Capacity with a pOsitive enviRonmEntal and societAL footprInt: portS in the future era

COREALIS
THE PORT OF THE FUTURE

D.2.1: State of the Art of Port-Hinterland Connections

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List of Acronyms

Abbreviation / acronym	**Description**
AIS	Automatic Identification System
BP	Best Practise
BTS	Barge Traffic System
CEU	Car Equivalent Unit
D1.1	Deliverable number 1 belonging to WP 1
D1.2	Deliverable number 2 belonging to WP 1
EC	European Commission
ECT	Europe Container Terminal
ELWIS	Electronic Waterway Information Service
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FIS	Fairway Information Services
GDP	Gross Domestic Product
HPA	Hamburg Port Authority
ICT	Information and Communication Technologies
INE	Inland Navigation Europe
IT	Information Technologies
ITF	International Transport Forum
ITS	Intelligent Transport System
IWT	Inland Waterway Transport
LCT	Liège Container Terminal
LISP	Logistics Infrastructure Service Provider
LOLO	Load On Load Off
NtS	Notice to Skippers
OCR	Optical Character Recognition
PAV	Port Authority of Valencia
PBS	Premium Barge Service
PCC	Pure Car Carrier
PCS	Port Community System
PCTC	Pure Car and Truck Carrier
RIS	River Information Service
RORO	Roll In Roll Out

Abbreviation / acronym	Description
RSC	Rail Service Centre
TAS	Truck Appointment System
TEN-T	Trans-European Transport Networks
TEU	Twenty Equivalent Unit
TOS	Terminal Operating System
UIC	Railway International Gauge
ULCV	Ultra Large Container Vessel
VGM	Verified Gross Mass
VSA	Vessel Shared Agreement
VTS	Vessel Traffic Service
VTT	Vessel Tracking and Tracing
WP	Work Package

Executive Summary

The purpose of the D2.1 "*State of the Art of Port-Hinterland Connections*" is to provide an overview of the hinterland connections (road, railway and inland waterways) of the COREALIS ports (i.e. Antwerp, HaminaKotka, Livorno, Piraeus and Valencia). The deliverable firstly addresses how the hinterland connectivity of a seaport is identified as a key factor for the port competitiveness, taking into consideration not only the hinterland infrastructure but also the sustainability of the transport chains and the efficiency of the services provided. Additionally, the deliverable assesses the most important trends of the maritime industry and their consequences and impacts for ports, terminal operators and hinterland connections.

Secondly, the deliverable identifies potential ICT innovations and new technologies that can help to foster hinterland connectivity, optimizing procedures and streamlining information flows in the transport chain. In this sense, D1.1 "*Port of the Future challenges, enablers and barriers*" feeds this deliverable that focuses the attention on specific disruptive technologies such as automation, Internet of Things, Big Data analytics, Blockchain or Artificial Intelligence as the ones that may impact on day-to-day port operations, and more specifically, impact on hinterland connections and its related processes.

The definition of the main challenges, the trends of the maritime-port industry and the potential ICT solutions is followed by a summary of the main hinterland connections of each of the COREALIS ports. In this sense, the deliverable focuses on those traffics that have higher impacts on the transport chains, such as the container traffic and RORO. Key hinterland infrastructures of each port are also identified.

Finally, sections 4 and 5 identify and summarize, respectively, a set of already implemented solutions worldwide to improve hinterland connectivity (i.e. rail, road, inland waterway and others) that can be used for benchmarking purposes for the COREALIS ports. Besides, the identification of the successfully implemented experiences in other ports may be interesting for seeking alternatives to the different problems to be faced not only in the COREALIS ports but also in others. In addition, it can provide an overview of the port industry trends in the pursuit of the port of the future era.

As a conclusion, it is worth mentioning that after the assessment of the hinterland connectivity of the COREALIS ports, there are important differences in terms of hinterland connectivity and the level of technological development. On the one hand, there are major ports such as the Port of Antwerp (the second largest port in Europe) that is really well connected by rail and inland waterways to a huge hinterland such as central Europe. On the other hand, ports such as Piraeus and Valencia that, even though they are important ports in terms of traffic, they are located in peripheral areas of the European Union, which means that have more limited hinterland connections and more constrains in terms of gateway traffic generation. In the same manner, ports or Livorno and HaminaKotka are also located in more constrained areas with more limited accesses and less development potential that influence their hinterland connectivity. In reference to the implementation of cutting-edge technologies and innovative business models, it is also possible to identity the gap between major ports such as Antwerp and Valencia and smaller ones but this is justified by the level of complexity and number of simultaneous port operations.

1. Introduction

As a result of the Task 2.1, the D2.1 “State of the Art of Port-Hinterland Connections” tries to depict the state-of-the-art of hinterland connections, on the basis of road, railway and inland waterways connections, of the COREALIS ports, namely the Port of Antwerp, the Port of HaminaKotka, the Port of Livorno, the Port of Piraeus and the Port of Valencia.

The first section “*The importance of hinterland connections*” addresses how the hinterland connectivity of a seaport is identified as a key factor for the port competitiveness. Indeed, in the Deliverable D1.2 on the “*COREALIS Personas and Stakeholder classification*” there were collected opinions of different stakeholders and the Deliverable D1.1 “*Port of the Future challenges, enablers and barriers*” showed the results of these questionnaires in which the hinterland connectivity was selected, by far, the most important enabler for the Port of the Future. In this list of enablers, there were others such as automation, logistics hubbing scalability of operations or traceability of operations.

This first section of the deliverable also assesses the most important trends of the maritime industry and their consequences and impacts for ports, terminal operators and hinterland connections. More specifically, it addresses the growth of container vessels and the related cascade effect; the increase of shipping alliances and how it also increases the pressures on ports; the increase of volume peaks and their related impacts; and finally some basic strategies about how to respond to cargo concentration by transport mode.

In addition, section 2 of the deliverable identifies potential ICT innovations and new technologies that can help to foster hinterland connectivity, optimizing procedures and streamlining information flows in the transport chain. In this sense, D1.1 “Port of the Future challenges, enablers and barriers” feeds this deliverable that focuses the attention on specific disruptive technologies that may impact day-to-day port operations, and more specifically, impact hinterland connectivity. To that end, it is important to pay attention to automation, Internet of Things, Big Data analytics, Blockchain or Artificial Intelligence as the most disruptive ones that may affect the hinterland connectivity.

Section 3 of the deliverable “*Hinterland connections of the COREALIS ports*” summarises the main hinterland connections of each of the ports involved in COREALIS project (i.e. Antwerp, HaminaKotka, Livorno, Piraeus and Valencia). This section puts emphasis on those traffics that have higher impacts on the transport chains, such as the container traffic and RORO, identifies key hinterland infrastructures of each port and highlights the current strategies of each of them to foster hinterland connectivity. Moreover, a complete port template including most important traffics, hinterland connections, regular hinterland services, infrastructures (physical and IT) as well as some best practises can be found in Annex 1. This port template is divided in the following sections:

- INTRODUCTION – PORT GENERAL INFORMATION
- SECTION I. PORT TRAFFIC INFORMATION DATA, including hinterland and foreland most relevant traffics as well as port traffic evolution.
- SECTION II. PORT INFRASTRUCTURE AND SERVICES including infrastructure, maritime and rail regular services from/to the port and the most relevant hinterland infrastructures: land accesses and main links to the port.

- SECTION III. PORT IT SYSTEMS & COMMUNICATION AND INFORMATION EXCHANGE which includes the most relevant IT systems in the port for Road, Rail and Inland Waterway Transport and the existence or not of Port Community Systems (PCS)
- SECTION IV. IDENTIFICATION OF HINTERLAND BEST PRACTICES in which there is a short description of Best Practises related to hinterland connectivity implemented in the port and also includes the main barriers identified, the objectives pursued and the main actors and beneficiaries involved.

Sections 4 and 5 identify and summarize, respectively, a set of current practices worldwide to improve hinterland connectivity (i.e. rail, road, inland waterways and others) that can be used as benchmarking solutions for the COREALIS ports. In total, nine best practises for road transport have been identified, six best practises for rail transport and nine for inland waterway transport. Additionally, two hinterland connectivity platforms (Navigate in Rotterdam and Connectivity Platform in Antwerp) were also identified as best practises that provide the users the possibility to find the best and most efficient way to transport container cargo via their respective ports.

Best practises and solutions identified on Road Transport:

- Port Community System
- ZEAL
- SI-ZEAL
- Intelligent Logistics Chain
- Closing Time
- Road Transport App
- Smart Port Logistics
- Off-Peak and Truck-Tag Programme
- Truck Appointment System

Best practises and solutions identified on Rail Transport:

- Extended gateway inland platforms
- Implementation of hinterland corridors
- OCR rail
- Rail port shuttle
- Rail incubator
- Optimised distributed rail transport in the in the port: Railport

Best practises and solutions identified on Inland Waterway Transport:

- River Information Services (RIS)
- Instream: smart and efficient inland navigation
- Automatic Identification Systems (AIS)
- Estuarial vessels in the region of Flanders: Deseo/Tripoli and Amberes
- LIVRA - Logistics Chain Information on the Fairway from Rotterdam to Antwerp
- ECT Extended gate concept – European gateway services
- Vessel Traffic Services (VTS) in the Netherlands – focus on VTS Nijmegen
- ELWIS - Electronic Waterway Information Service
- Bottleneck Information in the Danube FIS Porta

Some of the best practises identified are already implemented in some of the COREALIS ports. However, the identification of best practises and successful solutions is not limited to the ones implemented in the ports of the COREALIS project. The Task 2.1 has assessed solutions for hinterland connectivity in other ports because other successfully implemented experiences worldwide may be interesting for seeking alternatives to the different problems to be faced by ports of the COREALIS project. Besides, the identification of these best practises related to hinterland connectivity, provides an insight on the port industry trends in the pursuit of the port of the future era.

Finally, the deliverable concludes with the assessment of the hinterland connectivity of the COREALIS ports highlighting that there are important differences in terms of hinterland connectivity within them due to the variety of ports assessed and the location and potential hinterland accessibility of each of them.

2. The importance of hinterland connections

2.1. Hinterland implications of the current maritime trends

The importance of the hinterland connectivity of a seaport is identified as one of the key factors for the port competitiveness [1]. Moreover, the efficiency of the hinterland accessibility is based in five conditions [2]. Firstly, the transport infrastructures to the hinterland need to be well developed (i). Secondly, the transport infrastructures need to be used efficiently (ii) and the transport chains need to be coordinated (iii). Finally, it is needed a sustainable hinterland transport system (iv) and the service provided by the private sector need to be attractive (v). In response to this, ports have developed multiple strategies and policies to improve their hinterland connections, aiming at extending the hinterland destination of the cargo handled in the port (e.g. dry ports, better gates management, modal split policies, etc.). For this reason, this section assesses the most important trends of the maritime industry and their consequences for ports, terminal operators and hinterland connections.

So far, one of the major challenges for ports and operators is the upgrading of facilities to cater the increase in vessel size and react to carriers' pressures. Larger vessels generate cost savings for carriers by decreasing maritime transport cost. However, larger ships require infrastructure, equipment and processes able to handle larger traffic peaks, so ports need to offer solutions regarding the spatial and time aspects of cargo handling.

The new mega vessels, shipping alliances and volume peaks require important investments in infrastructures, equipment (e.g. bigger cranes), more effective processes' and better planning in order to meet the carriers' demand. Outside the port facilities, the increment of the cargo peak volumes affects the highways, inland waterways and rail networks that need to be adapted to the new market trends and have to answer the increase of cargo volumes. In this sense, the increment of cargo peaks requires higher number of trucks, trains or barges calling at the port day to day. This situation creates new problems in the land-based infrastructures due to their higher rigidity and the lower capacity of the inland vehicles. Following schematic illustrates the main consequences of the current key maritime trends that affect ports (Figure 1), and more specifically, their implications for the terminal operators according to Drewry [3].

