applications for yard management, area optimization, ship arrival planning, and messaging with external users. The COSMOS system has been developed with the primary objective of connecting the Terminal with the navigation lines that belong to it. Access is also provided for other users (Shipping Agent, Freight Forwarder), and each of them can access the system for specific functions. The shipping company, for example, may decide to provide access credentials to the agents representing it, allowing them to consult a range of data useful for travel management.

5.6 Expectations and goals

Cooperating stakeholders with each other is essential to achieve the goals that have set themselves. Entering into smart partnerships and working on networks aimed for knowledge sharing, synergy and combining capacity for innovation, thus creating value for the port economy as a whole, is the key to contribute to develop of a greener, more sustainable, more attractive and smarter port, in harmony with social and environmental background.

5.6.1 Economic expectations and goals

All stakeholders may create a good and solid development framework for enterprises in order to implement new business models, building new partnerships able to be better up against market's challenges. By implementing a new business model in the port that involves more stakeholders and makes them active part in planning process of new business possibilities, it is possible to strengthen the cooperation, to increase the network and, above all, to raise the port attractiveness. To achieve the goals whom it is quoting for, a few elements are essential:

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- **Smarter and faster procedures and activities**
  By introducing digital innovation and processes, they lead to work in the most efficient and customer-focused manner possible. The stakeholders, taking advantage of digital data and collaborating each other in a digital environment, enable to strengthen them own organisation, but also to improve them customers' logistics processes.
- **Operational efficiency**
  This is one of the most important drivers of port competitiveness. Port users, especially shipping companies, look carefully at the aspects related to the execution of port operations, mainly in terms of reliability and timeliness. In fact, sector studies have shown that the *quality of services* offered and the degree of *connectivity to the hinterland* are among the main requirements to which companies and shippers refer when planning routes and ports to step.
- **Traffic measurament and information control**
  Monitoring traffic and the efficiency achieved in the use of the resources available in the port (infrastructures and superstructures) is essential for the constant improvement of performance. The measures carried on traffic demand summarize the port's ability to attract traffic flows and defend its competitive advantage. Moreover, the constant control over time of this information is a valid support to the Port Authorities that, during the planning step, they have to make appropriate decisions to face possible changes in the external environment that inevitably influence the market dynamics. By having such a measurement tool allows to better manage any threats and seize what are opportunities.

By employing tools that allow monitoring and by analysing port's performances, thereby it will be possible to correct any critical issues and likewise boost strengths, for instance, by identifying clear strategic priorities in port activeness.

5.6.2 Environmental expectations and goals

Customers care about environmental issue much more than in the past and stakeholders moderate one's own behaviour economic goals, tending to be conjoined with environmental ones, by promoting and implementing the circular economy. Businesses' advancement toward new sustainable paths is one of most relevant stakeholders' expectations, due to just mentioned subjects. A greener business management can be achieved through:

- **Innovation and cooperation**
  Working in close collaboration with the scientific field and innovative companies in the chemical manufacturing industry to research and test new possibilities. Nevertheless, those greener innovation (them could also be just of processes) need to be balanced with economic and infrastructural (both material and immaterial) realization's possibilities.
- **Environment-friendly management**
  The presence of a certified environmental management system confirms the real and concrete commitment of a port that wants to operate in respect of the environment in a systematic way establishing objectives and actions for the continuous improvement of its environmental performance. The management could involve tools like Green Scheduler (GS) to evaluate the environmental impacts of port operations through a set of parameters, for instance, concerning fuel and energy consumption of port-related operations.

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- **Environmental-friendly policy**
  It allows to manage the activities by monitoring the environmental impacts related to them with the aim of reducing or preventing them. Proceeding on this way, will be implement an intelligent port strategy that could truly contribute to develop a greener and more sustainable port, from which take advantage also the resident around.