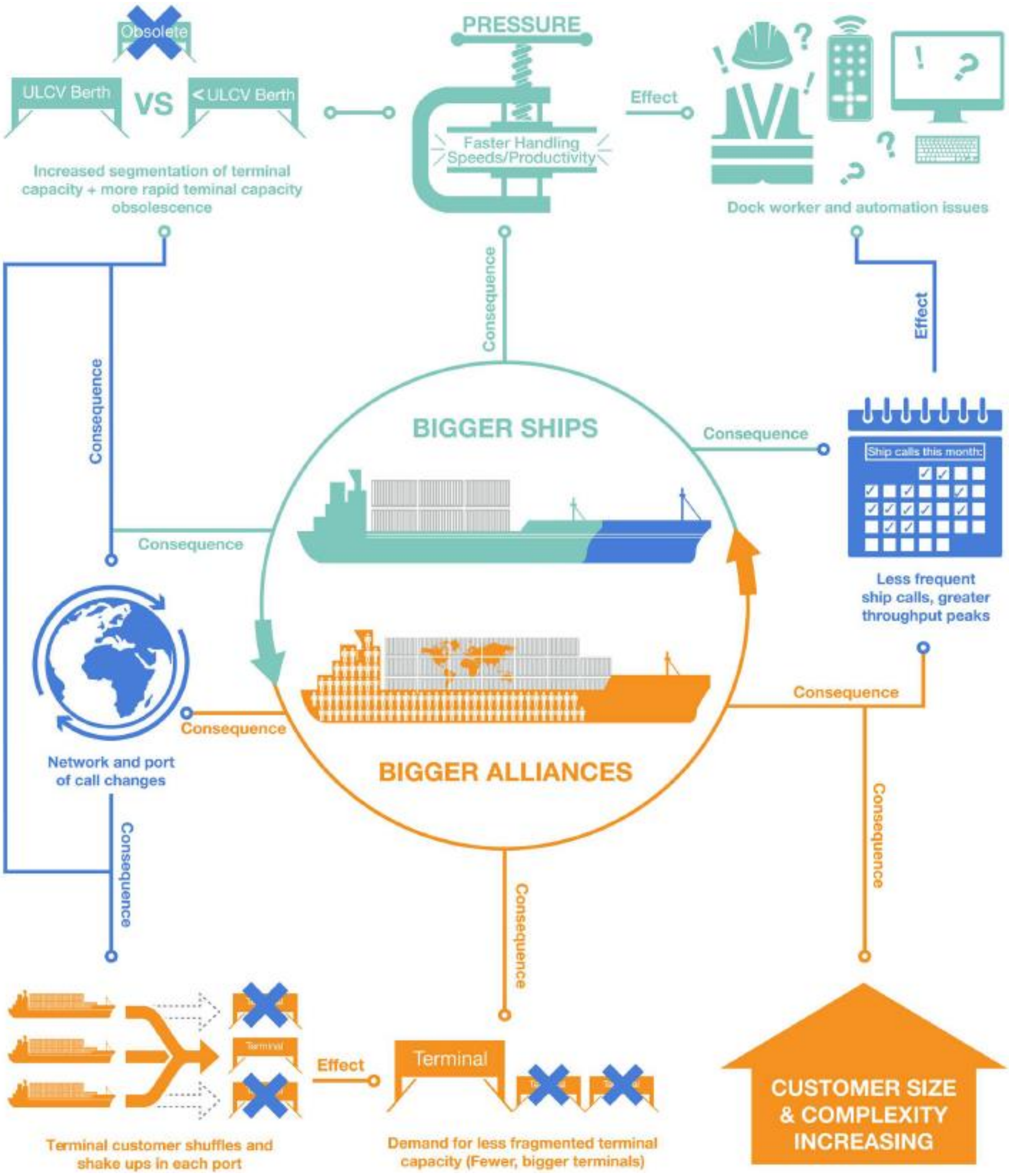

Figure 1. Key challenges of the maritime industry for ports and terminals
Source: Drewry – Global Container Terminal Operators: Annual Report 2015 [3]

2.1.1. The growth of vessel size

The principle of economies of scale is a key element to the economics of maritime transportation so the larger the vessel, the lower the cost per unit transported [4]. This principle started with oil tanker vessels, which reached their maximum size during the '70 and '80. However, due to environmental disasters, this trend stopped for oil tankers and nowadays the principle has particularly been introduced in bulk carriers and container vessels.

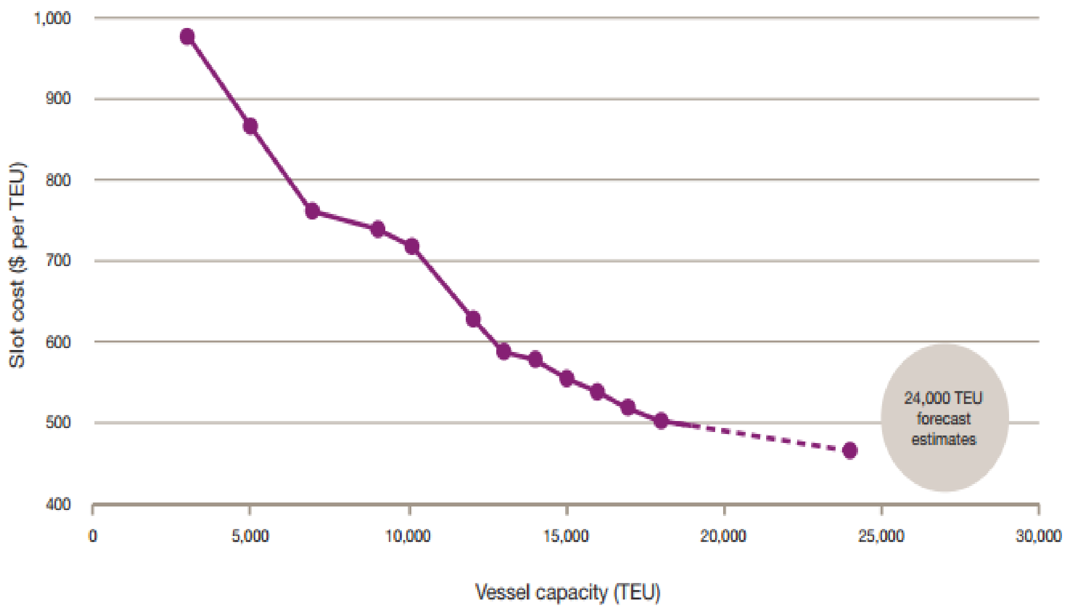

Figure 2. Operational cost per vessel size and TEU
Source: Drewry – Consolidation in the liner industry 2016

From the perspective of the maritime carriers, the use of larger vessels produces economies of scale and, consequently, lowers costs per unit carried (Figure 2). On the contrary, from a terminal operator perspective, the larger the ship the more intense pressures in terms of infrastructure investments, crane and equipment operative and performance level requirements.

Nowadays, the biggest containership of the world, the OOCL Hong Kong delivered in May 2017, is 399m long and almost 59m wide. This vessel is part of the family of Ultra Large Container Vessels (ULCV) of the shipping line OOCL that has a nominal capacity of 21.413 TEU. This containership just an example of the new generation of ULCV transporting nearly 20.00 TEU (e.g. MSC Oscar, Madid Maersk, MOL Triumph, etc.) that have allowed the carriers to reach economies of scale decreasing the cost per unit transported. However, the range of ports that can accommodate ships of these dimensions is limited. This is why the operations of these mega vessels are scheduled along the most important trade routes, such as the East Asia - Europe route. Moreover, the increase in the size of the container vessels affect the rest of the ports due to the cascading effect, which means that the old vessels are deviated to other routes and ports. This trend principally affects the container industry even though it also concerns the bulk cargo and, in a more moderate growth rats the RORO cargo [5].

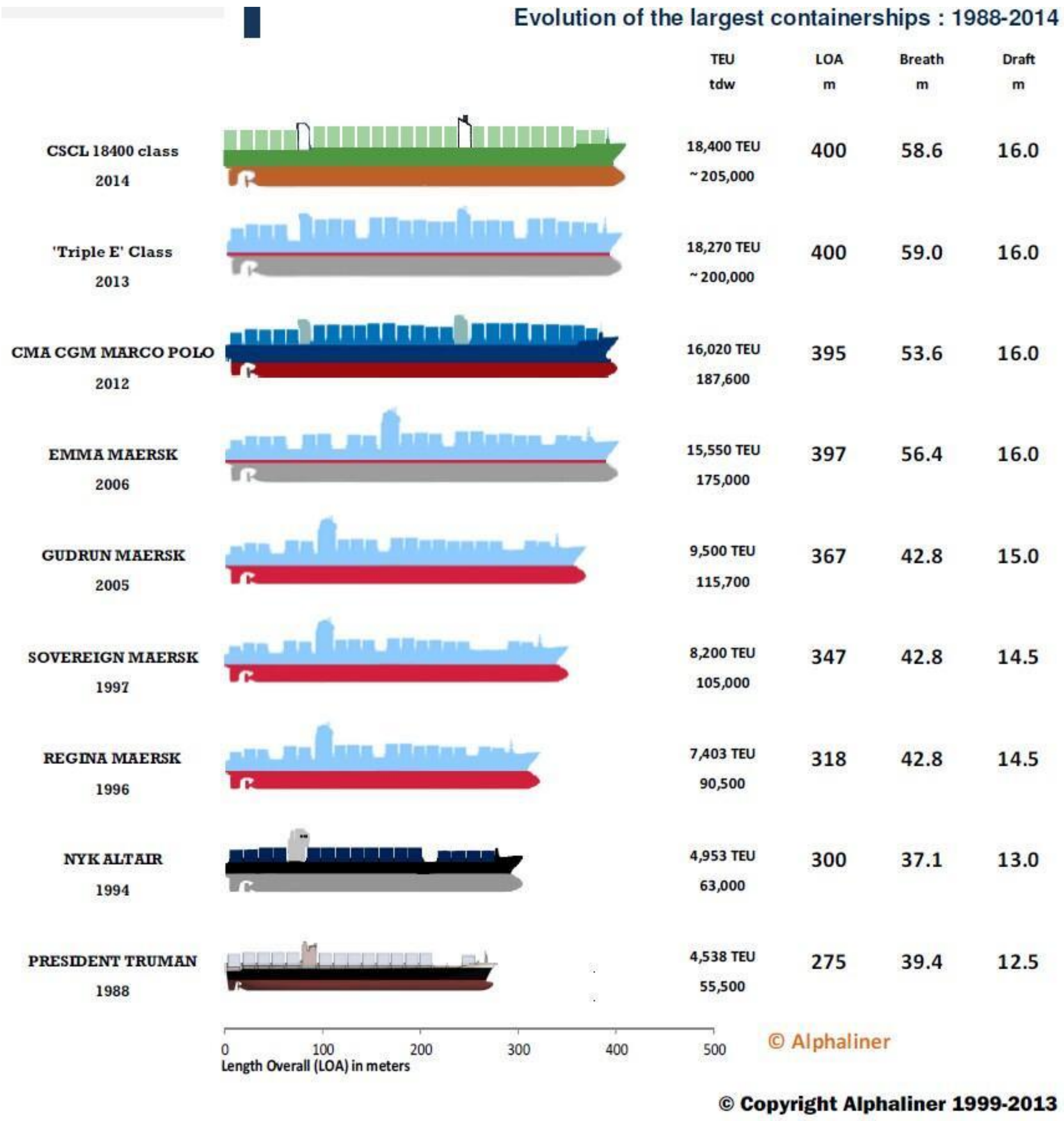

Figure 3. Evolution of the size of containerships
Source: Alphaliner [6]

In conclusion, the pursuit of economies of scale in the maritime transport (i.e. reduce the cost per unit transported) leads to an increase of the vessel size but also implies that a fewer ports are able to handle them, increasing the pressure for the inland operations. Bigger vessels mean larger number of containers arrive in every port call, so increases the difficulty to serve them with an acceptable level of service.

2.1.2. Shipping Alliances

The increase of the shipping alliances and number of VSA (Vessel Shared Agreements) is in relation to the growth of the size of containerships. As aforementioned, the bigger the ship the smaller cost per unit transported, but the only way to fill the new large containerships and, consequently, obtain economies of scale, is to pool volumes of the carriers by sharing ships on particular trade routes with high cargo volumes.

Larger containerships are only economical feasible and profitable but mainly if they are full-loaded. The container shipping industry is mainly driven by price competition and differentiation respect the others players is not significant. Under this framework, container-shipping lines are following a strategy of alliances and VSA in order to be able to fill the so-called mega-vessels on the main routes. The different players of the shipping industry that are operating on the same trade routes share their capacity to fulfil their ships but also try to expand their networks and their geographical coverage.

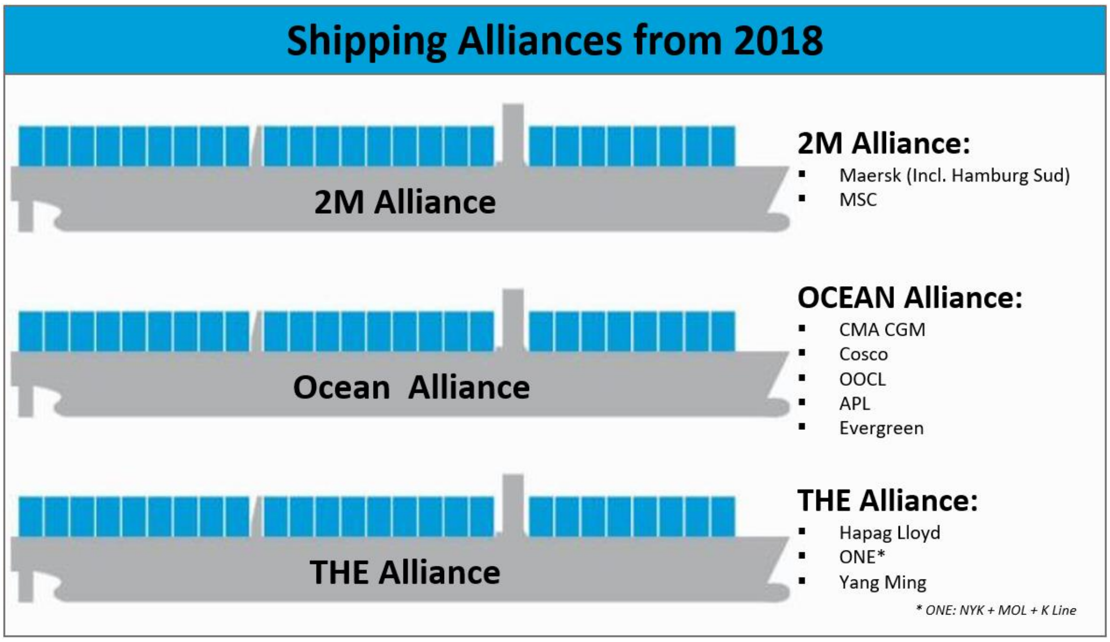

Figure 4. Current shipping alliances
Source: Own elaboration

The expansion of carrier alliances has consequences for ports and terminals, which have to face the challenge of greater concentration volumes. Due to the increase of the vessels, there are fewer players capable to operate them, thus less choice of ports and terminals for the carriers. In this sense, the concentration of greater volumes and the increasing concentration of alliances affects the terms of negotiations between shipping carriers and terminal operators, reducing the bargaining power of ports and terminals. Bigger ships mean greater concentrations of cargo that has to be accommodated in one port or terminal so that traffic can be gained or lost in huge volumes. This situation adds new pressures to ports and terminals that have to respond properly to the new market guidelines.