5.6.3 Social expectations and goals

In order to gear the port's interests as closely as possible to developments in the city and the rest of the region, it is important to maintain a constant dialogue between all stakeholders involved. To reach the goals could be involved:

- **Positive interaction city-port**
  They allow to better coordinate demand and supply, energy costs are reduced for companies and residents in metropolitan areas around port, creating more favourable conditions for establishing businesses and for the daily life of citizens.
- **Monitoring and analysing system**
  Reducing supply chain's social impacts is a relevant goal that stakeholders take into consideration to create a more attractive environment. To achieve the goal that it is quoting for, it is essential to employ a smarter supply chain policy. In this way, a relevant perspective for action is analysing social risks produced by the chain of goods and raw materials transported from and to the port terminal and reducing the negative social impact of them. For instance, drawing up a noise distribution plan to examine the best sounds' distribution in the port area based on noise capacity applications by noise-producing companies, the maximum permitted volume of noise pollution could be better distributed.

Overall, the results achieved in terms of job creation and benefit are important data to demonstrate to all stakeholders, especially to the local community, that the port is a source of wealth for the territory. This information is relevant, such that it can be also used by institutions to carry out a better public funds allocation.

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6 Port of Magdeburg

6.1 Port introduction

Since the founding of TRANSPORTWERK Magdeburger Hafen GmbH TMHG substantial contributions to the successful development of the business location Magdeburg and the surrounding economical areas were given by the Port of Magdeburg. In the recent years, the growth of the business gained a higher intensity. Today the Port of Magdeburg owns six terminals, which are located on the east waterside of the river Elbe. The terminals are not located in one closed area. They are embedded as connected single locations in a large industrial area. The following figure gives an impression about the geographical plan of the port structures and the surrounding economical areas.

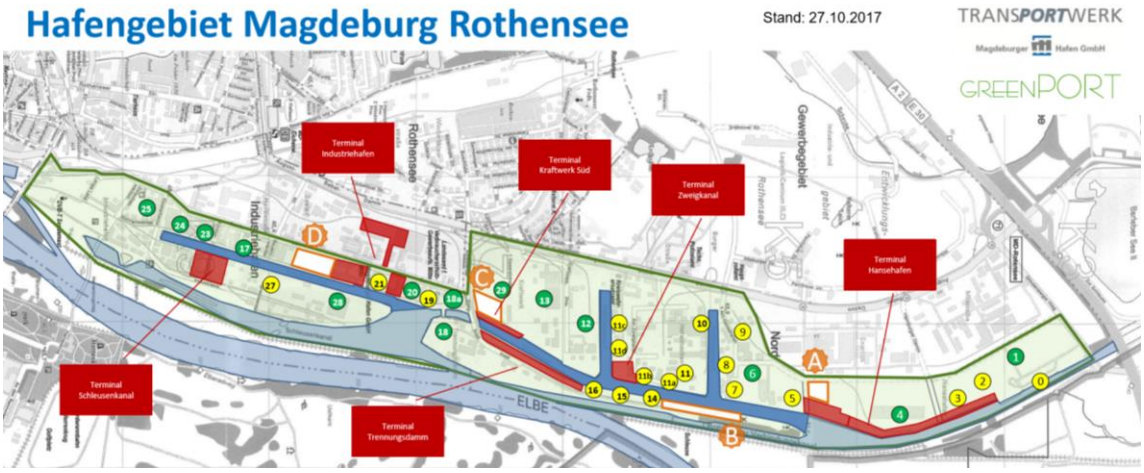

Figure 27 – Overview of the port of Magdeburg

Because of the increased port handling and terminal scheduling the port of Magdeburg has to face new challenges today. Considering the changes in the society and the changed needs of the customers and business partners the TMHG is continuously developing and adjusting its business and service concepts. Formerly working on classical port objectives like providing infrastructures and development of port-relevant areas the **TMHG today is also a logistic service partner and system provider and manager of multimodal transport logistic chains.**

The port of Magdeburg is the biggest inland port in Central Germany. The port is located in the centre of the federal state Saxony-Anhalt. All relevant transport links such as highways and railways can be reached in short time. Because of its low-water lockage the port is independent of the water level of the river Elbe and can provide a continuous direct connection to the German canals network and the European waterways. The excellent trimodal connection of the port to the transport network, the "green footprint" of the port and its development areas are the fundamental reasons for the interesting opportunities the port can provide to its customers and business partners.