2.1.3. Mega-Ships, Volume peaks and alliances: Impacts

The new generations of ultra large vessels have significant consequences that affect the rest of the transport chain. This especially affects the inland transport, because the infrastructures required for the inland transport are more inflexible. Besides, the investments in port infrastructures and superstructures need time to be amortized.

In reference to port activity, new mega-ships produce very large volume peaks of hinterland traffic in gateway ports. The impact on inland transport is not new but the scale is unprecedented and is heavily dependent on the vessel type and operation. For instance, RORO import operations generates significant volume peaks after the vessel call, meanwhile it generates volume peaks before the vessel call for export operations. However, for container traffic, car carriers or break-bulk cargo the volume peak can be spread in a larger time window.

The response to volume peaks needs to be address not only from the infrastructure point of view. In this sense, the capacity optimization through better planning thanks to new IT solutions is particularly necessary in gateway ports. Solutions for better gate management such as Truck Appointment Systems or promotion of off-peak operations are compatible with infrastructure upgrades. In addition, modal shifts from road transport to rail or inland waterway transport become essential to face the volume peaks generated.

Thus, mega vessels imply hinterland capacity and management requirements to ports in the main commercial routes that need to be addressed in order to handle the new generations of mega ships. Moreover, not only major seaports are facing new infrastructure requirements and policies for road, rail and inland waterway transport, the smaller ones will have to update their infrastructures and systems due to cascading effect.

As an example of the hinterland impact, following figure illustrates impact in terms of inland transport of a mega vessel that realizes a port call of 8.000 TEU. In this example, it was considered a 50% of transshipment and 50% gateway for the container traffic.

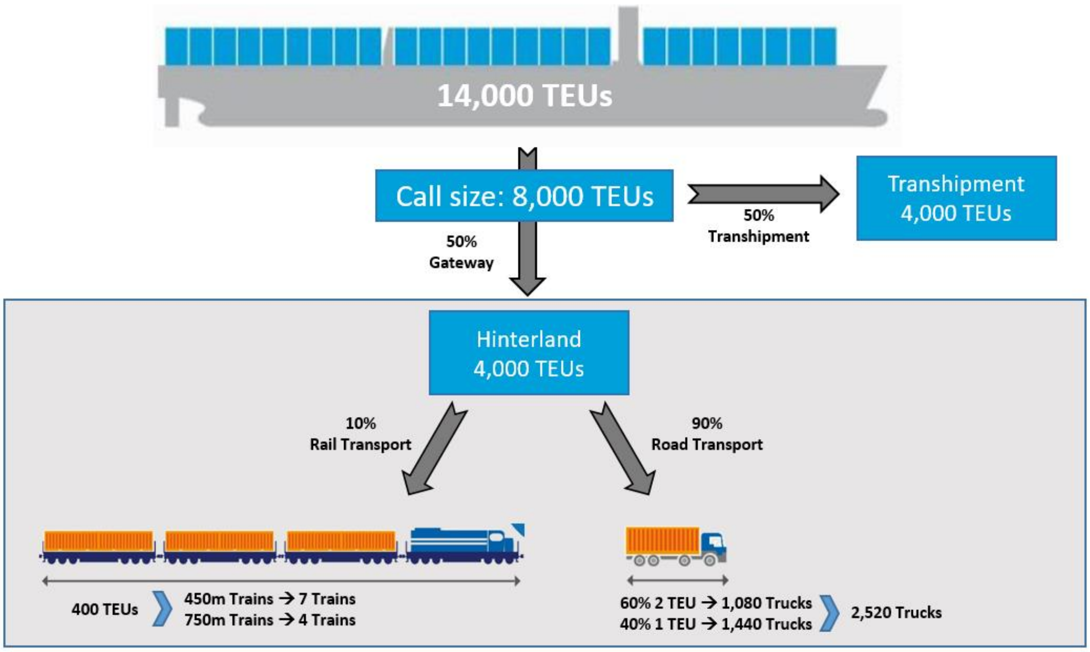

Figure 5. Hinterland impact of a mega containership port call
Source: Own elaboration

RORO cargo is other port flow with significant hinterland impact. MOL launched the first Pure Car Carrier (PCC) in 1965 to meet the needs of Japan's emerging automobile export trade. The capacity of the first PCCs were about 1,200 automobiles. Currently, their cousin vessels, pure car and truck carriers can accommodate all types of vehicles: cars, vans, trucks or even construction machinery. They count with up to 14 cargo decks and nowadays the largest PCTC (i.e. mv "Hoegh Trigger") has the capacity to carry 8500 Car Equivalent Units (CEUs) at once. Consequently, following a similar approach to the container vessel operative, it has been assessed the hinterland implications in terms of inland transport of the Pure Car and Truck Carrier (PCTCs) export operation.

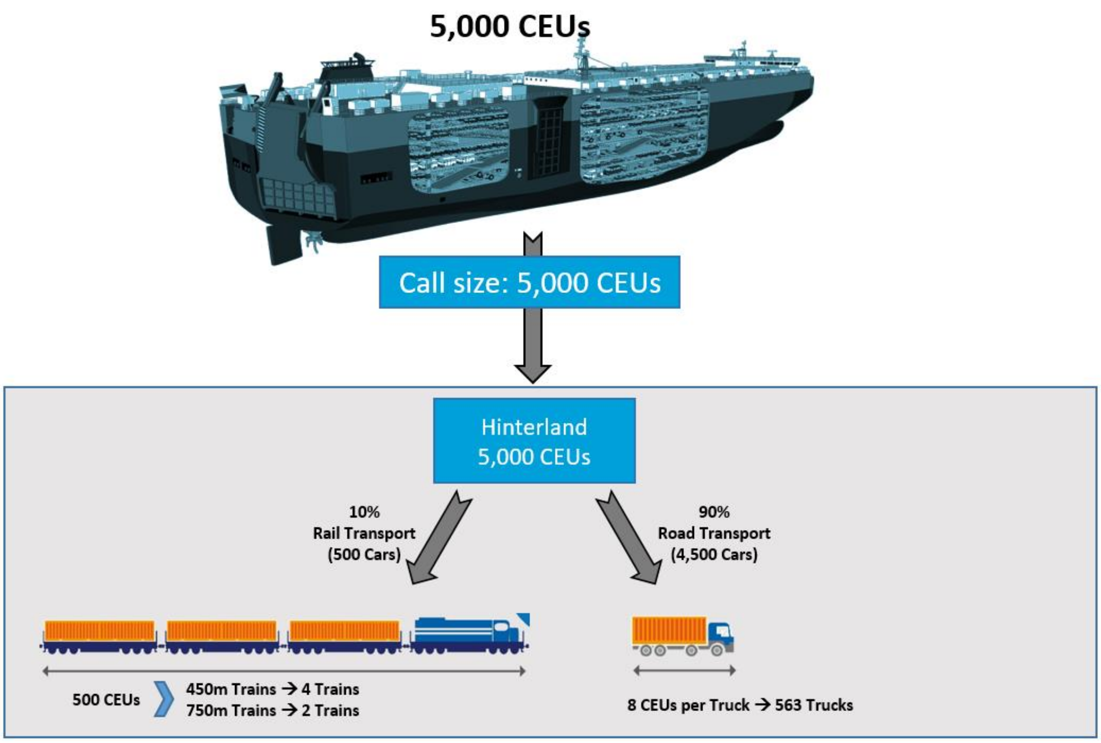

Figure 6. Hinterland impact of a Pure Car and Truck Carrier (PCTCs) export operative
Source: Own elaboration

As a consequence of the cargo concentration, some actors of the transport chain are not favourable to mega-ships due to the problems they might cause for logistic chain, especially to the inland transport. On one hand, shippers are interested in frequent and reliable maritime transport links. However, bigger ships and shipping alliances will reduce the service frequency and the number of port calls. Moreover, shippers parcel out the deliveries in different ships in order to hedge risks instead of concentrating everything in one.

Besides this, there are confronted some of the main actors of the port community. Firstly, terminal operators have to face the need to adjust equipment and upgrade their infrastructures in order to be able to handle volume peaks. Terminals are already facing major challenges in handling the existing generation of vessels but new vessel generations will require bigger cranes and also more cranes per vessel to increase the productivity and reduce the stay in port. In the same manner, ports are confronted with new requirements on port infrastructures and transport ministries concerning port hinterland infrastructure and inland transport. Freight forwarders and logistics operators have to be more concerned with disruptions or delays of mega-ships because they could cause additional transaction and coordination costs. Finally, the peaks associated with mega-ships could cause congestion and delays to the inland transport due to its lower flexibility, and consequently, affect the entire logistic chain.

2.1.4. Response to the volume peaks by transport mode

The response to the volume peaks caused by the traffic concentration can be faced following different strategies. On one side, following modal split strategies and shifting to other hinterland transport modes (i.e. railway, inland waterways and Short Sea Shipping) because in the majority of the ports the inland transport is dominated by road transport [7]. On the other side, following port gates strategies for better management and planning of the trucks calling the port. In both cases, the target is to mitigate the port traffic because trucks are responsible of a significant part the congestion nearby port area. This specially affects those cities in which the port is surrounded by the city neighborhoods, leading to urban congestion and environmental impacts. In response to this problematic, ports intend to shift from the road to other hinterland transport modes the gateway traffic. In this regard, ports can implement different policies to reduce the hinterland traffic such as incentives schemes, dedicated infrastructure and competition in hinterland modes. Some strategies and policies that ports can apply to respond more effectively to the volume peaks by transport mode are:

- Strategies for Road transport
  - Implementation of Truck Appointment Systems (TAS)
  - Implementation of closing times for transport deliveries/pick-ups
  - Incentive of Off-Peak deliveries/pick-ups
  - Implementation of dedicated logistics areas to organize the road transport
- Strategies for Rail transport
  - Dry ports
  - Rail shuttles/Corridors
- Strategies for Maritime Hinterland: Inland Waterways & Short Sea Shipping
  - Short Sea terminals
  - Coastal Shipping
  - Inland Waterways

These strategies will be further elaborated in following sections of the deliverable including some successful implementation stories.

2.2 New technologies and their application to hinterland connectivity and inland transport

The challenges of port-generated traffic affecting the city hinterland are common and have as a root cause the conventional port planning. Usually hinterland connectivity was not a priority in port planning and ports are reached through hectic city centres, resulting with increased road congestion.

Port hinterland connectivity and inland transport needs innovative approaches of various transport stakeholders, connecting road, inland waterways and rail networks, which are able to handle similar cargo volumes as the port itself.

Due to the fact that the ports have become more competitive and can offer a various number of facilities and services to the end user, the hinterland connectivity becomes an added value for the customer's choices for port services and offers.

As the technology is advancing at an enormous speed, port-hinterland connectivity is crucial and should be seamless with an integrated planning with road, water and rail hinterland connections. Extended gates and multi-modal connectivity will facilitate the port-hinterland connectivity [8].

The development of gateway, regional and land bridge connectivity is foreseen to expand opportunities for a major part of worldwide cities located in the hinterland in particular in Europe, United States and China.

With the high competition across various logistics actors, companies face a fast pace innovative ICT solutions, and as a result, many of the ports operations will be automatic.

New technology-driven companies within the e-commerce have already entered the transport and logistics arena and their applications to hinterland connectivity and inland transport will give them a competitive edge to bring new models to the market. In addition, forwarders are confronted to choose collaborative technology driven networks.

ICT innovations, new technologies and their application to hinterland connectivity and inland waterways are linked with the creative and disruptive environment of digital innovations. One of the true challenges will be to reconcile disruptive technology with the real-world environment of day-to-day port operations in particular to hinterland and inland waterways.

The new disruptive technologies and innovations will create a new market and value network and eventually might disrupt an already existing market and value network. In this case, particular attention should be given to robotics and automation, autonomous vehicles for port operations, drone planes and drone ships, Internet of Things, Big Data analytics, Blockchain, Artificial Intelligence etc. [9].

Robotics and automation

Automation of the ports has firmly advanced considering various operations from water side to the land side and from ship to shore activities through terminal tasks to land connected modes.

The degree of automation varies from the port remote controlled operations to the full participation of port services and logistics providers in an interrupted economy, growing the ports attractiveness and boosting the inter-connectivity with local industry or industry clusters in the hinterland.