The port combines its port activities with generation of energy from 'green' renewable energy sources in geographical as well as in a logistical way. Electric sockets supply the inland ships with electricity. A wind energy plant close to the docks generates this electric energy. The emission of CO_2 by the ships at the docks is significantly decreased in this way. The port owned railway runs a Plug-In Hybrid locomotive, which reduces the emissions and the diesel consumption. Infrastructures for e-mobility concepts are in planning.

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6.2 Stakeholder identification

The TRANS*PORT*WERK Magdeburger Hafen GmbH TMHG runs the port operation and the business on its own responsibility as an independent economic entity.

Beside this there are various stakeholders connected to the port operation on a secondary level:

1. State capital City of Magdeburg. The TRANSPORTWERK Magdeburger Hafen GmbH TMHG as municipal company and belongs to the state capital city Magdeburg. For This reason, the city of Magdeburg is a stakeholder who has to be considered mainly. Beside the financial income from the port services the cities the main interests are tax earnings from the external companies who settled in the port area, jobs created directly by the TMHG and secondarily by the companies in the port area.
2. The state of Saxony-Anhalt. The main interest of the Government of Saxony-Anhalt is the successful holistic development of the state. The transport policy objectives of the state are directly connected to the port. One objective of the government is the adjustment of the freight traffic. More freight volumes should be transfer from the streets to the inland waterways. Ecological issues motivate this objective of the state.
3. The German federal government. The federal government represented by the German Water and Shipping Authority has the general interest of a safe operation of the German inland waterways and the fulfilment of all relevant laws in the port facilities.
4. Customers of the TMHG. The main interests of the customers of the TMHG are high-quality and efficient port services (handling and storage of freights etc.) which are necessary for their business.
5. External companies and industries in the surrounding port area. These companies want to develop their own business in the best way using the port services.
6. Suppliers, sub-contractors, service providers. These companies take part in the port services in a supporting role. Their business are positive affected by the port.
7. The employers of the port are stakeholders, which are also interested in an optimized and sustainable operation of the port.

The stakeholder identification will be concretise in the port-specific stakeholder list.

6.3 Port processes description

6.3.1 General services

The following general services were identified in the port of Magdeburg:

- Provision of berths
- Scheduling for the ships and the handling processes of their freights
- Supply of local green electrician energy (wind energy) for the inland ships
- Coordination of traffic (Pick-Up, Delivery) in the dock areas
- General Controlling of the port operation regulations and guiding of operation in the docks

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- Provision and management of multi-modal transport logistics chains

6.3.2 Port services

The following port services have been identified:

- Handling and Storage of different freights
  - Container
  - General Cargo
  - Bulk material
  - hazardous cargoes
  - heavy duty
- Provision and control of operating supplies (gantry crane etc.)
- Commissioning of freights
- Cleaning of the docks – continuous Service, not related to a single handling job
- Renting and leasing of areas
- Support for the necessary customs services
- Port railway services

6.3.3 Commercial services

In addition to the described port services, the following commercial services are relevant:

- Logistic services – transport of freights from their origin location to the port and transport from the port to their next destination in the hinterland area
  - Container
  - General Cargo
  - Bulk material
  - hazardous cargoes
  - heavy duty
- direct sub-contracting to service providers – no intermediaries are involved

6.3.4 Maritime signalling services

- No classical maritime signalling services
- Signposting and signalling of the waterways in the port area
- Signposting and signalling of transport ways and streets in the dock areas

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6.4 Hinterland transportation and urban environment

The port of Magdeburg is a hinterland port. One of its primary purposes is the distribution of freights to the seaports and the distribution of freights from the seaports to its hinterland area. In order to fulfil the working tasks which result from this purpose, the port of Magdeburg has established a suitable trimodal infrastructure system. The railway is owned by the port. The road transport to the hinterland and external destinations is performed with the support of sub-contractors as well as the in- and outgoing traffic with inland ships.