Autonomous vehicles for port operations

The development of autonomous vehicles such autonomous trucks and cars involves its own threats and opportunities to hinterland connectivity and inland transport. In fact, the definition of the levels of driving automation is based in who does what (i.e. the car or the driver) regarding the different driving actions: (i) steering, acceleration, deceleration and signalling; (ii) monitoring and responding to driving environment; (iii) fallback performance of dynamic driving tasks; and (iv) context [10]. See figure below to understand the five different levels of driving automation:

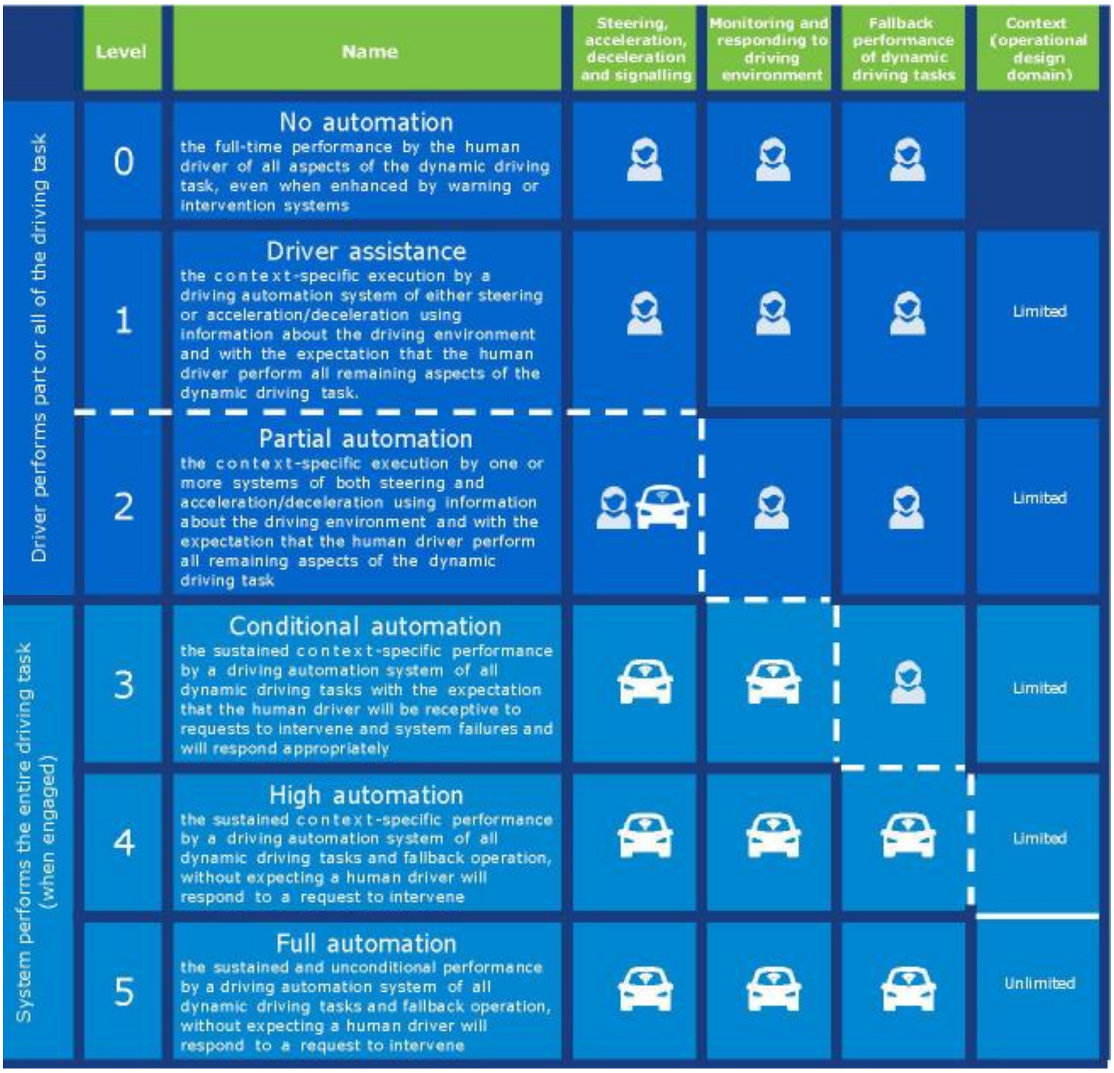

Figure 7. Levels of driving automation
Source: ITF (2017) Managing the Transition to Driverless Road Freight Transport [10]

In reference to truck automation, many advances have been done in the recent years and one is especially outstanding: platooning. Platooning consist of a lead truck whose human driver navigates traffic, with a number of trailing vehicles automatically undertaking the steering and braking required to maintain a safe (mostly fixed) distance between the vehicle in front [11].

While there are important possibilities for platooning to reduce crashes, fuel and labour costs of a given set of trips, these advantages should increase as increases the driverless operation of trucks. In this sense, the key motivations for having higher degrees of autonomous trucks are increased efficiency and safety, reduction of accountability for logistics firms when human driver commits an error and reduction of transportation costs etc.

Drone planes and Drone Ships

Drones as a new technology for hinterland connections and inland transport can be useful port tools for security surveillance of ports and monitoring its operations, noticing port equipment and ships problems.

Main current obstacles for usage of drone planes are more in the legal aspects such as the regulatory issues and harmonization challenges in international setting along with risk related issues and complexity of drone usage in public domains.

Nevertheless, the application of drones is currently having a less strong direct impact on port logistics operations where inter-connection with other supply chain actors is involved and is not foreseen in the very near future.

In addition, drone ships are robots which are less noticeable and face as well regulatory challenges as international maritime agreements have very specific and clear specifications on minimum crew requirements, along with the safety concerns (specifically weather aspects, repair requirements and the uncertainty how such autonomous operated ships would function).

Internet of Things

Internet of Things (IoT) is a new technology that has the tendency to revolutionize many aspects of our life with the tendency to increase the efficiency. This technology has experienced a rapid growth and will experience even a greater progress notably by the coming years.

Nevertheless, with this revolution the security threats and privacy challenges related to inland transport have to be considered and never underestimated. Connecting of vehicles to Internet opens up the possibility for the new logistics company to come with innovative services to make the inland transport easier.

Ever more a large range of physical objects are being equipped with sensors, allowing port equipment, infrastructure including autonomous and robotised vehicles to generate data. Port stakeholders will benefit from this way of communication in order to optimise and automate processes and have real-time insight.

Some IoT domains and key applications to hinterland connectivity and inland transport range from transportation and logistics (augmented maps, assisted driving, mobile ticketing, environment monitoring), smart water (portable water monitoring, chemical leakage detection, pollution levels, river floods), smart cities, smart environment etc.

Ever more a large range of physical objects are being equipped with sensors, allowing port equipment, infrastructure including autonomous and robotised vehicles to generate data. Port stakeholders will benefit from this way of communication in order to optimise and automate processes and have real-time insight.

Virtual reality

Virtual reality (VR) is a technology in full expansion which will become part of most almost every business operation including port related activities.

In a port related environment the VR will have a wide field of applications ranging from operational support of how to execute certain processes to active safety or security interventions.

Other applications could regard more complex VR applications in extending value added service offerings in warehouses, assisting the service providers with product assembly, refurbishment or repair activities.

Blockchain and Artificial Intelligence

In the future, blockchain will probably offer solution for ports and inland transport and they will face benefits from this technology. Various drivers who collect containers, carriers, forwarders, haulage companies will benefit from blockchain distributed database and its secure system. All the parties involved in application of the blockchain will keep control of the information in a secure way, avoiding the possibilities of manipulated information.

Blockchain technology application to hinterland connectivity and inland transport will additionally make it possible to transfer documents in a secure way, or to obtain a complete overview of the physical progress of the container.

In fact, there are several possible applications with blockchain technology and artificial intelligence and various ports have to co-operate in knowledge sharing and best practices to come up with some shared solutions.

Last but not least, many of the key activities in transport sector will experience tremendous change e.g. from manual driving to autonomous driving, from decision making capabilities to machine learning algorithms, from memory to maps and environmental models, eyes to sensors, ears to vehicle to X communication, reflexes to actuator control.

These technological breakthroughs linked with consumer preferences are going to shift the entire future behaviour of hinterland connectivity, inland transport and revolutionize port operations [9].

Obviously, the traditional business models for hinterland connectivity and inland transport will be replaced and enriched with new IT solutions.

3. Hinterland connections of the COREALIS ports

This section presents a summary of the COREALIS ports (Antwerp, Hamminakotka, Livorno, Piraeus and Valencia) including, on one hand, most important traffics and characteristics of the ports and, on the other hand, most important hinterland connections (i.e. rail, road and inland waterways). A complete description of the hinterland connections of each port can be found in the Annex 1.

3.1 Port of Antwerp

The Port of Antwerp is the second largest port in Europe with more than 223 million tones and 10.4 million TEU handled 2017 [12] and it has exceeded the 200 million tones milestone for the third year in a row. Its geostrategic position as one of the main ports of the route Far East – North Europe, makes it a global actor with more than 300 port calls to more than 800 destinations. The Port of Antwerp has a central position in central Europe that provides to its customers a link between the world's biggest maritime routes and Europe's most important centres of production and consumption. Besides, compared to its neighbourhood ports in the Le Havre – Hamburg range, including some of the most important of Europe such as Hamburg, Rotterdam, Le Havre, Bremerhaven, etc., Antwerp is the furthest inland (i.e. 80 kilometres), which makes Antwerp the fastest and most sustainable connection with the hinterland.

In reference to the port facilities, it counts with five deep-sea dedicated container terminals and is the home of the largest petrochemicals cluster in Europe, which creates a strong demand for containerised and other freight transport. Besides, the port has 16 liquid bulk terminals and 12 for dry bulk [13]. All these diverse traffics complement each other and involve the production, handling and transport of large volumes of freight cargo in the Port of Antwerp.

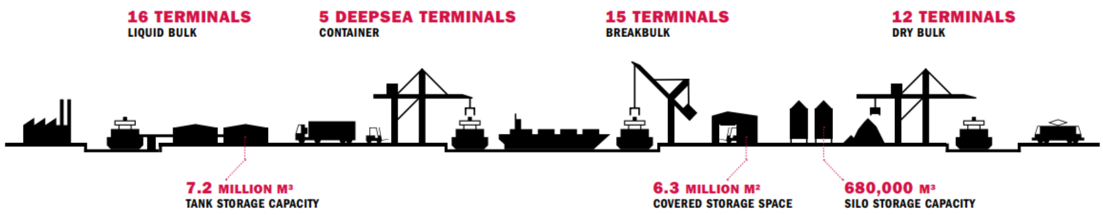

Figure 8. Schematic of the main facilities of the Port of Antwerp
Source: Port of Antwerp website [13]

In reference to the containers industry, the Port of Antwerp has five main container terminals: MSC PSA European Terminal, Antwerp Gateway Terminal, PSA Noordzee Terminal, PSA Europa Terminal and Independent Maritime Terminal, some of which can accommodate the largest container vessels in the world (ULCS). For instance, in the new Deurganckdock, the Port of Antwerp can handle container vessels with a draught up to 16.0. Besides, the high productivity, flexibility and cost efficiency offered to the shipping companies by Antwerp makes it one of the fastest growing container ports of the Hamburg - Le Havre range.

The Port of Antwerp has modern infrastructures, facilities and equipment, semi-automated operations and highly trained personnel that contribute to outstanding its productivity, making it a port with one of the highest productivity in Europe in terms of container movements per crane and hour.

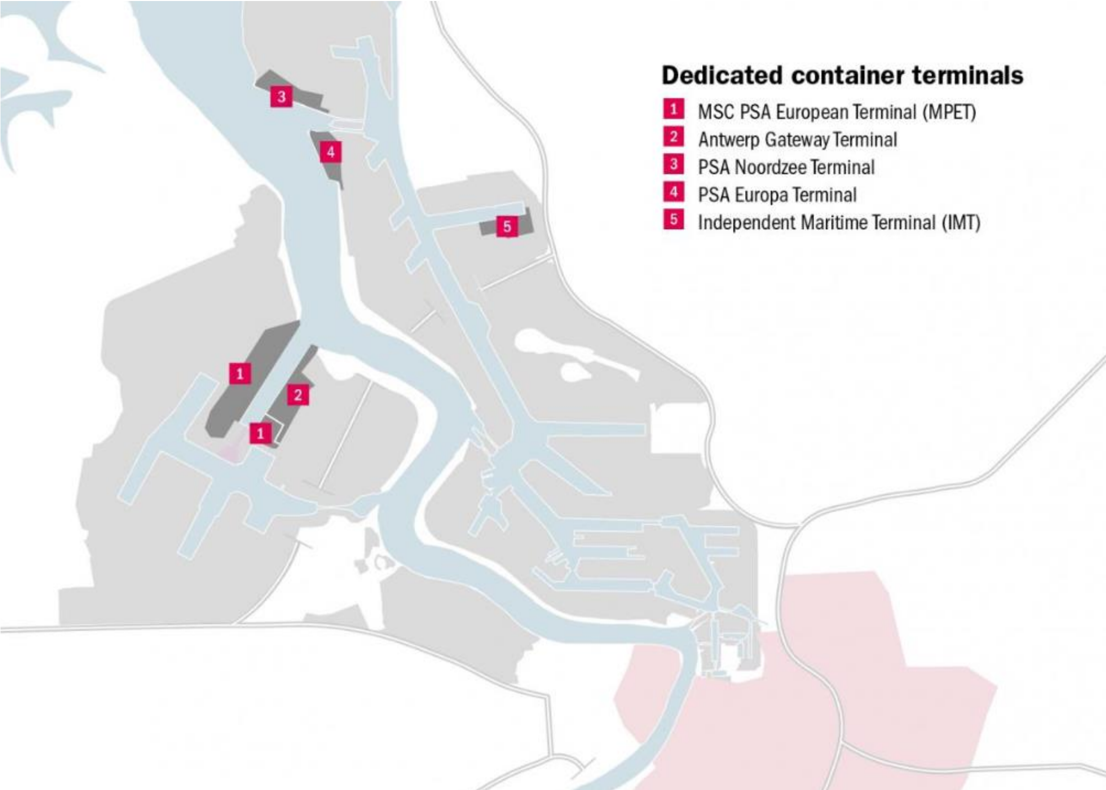

Figure 9. Location of the deep-sea container terminals of the Port of Antwerp
Source: Port of Antwerp website [13]

In terms of hinterland connections, all the container terminals located at the port has a multi modal access, providing fast and efficient barge, rail or road transport to and from the hinterland. Currently, barge and rail already account for 47% of all the freight transport if we exclude pipeline cargo movements and it is targeted to increase up to 60% by 2030. This means that currently there are around 950 barge calls per week and 130 cargo trains [13].