Social Impact:

Beside the distribution of freights, the port of Magdeburg generates 80 internal jobs and give many companies a location for their production and operation. 5,000 more people find their work in external companies located in the port area of Magdeburg. Because of its impact to the city and the region of Magdeburg, the port is a very important factor in the social system of the area.

Economical Impact:
The state capital city Magdeburg its he owner of the TMHG. The earnings from the port services are a very important economical factor for the city of Magdeburg as well as tax incomes which are generated by the companies settled close to the port because of the logistic and port services the TMHG provides.

Impact to other Cities:
Beside its social impact to the whole region the port of Magdeburg supports the port of Aken in critical situations, such as low-water periods.

6.5 Port systems description

The different port terminals and infrastructures in Magdeburg were build up, restructured and modernized in a continuous way over the time.

Today a fibre-optic cables system connects all terminals and the port administration. From all relevant locations and working places in the port the employees get access to the company intranet. The operation in the docks, the trimodal freight handling and the communication from the workers in the docks to the employees in the port administration are supported additionally by radio communication solutions. Most terminal sites are equipped with video surveillance systems.

Within the trimodal Hanse-Terminal the Saxony-Anhalt Galileo Test Bed provides additional process monitoring systems. These systems enable the research and development of process monitoring functionalities in a productive port environment.

Several working tasks of the locational and operational management are solved with the use of classical office tools. Specific data base solutions support the work of employees in the port administration. Company-specific solutions were established for three different fields of work:

- Logistics and operational management,
- Real estate management,
- Port railway operation.

Beside of this the responsible workers of the TMHG working with customer-specific management solutions including direct access to external server infrastructures of major clients.

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A freight management system supported by office tools and company-specific database solutions is in use.

Furthermore, a maintenance system supporting a Lifecycle monitoring of the facilities, the infrastructures and the operating equipment gives a holistic view to the actual state of the port and the necessary maintenance activities in the future.

A traffic controlling system gives report about the in- and outgoing vessels. The system works also autonomously. Because of this, the responsible operators have a full overview about the in- and outgoing traffic.

The controlling systems, which is in use for monitoring the financial, the personal and other internal issues is based on SAP.

A daily and continuous information flow from the German weather service brings information to the port authorities, which are necessary to be prepared for weather and natural phenomes and to ensure the safety of the freight and the facilities.

6.6 Expectations and goals

6.6.1 Economic expectations and goals

The results of the PortForward project are intended to increase the efficiency of the production and logistics concepts at the Port of Magdeburg. The term production stands for port handling operations. The implementation of novel technology solutions, as they are planned in PortForward, should also lead to efficiency increases and cost reductions, as well as to qualitative improvement in the handling and operating processes. Technical focuses are:

- Digitally assisted management of port operating areas and resources
- GIS and site information solutions
- Virtual Twin Solution integrating real time operational information (e.g. from tracking services)
- Decision Support based on digital systems for optimizing structures and processes

The handling of general cargo has a special significance for the TMHG from an economic point of view. Because of that, these processes shall be focused within PortForward. The Port of Magdeburg expects to achieve improvements in efficiency and quality through targeted technology developments, especially in this segment.

6.6.2 Environmental expectations and goals

The Port of Magdeburg integrated the term "GREENPORT" in the company logo. It has incorporated the ecological design of the location and the operational processes into the mission statement of the company. The port hopes that PortForward supports this fundamental concern of the company. In particular, the following environmental goals of the company should be addressed:

- Reduction of CO2 and NOX emissions
- Use of novel environmentally friendly equipment (e.g. Hybrid Locomotive) and logistics concepts (energy efficient operational processes)
- Generation of renewable energy at the port area and use of renewable energies for the partners and customers of the Port of Magdeburg

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- Improvement of resource and energy efficiency in the production and logistics processes

The Port of Magdeburg wants to use novel, environmentally friendly concepts and solutions in the internal processes and even offer these to its customers and partners in the port area environment. Based on these goals the Port of Magdeburg developed the idea of the CityHub. This is intended to increase the impact of positive ecological effects.