Key facts for hinterland connectivity:

- **Road:** The Port of Antwerp has a strategic location in central Europe that ensures a huge amount of traffic in the port and in 2016, 52% of the total cargo flow to/from the Port of Antwerp went by road. In order to avoid congestion issues in the port, The Port Authority of Antwerp is on one hand upgrading road transport facilities and infrastructures so that the same volumes of cargo can be carried by fewer lorries and on the other hand, enhancing a modal shift from road transport to rail and inland waterways.
- **Rail**: Port Authority of Antwerp aims at expanding rail services through new and improved connections and reach by 2030 15% of the port's total goods flow by rail. The port will try to achieve this target by implementing initiatives that increase rail accessibility and offer optimal, more frequent and new rail links to the strategically important areas of Europe. Additionally, the port will improve railway infrastructures

such as the Liefkenshoek rail tunnel: a 16.2km railway line in the port with the capacity to handle 109 goods trains per day in each direction. Besides, the port will also develop a connection with the Zuid rail fan: direct connection between the Liefkenshoek rail tunnel and the west side of the Deurganck dock to enable better access to the Deurganck dock.

- **Inland shipping**: in the same manner with the rail, the Port Authority of Antwerp is seeking for a transport mode shift from road to inland waterways and aims at 2030 to reach 42% of the total goods flow in the port via inland shipping. To accomplish within this objective the Antwerp Port Authority, in close collaboration with public and private partners, will take the leadership in innovative projects and solutions to boost inland waterway transport. Some of the main projects in which the Port of Antwerp has invested to increase the inland shipping modal share are:
    - Nautical coordination: coordination of inland shipping & the Automatic Identification System (AIS)
    - Optimum container handling via the Barge Traffic System (BTS) and central scheduling of lightering.
    - Efficient internal distribution of containers via the Premium Barge System and consolidation of inland-shipping volumes.

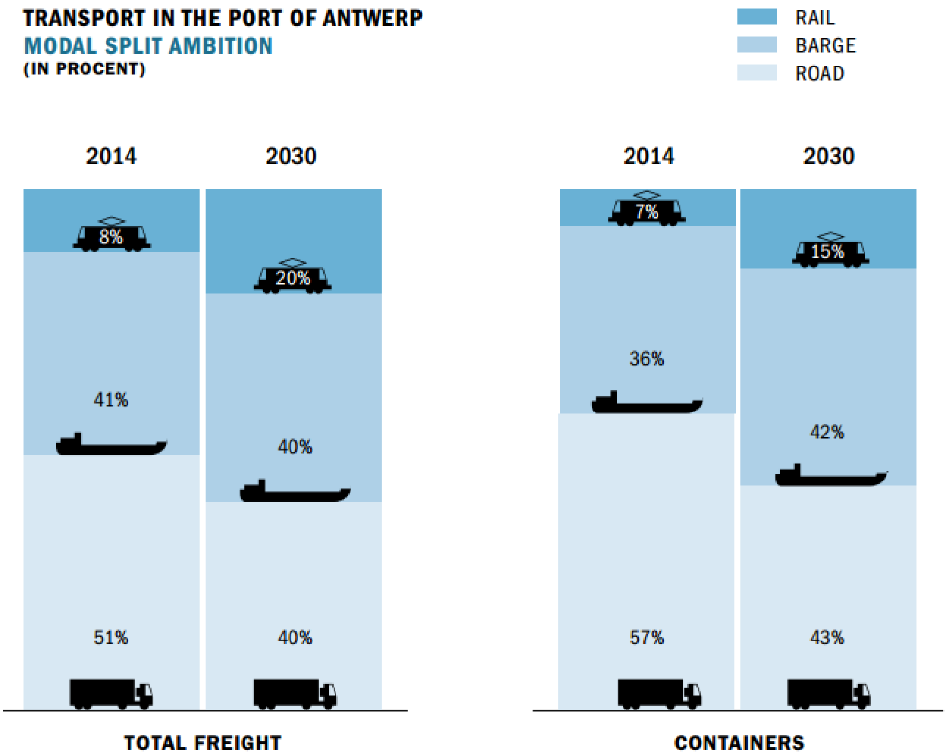

Figure 10. Current and targeted modal split for the hinterland connectivity of the Port of Antwerp
Source: Port of Antwerp website [13]

3.2 Port of HaminaKotka

The Port of HaminaKotka is the largest Finnish seaport with regular connections to all major European seaports and, consequently, to the rest of the world, and it is located on the border between the European Union and Russia, which provides a unique location on the route all the way to Central Asia and China for the northern countries. Its location on the Gulf of

Finland only 35 kilometres from the Russian border benefits Finnish and Russian imports and exports, especially serving the Russians' regions of St Petersburg and Moscow.

HaminaKotka is a general cargo port, moving from containers, liquid and dry bulk to gas, RORO cargo and project shipments and provides service to the main Finnish exporting industries, as well as serving for transit traffic. According to its annual statistical bulletin [14], HaminaKotka port moved in 2017 a total of 14.6 million tons (74% export and 26% import) with an increase of 9.5% compared to 2016. In terms of container cargo, HaminaKotka Port moved 690,326 TEUs, with an increase of 9.3% compared to 2016.

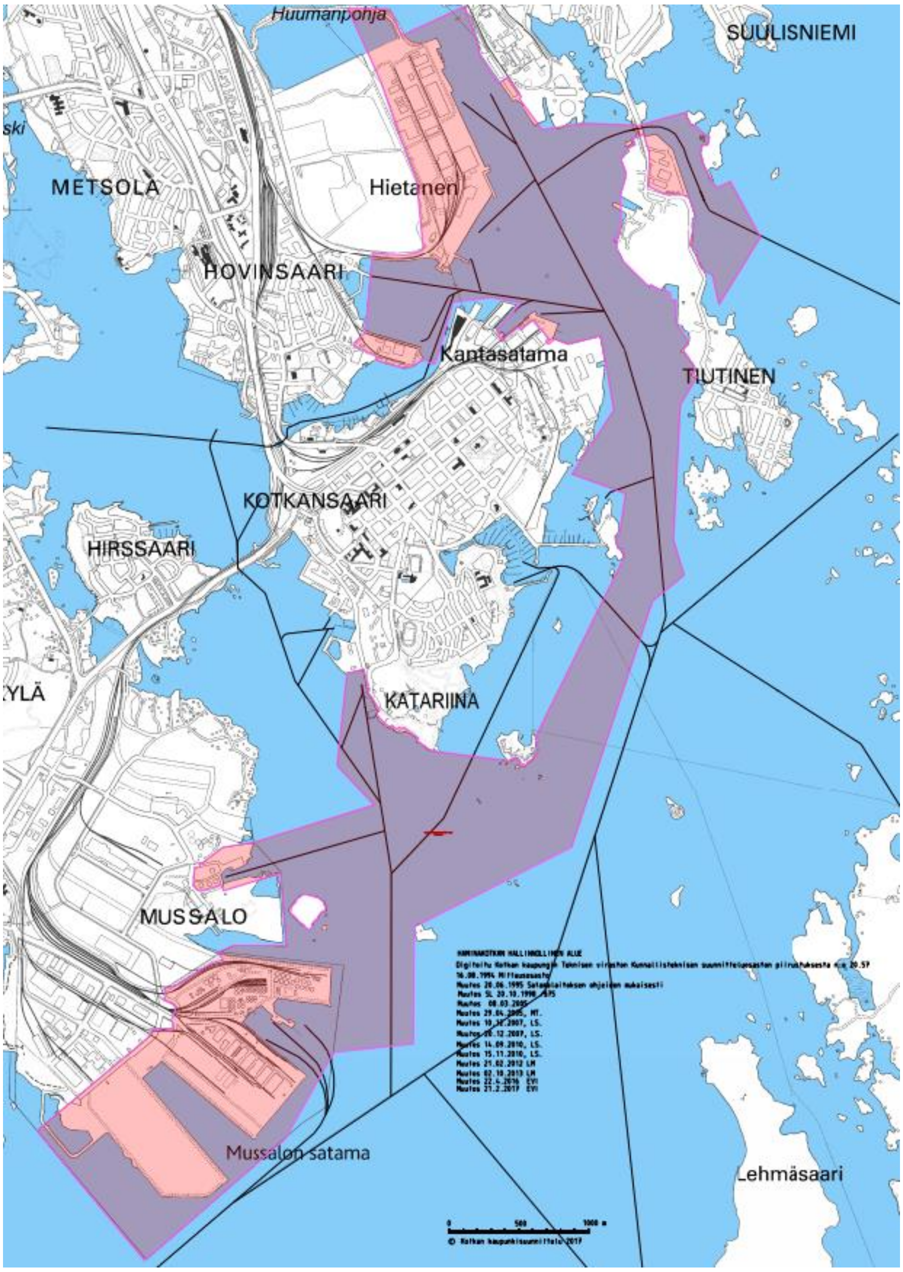

Figure 11. HaminaKotka Port extension
Source: Port of HaminaKotka website [14]

In reference to the port facilities, the port in numbers can be summarized as follows:

- 1,100 ha of land areas

- 1,400 ha of sea areas
- Max. draught 15.3 m
- 9 km of quays
- 76 berths
- 80 km of railways

In reference to the container traffic, the Port of HaminaKotka has the largest container terminal in Finland, the Mussalo Container Terminal, which has daily connections to all major ports in Europe. Mussalo Container Terminal is one of the busiest container terminals on the Baltic Sea, and, as an example of its importance for the Finnish container traffic, almost half of import/export container movements from/to Finland are handled through HaminaKotka port.

In terms of connectivity, the port has regular liner services to seaports in Continental Europe, and in terms of hinterland connectivity, the port has identical track gauge with Russia and the CIS countries and is well connected by road through the E18 motorway. Thanks its hinterland connections, a complete range of port infrastructures and a comprehensive range of logistics services, the Port of HaminaKotka has turned into a logistics hub in the Gulf of Finland.

Key facts for hinterland connectivity:

- **Rail**: The rail network of the Port of HaminaKotka comprises approximately 80 kilometres and two main railway terminals from which hundreds of rail wagons arrive at and depart from the port in daily basis. The rail infrastructure of the Port of HaminaKotka has the same track gauge than Russia and the CIS countries, which allows trains to/from the Port of HaminaKotka to reach the Chinese border without transhipment. Regular rail services provide efficient cargo transport of large goods, which in some cases lead directly into terminals and warehouses, so that wagons can be loaded/unloaded in an efficient way.
- **Road**: Road transport is the most important transport mode to/from the port due to its location between the European Union and Russia plus the connection to the E18 motorway, which offers competitive and safe transport routes to all directions from/to the port. The drive from HaminaKotka to Helsinki takes around an hour meanwhile the distance to the main Russian cities is approximately 250 kilometres to St Petersburg and around 1,000 kilometres to Moscow.

3.3 Port of Livorno

The port of Livorno located in the north-western part of Tuscany, at the Tyrrhenian Sea, and it is considered as a core port within the trans-European transport networks (TEN-T). The Port of Livorno is a multi-purpose port, with infrastructure and means that can accommodate any type of ship and handle any type of traffic (LOLO, rolling RORO, liquid and solid bulk, new cars, cruises, ferries, forest products, machinery, etc.).

The Port of Livorno is part of the Harbour System Authority of the North Tyrrhenian Sea, which includes the following ports: Livorno, Piombino, Capraia Isola, Portoferraio, Rio Marina and Cavo. This port system moved approximately a total of 41.1 million tons in 2017, recording a substantial stability of traffic compared to 2016. In this context, the port of

Livorno contributed with 33.7 million tons, which means 82% of the global traffic of the System Authority [16].

The RORO traffic is confirmed as a true stronghold for the entire port system of the Northern Tyrrhenian Sea. It amounted to over 20.4 million tons in 2017, recording an increase of 7.4% and thus making the ports of this system an important hub for the development of the Motorways of the Sea and a reference point for European policies and guidelines in this area. This traffic was led by the excellent performance of the port of Livorno that in 2017 has marked a significant +16.2% compared to 2016, with over 14.4 million tons and over 450,000 commercial vehicles moved, a new record for the port of Livorno. In the overall framework of the port system of the Northern Tyrrhenian Sea, the Port of Livorno handles 66% of the total RORO traffic moved [16].

In terms of container traffic, it is handled only in the port of Livorno and in 2017 ended with a slight decrease compared to 2016 due to the decrease in transhipment traffic. The port handled a total of 734,085 TEU in 2017 with a slight increase in full containers (+1.3%), both in terms of imports and exports [17].

Figure 12. Aerial view of the Port of Livorno
Source: Port of Livorno website

The infrastructure of the Port allows connection to the main national roads and railways and the airport areas of Pisa and Florence. The port is connected to its wide hinterland, mainly formed by the regions of Tuscany, Emilia Romagna, Umbria and Marche [16]. Major infrastructural interventions are already ongoing as the works for direct electrified railway link from the port to the coastal railway line. Key connections by road and rail are following listed:

- **Road:** The main connections of the port are the motorways A11-A12 Firenze-Pisa-Livorno, A12 Genova Rosignano, with connections via Parma with the A1 and Brenner. The port of Livorno is also connected to the S.G.C. Firenze-Pisa-Livorno.

- **Rail:** The Port of Livorno has two main railway terminals located in “Darsena Toscana”, mainly for containers, and in “Porto Nouvo” dock, mainly for RORO cargo. Besides, the port has an industrial railway terminal called “Stazione Livorno Calambrone”, which is connected to the previously mentioned terminals and to Livorno Centrale Railway station. In 2014, the port moved 1688 trains, which represented 11% of the modal share and it is expected to increase up to more than 20% in 2025. This objective is expected to be accomplished thanks to the inland platform “Americo Vespucci”, located 4 kilometers from the port.

3.4 Port of Piraeus

The Port of Piraeus is the main sea gateway port of Greece and one of the busiest ports in the Mediterranean Sea thanks to its location, which allows it to be the first European westbound port after crossing Suez Canal with no major deviations from Far East trade routes. Besides, it has suitable infrastructure to serve deep-sea vessels. Its location and infrastructures makes it a hub port for international trade and a focal link between the Greek islands and the mainland as well as a cruise centre. In this sense, the Port of Piraeus is not only a busy port in terms of international trade; it is also one of the most important ports of the Mediterranean Sea for cruises.

The port could be geographically divided into two separated parts. On one hand, the East part is dedicated to passenger traffic and counts with up to 11 berthing positions for passenger traffic, three of them for the latest generation cruise vessels. In total, there are more than 2.8 kilometres of berthing positions with drafts up to 11 meters that allow continuous operations 24/7.

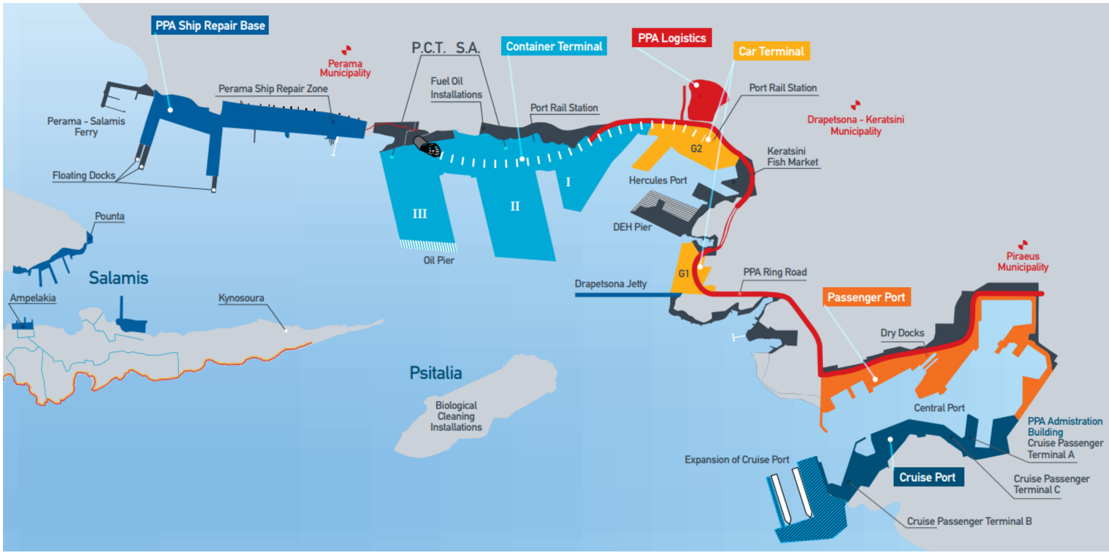

Figure 13. Geographical distribution of the Port of Piraeus
Source: Port of Piraeus website [18]

On the other hand, the west part of the port is dedicated to cargo. In terms of container traffic, the Port of Piraeus is on the top 10 largest ports in Europe and is the biggest transhipment centre of Eastern Mediterranean, providing services to the largest shipping companies and alliances. In the port, there are two main container terminals: PPA S.A. manages Pier I with an annual capacity of 1M TEUs meanwhile PCT S.A. manages Piers II and III with an annual capacity of 4.8M TEUs. However, after the expansion plans of the port, the Pier II will have a capacity of 3.2M TEU and the Pier III of 3.0M TEU, which means a total capacity of 6.2M TEU. Besides, the expansion will allow the Port of Piraeus to be able to service simultaneously four mega container ships over 18,000 TEUs (draft alongside berth up to 19.5 m).

Figure 14. Geographical distribution of the Port of Piraeus
Source: PCT website [19]

In terms or RORO traffic, the port of Piraeus serves the demand for transhipment of vehicles in the Eastern Mediterranean, Black Sea and North Africa, putting Piraeus port at the centre of the car trade for these areas. The implementation of the investment plan concerning the expansion of the RORO Terminal facilities will result in a significant increase of its productive capacity. Currently, the port has two terminals with a total area of, approximately, 191,000 m2 and five berths with a total berth length of 1.5 km and a draft of 11m, which provides a total annual handling capacity of about 600,000 vehicles.

3.5 Port of Valencia

The Port Authority of Valencia (PAV), commercially known as Valenciaport, is the public body responsible for running and managing three state-owned ports along an 80km stretch of the Mediterranean coast in Eastern Spain: Valencia, Sagunto and Gandia. The port of Valencia, the biggest of the three managed by the PAV is specialised in interoceanic container traffic and cruises although other cargo is handled in the port. The Port of Sagunto, is dedicated to RORO cargo, being acknowledged as the best port in Spain in 2011 on automobile logistics, liquid bulk (natural gas) and general cargo (steel products). Finally, the Port of Gandia, the smallest of the ports managed by the PAV is mainly dedicated to general cargo and especially to the paper industry.

As a hub for the entire Western Mediterranean, Valenciaport moved in 2017 more than 73.5 million tons and 4.8 million TEUs, being the first port of the Mediterranean Sea in container traffic and fifth in Europe. The majority of the container traffic was handled in the Port of Valencia, with an annual throughput in 2017 of more than 4.7 million TEUs [20]. Concerning this traffic, around 50% of it is import/export while the rest is transshipment. This makes

Valenciaport a key element for maritime gateway traffic in the Valencia Region but also for the entire Iberian Peninsula.

Valenciaport has become a leader in the Mediterranean Sea thanks to its privileged location in the Iberian Peninsula, providing the closest commercial port to the Suez-Gibraltar axis and an area of influence (350 kilometres radius) that generates 51% of Spain’s GDP and includes half of Spain’s entire working population. Thanks to this, Valenciaport can offer a complete network of connections with the most important ports worldwide with over 100 regular lines. Besides, in order to serve the vessels that call Valenciaport, it counts with three container terminals: MSC Terminal Valencia, a dedicated terminal of MSC shipping line; APM Terminal Valencia, a multipurpose terminal with an annual throughput of around 1 million TEUs annually; and Noatum Container Terminal Valencia, the public container terminal of the port. These three container terminals offer a capacity of more than 5 million TEUs, capacity that will be doubled once the port expansion will conclude.

Figure 15. Aerial view of the Port of Valencia
Source: Port of Valencia website [21]

The Port of Valencia, which is the most important of the ports managed by the PAV, is focused in the specialization of container traffic (combination of Import/Export (I/E) containers and interoceanic transit container traffic) and cruise and ferry traffic according to its strategic plan 2020. In order to accomplish with this objective, the Port of Valencia aims at consolidating the Iberian Peninsula hinterland traffic and progressive development of Southern European countries. For this reason, the PAV is heavily investing in the hinterland connections of the port of Valencia among other important investments such as the future port expansion.

In reference to the hinterland connections, Valenciaport is located in the heart of the Valencia Region, and has excellent road and rail connections to the centre of Spain, making it the ideal natural port for Madrid, and an essential platform for the entire Iberian Peninsula. The Port Authority of Valencia has port and intermodal infrastructure that make port activities and goods transport highly efficient and with competitive charges and tariffs. Below there are briefly explained the main hinterland accesses of the Port of Valencia:

- **Road:** The Port of Valencia is connected to the national road network via the V-30, the ring road that bypass the city of Valencia in the southern part of the city. This is the unique access for trucks to the port, even though future accesses will be constructed when the new port expansion plans will be finished. The V-30 links up directly to the A-7 motorway, which covers the Mediterranean arch from north to south (France-Algeciras), and also the East-West corridor centered on the A-3 toll-free motorway (Madrid-Valencia) which connects to the A-43 motorway to Lisbon, on the stretch near Atalaya. In terms of traffic, more than 90% of the gateway container traffic is done by trucks, which means that more than 5,000 trucks call the port in daily basis. In this sense, one of the main objectives of the PAV is to sift progressively the modal share to rail for import/export traffic.
- **Rail:** Port of Valencia is a core port in the TEN-T network and it is a key Spanish node within the TEN-T core network in the Mediterranean corridor. The port is currently immersed in a process of upgrading its rail infrastructures aiming at improving Valencia's Port interconnectivity. For this purpose, the port is upgrading the rail infrastructure with UIC gauge and improving the rail network and terminals to be able to handle trains up to 750 meters in length. The main rail links of the port of Valencia are Valencia – Barcelona – Port Bou; Valencia – Zaragoza – Basque Country and Valencia – Cuenca – Madrid. In terms of traffic, the rail moved in 2017 a total of 171,250 TEU (7.8% of the gateway traffic) and 2.69 million tons (7.18% of the gateway traffic). It is worth mentioned that the corridor Valencia-Madrid is currently the corridor with higher container traffic in the Iberian Peninsula with more than 150,000 annually.

4. Identification of Best Practices: Port-Hinterland Connections

This section presents a summary of international good practices with solutions to improve hinterland connections (i.e. rail, road and inland waterway). Furthermore, it summarizes some solutions already implemented in the COREALIS ports (Antwerp, HaminaKotka, Livorno, Piraeus and Valencia) to optimize hinterland transport.

The review of good practices allows benchmarking and identification of experiences of hinterland traffic management with solutions that may be interesting for searching alternatives to the different problems to be faced. This review of good practices may inspire solutions for the transferability of such experiences to the COREALIS ports and to other ports as well.

4.1. Road transport best practices and solutions

4.1.1. Collection of best practices and solutions

Best Practice	***Port Community System***
Port	Several Ports, including COREALIS Ports of Anterwp, Livorno, Pireaus and Valencia
Description	Port Community Systems (PCS) are solutions to optimize the different processes and information exchange between the port agents. They are open and neutral electronic platforms (public or private) that allows a safe and smart information exchange between public and private agents in order to improve the competitiveness of a Port Community due to the process optimization. PCS also makes more reliable the way in which the actors involved transmit the information related to the traceability of the cargo, making possible simplified customs control but also making them more efficient, secure and transparent.
Objectives	Optimize proceses, facilitate information exchange, increase competitiveness of the port, make transaction between agents more transparent and reliable
Main Beneficiaries	Port Authorities, Port terminals, Importers/exporters, Freight forwarders, Carriers, Customs, Transport operators, Depots, Shipping agents, etc.

Best Practice	***ZEAL***
Port	Port of Valpariso
Description	The ZEAL is a logistics control and coordination platform, which includes the primary customs area of Valparaiso Port and a set of added services for the attention of the cargo that is mobilized by this port. It was imlemented due to the high levels of congestion in access roads and common areas and due to the collapse of existing infrastructure and systems. In this sense, the ZEAL has three different zones (ZAO, ZRA and ZL) that have allowed to increase port efficiency, allowing the spaces of the port to be used only for those activities strictly necessary for the direct attention of the ships in a very constrained port such as the port of Valparaiso.
Objectives	Increase efficiency of port operations, reduce congestion in the port and

	surronding areas, reduce cost of the logistics chain, optimize transport procedures, improve logistics control
Main Beneficiaries	Port Authorities, Port terminals, Freight forwarders, Carriers, Customs, Transport operators, Depots.