6.6.3 Social expectations and goals

The integration of innovative and state-of-the-art technologies is an integral part of the mission statement and long-term strategy of the Port of Magdeburg. In addition to improvements in the production and logistics concepts, the port expects positive effects for the social environment and the general working environment of our port location.

The port wants to offer a modern work environment with effective tools to its employees. As the port processes are mainly connected to physical stress and stress based on the complexity of single operations, innovative solutions, like in PortForward, shall assist the employees as also facilitate and increase the satisfaction and identification of employees with their work. In addition, the use of innovative technologies increases the attractiveness of the workplace and supports the acquisition of new skilled workers or young workers.

The Port of Magdeburg attaches great importance to ecologically optimized and efficiently designed services in its external presentation. The integration of modern technologies, as made possible by the PortForward project, supports this approach and the fundamental principles of the company.

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7 Common expectations and goals

As it could be expected, each of the case study ports participating in PortForward have significant differences in terms of port main activities and stakeholders, processes more relevant for the port, interactions with its hinterland and urban environment, and implemented port systems. These differences imply as well different economic, environmental, and social expectations and goals. However, from the analysis that has been done of each port, it is possible to extract some commonalities in terms of expectations and goals that are shared by two or more of the PortForward ports. These common points are synthesized in the subsections below, covering the economic, environmental, and social axes.

Ports of the future should have as main strategic goal the adaptation of their development patterns to a changing environment. This strategic goal will encompass different aspects, such as the pursuit of single port logistics efficiency and cost optimization, or the close cooperation between the different members of the supply chain of marine logistics and land logistics, in order to reach a win-win collaboration and a sustainable, environmentally-friendly development. On the other hand, ports of the future shall aim at seamless information sharing and dynamic collaboration between all the agents involved, improving the efficiency, accuracy, observability, safety and environmental security of port operations.

7.1.1 Economic expectations and goals

From the analysis of the economic expectations and goals of the case study ports involved in the project, it can be derived that the economic dimension has to be analysed at two different levels:

- *Port authority + Port operators/key stakeholders:* the core expectation is that the Port Authority, together with the main stakeholders of the port, i.e. the different actors supporting the core port operations, are able to increase the competitiveness of the port. Among the shared port goals at this level, the following ones can be highlighted:
    - **Increased efficiency of port operations:** depending on the port, the goal of efficiency improvement may be focused on key operations of the port, or it can be addressed at a more general level. For instance, a key aspect for the Port of Magdeburg is the general cargo handling efficiency, while for the Ports of Baleares efficiency has to be addressed with a more transversal approach, covering a wide range of port activities.
    - **Increased quality of port operations:** in addition to the improvement in efficiency of port operations, some ports have highlighted as well the importance of increasing their quality, which will usually involve a more intensive monitoring of these operations.
    - **Cost reduction:** following to the improvement in the efficiency of port operations, the port authorities expect that together with the key port stakeholders, they will be able to increase the price competitiveness of the port services, e.g. price of techno-nautical services, cost of cargo handling, etc.
    - **Attraction of investments:** the attraction of private investments and supporting private initiative is a general strategic goal of any port. This goal can encompass different aspects, such as the upgrade/upscaling of port facilities and equipment, or

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enabling new business models and IT-steered innovative processes to address market's challenges.

- **Improved planning:** this goal can be interpreted differently by each port. It can be understood for instance as improved planning of maintenance activities (e.g. tailored and on-time maintenance), or improved planning of the port public domain, including infrastructure upgrades (e.g. measurement of demand for traffic to plan potential investments by the Port Authorities). In both cases, it is clear that the improved planning can have a direct economic return, and requires a deeper monitoring of the port infrastructure conditions and of the port processes.
- **Risk reduction:** although this goal has been mentioned only in the case of Livorno/Piombino, it can be an interesting economic goal for any port. Reduction of risks related to navigation, or to the handling of hazardous goods, can result in lower insurance costs for port activities.