Best Practice	***SI-ZEAL***
Port	Port of Valpariso
Description	The implementation of the ZEAL as a solution to organized the road traffic in a constrained port such as the Port of Valparaiso also required the upgrade of the IT systems and because of this, the ZEAL was implemented together with advanced information systems and the incorporation of technological devices.In this sense, the SI-ZEAL is the technological platform that allowed the control and coordination of cargo movements through the Port of Valparaiso in a fast, safe and efficient way.
Objectives	Facilitate information and interaction exchange between port actors, increase the security and control of the port processes, Traceability and follow-up of the cargo
Main Beneficiaries	Port Authorities, Port terminals, Freight forwarders, Carriers, Customs, Transport operators, Depots

Best Practice	***Intelligent Port Logistics Chain***
Port	Brazilian Ports and its logistics chain
Description	The Intelligent Port Logistics Chain initiative was studied and detailed to be implemented in several Brazilian ports. The main characteristic of the Intelligent Port Logistics Chain is the ability to adapt quickly and automatically to internal and external disturbances through the synchronization and articulation of the activities carried out by the different agents involved, thus promoting a more efficient performance of the system. The Intelligent Port Logistics Chain is supported by different "Control Points", which are areas of logistical-port support with large parking space for trucks and infrastructure to support transporters. This control points located all along the logistics chain aim at promoting synchronization of operational processes, consequently increasing the efficiency of logistical-port operations.
Objectives	Optimize the logistics chain, centralize information flows, increase security in transport operations, optimize information exchange, improve planning
Main Beneficiaries	Port Authorities, Transport Operatros, Truck Drivers, Port terminals, Freight forwarders, Carriers, Depots

Best Practice	***Closing Time***
Port	Port of Valencia
Description	The Closing Time System is a suitable solution for transport management in ports with high traffic of origin and destination in their area of influence and with difficulty in obtaining reliable information on the arrival times of trucks. The Port of Valencia successfully applies land and sea closing time, establishing time limits for the reception of the information required by the different actors involved in the admission and delivery of

	containers.
Objectives	Improve road transport management, reduce idle times, avoid congestion and queues in port gates and in termingal gates, speed up documentation exchange
Main Beneficiaries	Port Authorities, Port terminals, Truck drivers, Transport operators, Depots

Best Practice	***Road Transport App***
Port	Port of Valencia
Description	The PCS of the Port of Valencia integrates a module to manage the road transport. Additionally to this moduel, the Port Authority of Valencia has developed a tool, the first app developed through the ValenciaportPCS electronic platform, that allows users to consult the real-time status of their delivery and admission orders from their mobile phones in real time. To use this app it is necessary to be a registered user in the Land Transport Service of ValenciaportPCS as a carrier.
Objectives	Facilitate information about transport orders ans acceptance/delivery orders, increase visibility of the transport processes, facilitate the detection of incidents and missing information
Main Beneficiaries	Carriers, Transport operators, Truck Drivers

Best Practice	***Smart Port Logistics***
Port	Port of Hamburg
Description	In the port of Hamburg,there are approximately 40,000 vehicles circulating through the port in daily basis. In order to optimize the traffi inside the port, the Hamburg Port Authority (HPA) is implementing the initiative called Smart Port Logistics. This system, developed by the HPA is a traffic management system based on a "cloud" of private information that is being tested by some transport operators selected in a pilot test. In the project, several trucks were equipped with portable devices located in the cabs that were constantly connected to Internet. When these trucks entered the port, they send information to the Smart Port Logistics and it is possible to know their location and their loads through the exchange of information with these devices. The system provided information to drivers on traffic and parking congestion at each parking lots, a solution that helps to alleviate the ever-increasing traffic in the port environment and to reduce the delivery/receipt time of goods.
Objectives	Reduce traffic congestion inside the port, Optimize road transport in the port area, reduce waiting times, improve planning and operations, obtain ETA's
Main Beneficiaries	Port Authorities, Port terminals, Truck drivers, Transport operators, Depots

Best Practice	***Off Peak and Truck Tag Program***
Port	Port of Los Angeles and Port of Long Beach
Description	Due to the large volume of traffic from both ports, there were many problems of congestion and local pollution. The solution proposed was the Off-Peak program, in which a Traffic Mitigation Rate (TMF) was

	implemented. This fee is paid (except for exceptions) by trucks that access ports during peak hours (03:00-18:00, Monday to Friday). This was an incentive for cargo owners to use the off-peak period (18:00-03:00 from Monday to Friday and 08:00-18:00 on Saturdays) to carry out their operations. This fee is used to help cover the additional costs (overtime) of new working shifts.
Objectives	Reduce traffic congestion, reduce environmental issues, improve road transport procedures
Main Beneficiaries	Port terminals, Truck drivers, Transport operators, Depots

Best Practice	***Truck Appointment System***
Port	Port of Los Angeles and Port of Long Beach
Description	Due to the large volume of traffic from both ports, there were many problems of congestion and local pollution. Another of the solutions implemented in both ports to reduce these issues was the implementation of a truck appointment system. Time windows for trucks are 1 hour with a grace period of 30 minutes before and between 30 to 180 minutes after the scheduled time and pre-appointments must be done 48 hours in advance.
Objectives	Reduce traffic congestion, reduce environmental issues, improve road transport procedures
Main Beneficiaries	Port terminals, Truck drivers, Transport operators, Depots

4.1.2. Other Best Practices and solutions in the COREALIS Ports

Best Practice	***Assignment of Container Job Orders to Driver IDs***
Port	Port of Livorno
Description	Online portal that allows shipping agencies, freight forwarders and custom brokers to dispatch transport jobs to transport companies which in turn can assign specific jobs to drivers carrying an RFID ID card issued by PCT.
Barriers	No control over arrival times
Objectives	ISPS Compliance
Main Beneficiaries	Shipping agents, Freight forwarders, Custom Brokers, Transport companies and Importers

4.2. Railway transport best practices and solutions

4.2.1. Collection of best practices and solutions

Best Practice	***Extended Gateway Inland Platforms***
Port	Several Ports, including COREALIS Ports of Anterwp, Livorno and Valencia
Description	Inland terminals can be considered as ‘‘extended gates” for sea ports, through which transport flows can be better controlled and adjusted to match conditions in the port itself, helping to improve land accesses to the port. In some cases, the inland platforms can be also used in sea ports with important land restrictions, where the majority of the port space is dedicated to vessel loading/unloading operations. In this way, the use

	of this inland platforms allows a better land use of the port facilities.
Objectives	Improve inland operations, increase efficiency and productivity of freight transport, support port operations, control transport flows from/to the ports
Main Beneficiaries	Port Authorities, Port terminals, Railway undertakings, Railway operators, Railway infrastructure management bodies, Freight forwarders, Carriers, Customs, Transport operators, Depots, etc.

Best Practice	***Implementation of Hinterland Corridors***
Port	Several Ports, including COREALIS Ports of Anterwp, Livorno and Valencia
Description	The implementation of intermodal services between seaports and their area of influence through hinterland corridors is a key factor for the development of sustainable growth for the ports. Hinterland corridors can help to mitigate negative effects of the inland transport due to the increase of the railway modal split, which is cleaner and more environmentally sustainable than the road transport.
Objectives	Increase railway modal split, Enlarge hinterland connectiviy, reduce environmental issues, Improve inland operations, increase efficiency and productivity of freight transport, control transport flows from/to the ports
Main Beneficiaries	Port Authorities, Port terminals, Railway undertakings, Railway operators, Railway infrastructure management bodies, Freight forwarders, Carriers, Customs, Transport operators, Depots, etc.

Best Practice	***OCR Rail***
Port	Port of Hamburg
Description	OCR Rail is a ssolution for remote visual inspection and automatic identification of containers and railcars implemented in the Port of Hamburg in order to speed up railway procedures. It was the result of a continuous increase of the number of containers shipped via rail in the Port. Consequently, they needed an automated and faster way to carry out railway procedures such as inspection, identification and inventory of train containers.
Objectives	Increase the efficiency of railway procedures, speed up railway processes such as inspection, identification and inventory of containers.
Main Beneficiaries	Port Authorities, Railway undertakings, Railway operators, Railway infrastructure management bodies, Freight forwarders, Carriers, Customs, Transport operators.

Best Practice	***Rail Port Shuttle***
Port	Port of Rotterdam
Description	PortShuttle Rotterdam was launched to serve the main container terminals in Rotterdam and later on it has expanded into the neutral rail solution connecting the whole port of Rotterdam. This solution provides to railway operators, shipping companies and logistics service providers the possibility to use PortShuttle to transfer small or large numbers of transhipment containers between terminals inside the port but also is possible to use PortShuttle to connect the Maasvlakte terminals to the European hinterland by rail through the RSC

	Rotterdam.
Objectives	Facilitate container exchenges between terminals, speed up transfer operations, reduce railway transport cost, provide more flexible rail operations
Main Beneficiaries	Port Authorities, Port Terminals, Railway operators, Freight forwarders, Shipping agents , Logistics service provides.

Best Practice	***Rail Incubator***
Port	Port of Rotterdam
Description	Rail Incubator is an innitiative of the Port of Rotterdam Authority to support rail operators in establishing new rail connectionsas well as to remove the obstacles related to the creation of new rail connections. Within this innitiative, the Port Authority seeks for new ways of cooperation between stakeholders aiming at establishing new rail connections or increasing the frequency of already-existing rail shuttles.
Objectives	Increase cooperation between stakeholders, promote the use of railway services, establish new connections by rail
Main Beneficiaries	Port Authorities, Railway undertakings, Railway operators, Railway, Freight forwarders, Shipping agents , Logistics service provides.

Best Practice	***Optimised distributed rail transport in the port: Railport***
Port	Port of Antwerp
Description	The port of Antwerp set up Railport aiming at optimizing container transport by rail within the port facilities and findint alternative solutions to the road transport. Railport is one specialised, neutral port rail operator responsible for the marshalling and transfer of cargo wagons between the Antwerpen-Noord marshalling yard, the different rail fans and the companies in the port. Railport, as a unique rail operator for internal containers distrubution ensures a more efficient use of the existing rail infrastructure.
Objectives	Improve transfer time between terminals, reduce shunting cost, provide more flexible operations
Main Beneficiaries	Port Authorities, Port Terminals, Railway operators, Freight forwarders, Shipping agents , Logistics service provides

4.2.2. Other Best Practices and solutions in the COREALIS Ports

Best Practice	***Rail Traffic System***
Port	Port of Antwerp
Description	PCS-service that engages rail operators, rail companies and terminal operators for more efficient planning and offering visibility of rail operations.
Barriers	Human investments needed to engage with your Community stakeholders
Objectives	Offering visibility to all the stakeholders, and to increase the modal split for rail.More efficient planning and operations for trains at the terminals
Main Beneficiaries	terminal operators, rail operators, rail infrastructure company, freight forwarders, port authority

4.3. Inland Waterways best practices and solutions

4.3.1. Collection of best practices and solution

Best Practice	***River Information Services***
Port	Rivers Shine, Danube-Main, Siene-Scheldt-Meuse, Elbe
Description	River Information Services (RIS) are information services designed to enhance safety and efficiency of inland waterway transport (IWT) by optimizing traffic and transport processes.
Objectives	Streamline the exchange of information between all IWT stakeholders, foster the use of IWT, enhancement of safety in inland ports and rivers, enhance the efficiency of inland navigation
Main Beneficiaries	Port Authorities, River Authorities, Skippers, Barge Operators

Best Practice	***Instream: smart and efficient inland navigation***
Port	Port of Antwerp
Description	Antwerp Port Authority and its Barge Master Plan aimed at creating the right conditions for inland navigation to develop into an even smarter, more efficient mode. Consequently, the port of Antwerp implemented a strategy trying to be accomplished this objective through “Istream: smart and efficient inland navigation”. Instream is based on three main group of projects: Nautical Coordination, Efficient Container Handling and Efficient distribution within the port. In each of them, the port is implementing a set of projects in order to boost the use and efficiency of barges for its hinterland connections.
Objectives	Improve inland waterway supply chain efficiency based on the pillars of transparency, sustainability, fast and reliable connections
Main Beneficiaries	Terminal operators, Barge operators, Port authority, Nautical Services

Best Practice	***Barge Traffic System***
Port	Port of Antwerp
Description	The Barge Traffic System (BTS) is a monitoring system for container barges and terminals operators. BTS was developed in consultation with the barge industry to optimise the handling of container barges and to maximise loading and unloading efficiency. The BTS is service linked to the Port Community System that engages barge operators and terminal operators for more efficient planning of barge operations. The use of BTS is mandatory in the Port of Antwerp area and will lead to more efficient, safer and more sustainable management of barge traffic.
Objectives	Safe barge traffic in the port area (around 200.000 barge movements, combined with around 15.000 sea vessels arriving each year). More efficient planning and operations for barges at the container terminals. Cost savings and reliable lead times
Main Beneficiaries	Terminal operators, Barge operators, Port authority

Best Practice	*Premium Barge Service*
Port	Port of Antwerp
Description	The Premium Barge Service (PBS) is a shuttle service that works on the principle of a fixed bus service between port termianls. The aim of the service is to reduce the number of containers carried around by truck insider the port. The system works with barge calls at the same container terminals at fixed times each day. There are two loops: a first loop connects the maritime container terminals, while a second connects these terminals with terminals on the left bank.
Objectives	Reduce congestion inside the port. Promote the use of barges for transfer operations between termianls. Increase environmental footprin
Main Beneficiaries	Terminal operators, Barge operators, Port authority

Best Practice	*Automatic Identification Systems (AIS)*
Port	Port of Antwerp
Description	AIS is a standard technology that allows Vessel Tracking and Tracing (VTT), enabling automatic exchange of data between ships and between ships and shore infrastructures such as ports. Barges are equipped with AIS transponders that allow automatic identification of the name, position, speed and course of the barges and this allows mutual visibility between barges, seagoing vessels, and infrastructures. Therefore, the use of AIS in port environments and in inland waterways clarifies the overall picture of the shipping traffic conditions facilitating nautical communication between different actors.
Objectives	Increase barges traffic control. Increase safety of barge operations. Improve berth and locks management and optimise their capacities
Main Beneficiaries	Terminal operators, Barge operators, Port authority

Best Practice	*Estuarial vessels in the region of Flanders: Deseo/Tripoli and Amberes*
Port	Ports of Antwerp and Zeebrudge
Description	Due to the existen inland network between ports, a set of shuttle services between them and their hinterland was established with inland container vessels ranging from 240 to 400 TEU.
Objectives	Promote the use of IWT and facilitate transfer operations between ports and termianls
Main Beneficiaries	Terminal operators, Barge operators, Port authority, Inland terminals

Best Practice	*LIVRA: Logistics Chain Information on the Fairway Rotterdam - Antwerp*
Port	Ports of Rotterdam and Antwerp
Description	The LIVRA project aimed at achieving more reliable travel times on the Rotterdam - Antwerp because the fairway between both seaports is one of the busiest inland shipping routes in Europe. Thus, LIVRA project was lauched in order to optimise the logistic chain and the lock capacity, avoiding unnecessary queues and delays.