- *Port customers:* by increasing the competitiveness of the port, port customers (e.g. shipping companies) will in turn improve their own processes, and thus they will be more likely to call at the port. The expectations of customers can be summarized as follows:
  - **Improved port operations reliability and timeliness:** Port customers will be attracted by reliability and timeliness of the port operations.
  - **Reduced logistic chain costs:** Cost of the logistic chain as a whole will be determinant for a customer to choose to call at a specific port.
  - **Smarter and faster port processes:** Port processes will influence the customer own processes. By making these processes smarter and faster, customers will be more competitive.

7.1.2 Environmental expectations and goals

Regarding the common environmental expectations and goals of the ports, the following ones can be highlighted:

- **Pollution prevention and reduction:** this goal can encompass different aspects, such as the monitoring of pollutant emissions by the port and identification of the main pollution sources, the effective reduction of specific pollutants (e.g. NO_X emissions), or an "optimized distribution" of noise sources in the port area. From the goals expressed by the ports, it shall be highlighted as well that pollution prevention encompass the air environment (e.g. air pollution and noise), the marine environment (e.g. water quality), and the port land environment (e.g. avoiding land spillages)
- **Fight against climate change:** this goal can encompass monitoring goals, such as the knowledge of the carbon footprint of the port, or the reduction of CO_2 emissions, e.g. using alternative fuels or the use of hybrid vehicles.
- **Rational use of natural resources:** this goal is tightly linked with the previous one, as it will typically imply the incorporation of energy efficiency criteria in port processes (e.g. through the Green Scheduling proposed by PortForward), the generation of renewable energy at port area, or its use by the port operators and its customers.

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- **Environmental compliance:** this goal can comprise different aspects, e.g. compliance with environmental regulations, implementation of a certified environmental management system for a systematic planning of objectives and actions to improve environmental performance, or the definition and implementation of a port environmental policy.
- **Environmental awareness and innovation:** this goal would encompass different aspects, such as the increased environmental awareness of port workers, customers, and end users; the perception of the port as a "Green Port"; or the joint development or adoption by port stakeholders and customers of solutions for tackling environmental issues, including the promotion of a circular economy.

7.1.3 Social expectations and goals

Lastly, the main common social expectations and goals listed by the ports have been:

- **Improvement of working conditions in the port:** this can encompass different aspects, such as more modern (technology enabled) working environment for employees, which facilitates worker satisfaction and identification with the port, and attracts new skilled and young workers; reducing physical stress or stress derived from complex port operations; better training of workers; and improved work-life balance.
- **Economic revitalization of the port region:** this can be achieved through regional innovation fostering, enabling new business development opportunities and through job creation. Although the introduction of ICT-based innovations and automation can lead to job losses, the goal should be that these innovations could improve the competitiveness and strategic positioning of the port, thus maintaining or even increasing the employment levels.
- **Social perception of the port:** to achieve a positive perception of the port by the regional/urban society. This goal can include as well the shared use of the port public domain for activities of social interest.

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8 Conclusions

D1.1. has carried out the analysis of end users expectations and goals basing on a set of activities among which the most important has been the organization of technical visits and focus groups/workshops with key stakeholders in each of the PortForward ports, which has been complemented with analysis of technical documentation provided by the port authorities. These insights need yet to be complemented with the inputs retrieved from external stakeholders through the questionnaire published online by the consortium.

Basing on this initial work, an analysis of PortForward use cases is being carried out, which will in turn constitute the basis for developing the PortForward framework requirements specification, and the definition of PortForward KPIs, thus finalizing the WP1 activities, and setting the basis for the development of PortForward framework architecture and components, and its subsequent validation in the ports participating in the project.

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