Objectives	The main objective of the project was to provide more and better information to shipping companies and individual ships about the status of the locks and travel times in the fairways
Main Beneficiaries	Terminal operators, Barge operators, Port authority, Inland terminals

Best Practice	***ECT Extended gate concept – European gateway services***
Port	Port of Rotterdam
Description	In the same manner than the concept of the extended gate approach for rail transport, Europe Container Terminal (ECT) started to extend its network with inland gates. In 2010 a co-operation between ECT and LCT (Liège Container Terminal) further expanded the network of inland gates. This project was named 'European Gateway Services' and a scheduled shipping service between both terminals was part of the agreement. The concept of extended gate concept requires a close cooperation of the main sea terminal with the related hinterland terminals located at relatively short distances from the seaport as a means of bypassing congested roads in the port city.
Objectives	More flexible and realiable connections. Cost savings. New opportunities for ECT to grow
Main Beneficiaries	Terminal operators, Barge operators, Port authority, Inland terminals

Best Practice	***Vessel Traffic Services (VTS) in the Netherlands – focus on VTS Nijmegen***
Port	Ports of Antwerp and Rotterdam
Description	Vessel Traffic Services are marine traffic monitoring systems working that typically use radars, closed-circuit television (CCTV), VHF radiotelephony and automatic identification system to keep track of vessel movements and provide navigational safety in a limited geographical area. Vessel Traffic Services (VTS) are usually implemented for safety reasons because of high traffic intensity, such as the case of the Netherlands, and/or complex traffic situations leading to vulnerability in the area. The use of VTS provides improvements in efficiency, safety and environmental protection as well as increases the capacity of the fairways reducing congestion issues. In the specific case of the VTS of the Netherlands, it was unique in Europe and since it was deployed, different tools have been developed and employed, such as the use of River Information Services (RIS) and tools like Electronic Reporting and Information Management Systems.
Objectives	Improve efficiency, capacity, safety and environemtal protection of fairways
Main Beneficiaries	Barge operators, Skippers, River Authorities

Best Practice	***ELWIS – Electronic Waterway Information Service***
Port	German Waterways
Description	ELWIS (Electronic Waterway Information Service) was launched in 1999 as the German Waterways and Shipping Administration (WSV)

	aiming to provide skippers updated nautical information as well as traffic conditions in the german waterways. ELWIS provides data for all German waterways, but also Notices to Skippers (NtS) from selected additional countries. ELWIS offers data for nautical and operational purposes via internet, SMS and e-mail and its use is free of charge for all parties interested.
Objectives	Provide skippers updated date for planning, Improve plannning operations and increase efficiency, safety and environmental sustainability of inland navigation
Main Beneficiaries	Barge operators, Skippers, River Authorities

Best Practice	***Bottleneck information on the Danube FIS Porta***
Port	Danube river
Description	The Danube FIS is a portal provides information about bottlenecks in the fairway of Danube River and other fairway-related information from most relevant countries. The solution provides updated information via a web portal for the users of the waterway in all relevant Danube languages. This portal was developed for the use of skippers, shippers, logistical users and other interested parties and contain information about fairway bottlenecks, water level information (incl. forecast), notices to skippers, ice messages, waterway objects (e.g. bridges, ports, locks), authorities and most important downloadable information from river administrations.
Objectives	Provide reliable information to users about the main conditions of the Danuve river so that skippers can plan better their voyages
Main Beneficiaries	Barge operators, Skippers, River Authorities

4.4. Other best practices and solutions

4.4.1. Collection of best practices and solutions

Best Practice	***Navigate***
Port	Port of Rotterdam
Description	Navigate is a route planner that online platform that help users to find the best and most efficient way to transport container cargo via Rotterdam. It includes shortsea and deep-sea schedules, as well as rail and barge connections to more than 150 inland terminals in Europe that enables to optimise the efficiency of freight flows
Objectives	Informing the (professional) public for moving cargo to the hinterland via rail and barge
Main Beneficiaries	Transport companies, freight forwarders, shippers, 3PLs, rail operators, barge operators, etc.

4.4.2. Other Best Practices and solutions in the COREALIS Ports

Best Practice	***Connectivity Platform***
Port	Port of Antwerp
Description	The Port of Antwerp Connectivity Platform is a free online transport-

	planning tool that indicates the most appropriate intermodal transport options for your destination in the European hinterland and displays all deep sea and shortsea services with the Port of Antwerp All website visitors can see possible connections to and from a hinterland terminal, or a city or postal code anywhere in Europe.
Objectives	Informing the (professional) public for moving cargo to the hinterland via rail and barge
Main Beneficiaries	Transport companies, freight forwarders, shippers, 3PLs, rail operators, barge operators, etc.

5. Description of Best Practices: Port-Hinterland Connections

5.1. Road Transport

5.1.1. Port Community System

Initial situation:

The information flow around a port is very complex and involves a huge amount of agents and one single container movement requires multiple communications between our Port Community members, creating a complex information network. For this reason, port and transport sectors are currently one of the sectors where the efficient management of information technologies is a key factor of competitiveness, due to the enormous volume of information generated and exchanged.

In order to solve efficiently this information exchanged, the implementation of a Port Community Systems (PCS) becomes a powerful solution to optimize the different processes and information exchange between the port agents.

Solution proposed:

A Port Community System (PCS) is an open and neutral electronic platform that allows a safe and smart information exchange between public and private agents in order to improve the competitiveness of a Port Community due to the process optimization.

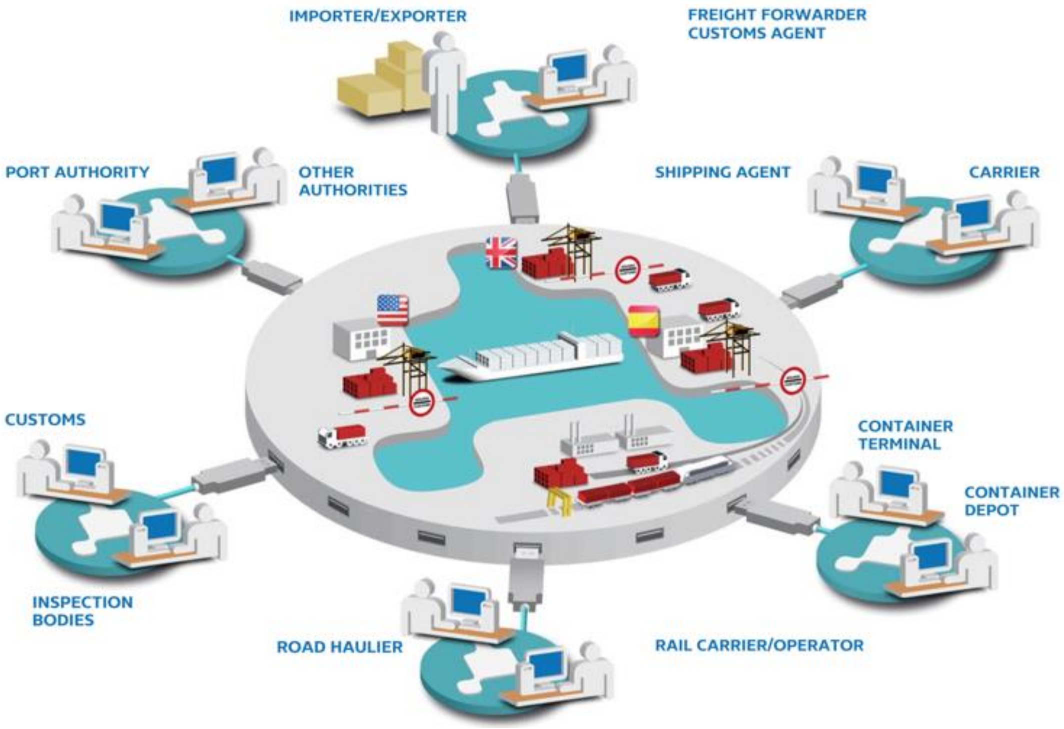

Figure 16. Systems links to the PCS
Source: ValenciaporPCS.com [22]

Port Community Systems aim at speeding up data exchanges, integrating all port systems and articulating them within a technological platform for the main actors in the logistics chain. The PCS also makes more reliable the way in which the actors involved transmit the information related to the traceability of the cargo, making possible simplified customs control but also making them more efficient, secure and transparent.

In summary, a PCS optimizes, manages and automatizes port and logistic processes in an efficient way by a single data transfer as well as connecting transport and logistic networks, supplying advanced management procedures to its users, which are:

- A better transaction efficiency
- Resources optimization
- Process automation
- Costs saving
- Error reduction
- Time saving
- Better client support

5.1.2. ZEAL – Port of Valparaiso (Chile)

Initial Situation:

The Port of Valparaiso in Chile is considered one of the main public service ports in Chile's central macro-zone. Containerized cargo represents 84% of the total, with approximately 1.0 MM TEUs in 2017 [23]. It shares hinterland with the Port of San Antonio, and both can be considered comparable ports as they are at a similar distance and travel time from cargo generation centres.

The port has two Terminals: Terminal 1 operated by the concessionaire Terminal Pacífico Sur (TPS) and Terminal 2, Terminal Cerros de Valparaíso (TCVAL). With respect to access, land access to the Port of Valparaiso is mostly through Route 60-CH, which connects Route 68 with the entrance/exit to the terminals of the Port of Valparaiso. At 8.7 km from Route 68 is the ZEAL, where it coordinates and controls the flow of trucks that circulate along this route in the direction of the port. As for railway infrastructure, the port has a connection to Santiago of 186.9 km in length, with a railway infrastructure within the port enclosure of 5.6 km [24].

In reference to the logistics model of the Port of Valparaiso, it has the following characteristics:

- Port with access from the East (Barón sector).
- Antepuerto (parking for trucks in Placilla) distant to 21 kms for control and coordination of horticultural load.
- Vulnerable and obsolete control and coordination processes.

Besides, the growing demand has put additional pressure on the model, generating the following problems:

- High levels of congestion in access roads and common areas.
- Collapse of existing infrastructure and systems.
- Low productivity.
- High length of stay.

- High costs of the logistics chain.
- Inefficient allocation of resources.

Solution proposed:

Due to the evidenced problems, it was necessary to define a new logistic model for the port of Valparaiso, which was the implementation of the ZEAL. The ZEAL is a logistics control and coordination platform, which includes the primary customs area of Valparaiso Port and a set of added services for the attention of the cargo that is mobilized by this port.

The ZEAL was conceived and started to be built in 2006 and began to be operated in January 2008 for fruit and vegetable cargo and in September of the same year for all types of cargo. The ZEAL is the entity in charge of coordinating the logistics chain of the export and import processes, given that it unifies in a single place all the procedures for phytosanitary inspection

New Logistics model:

- Definition of the Zone of Extension of Logistic Support (ZEAL), space that concentrated logistic operations at 11km from the port.
- Design of a new port system consisting of three components that require integrated management: ZEAL - Route - Terminals.
- Total re-engineering of the processes: regulation, planning, programming and control of operations.
- Separation of the operation by logistic lines and the daily planning of transport units required by the terminals.
- Incorporation of technology into the new model to improve visibility, traceability and cargo safety.

Figure 17. Main elements of the Valparaiso Port System including the ZEAL
Source: Own elaboration

and customs documentary control of loads (SAG, SNA, SERNAPESCA, Health).

The ZEAL has three management zones:

- **ZEAL OBLIGATORY ZONE (ZAO)**, where customs and phytosanitary inspection activities are carried out, document control and final coordination of truck traffic to the terminals of the Port of Valparaiso for import and export processes.
- **ZEAL RECINTO ADUANERO (ZRA)** consists of a Customs Warehouse enclosure. It provides storage and complementary services to cargo that has not yet been released by the National Customs Service. Additionally, it provides services of consolidation, transfer and monitoring of dry and refrigerated containers.
- **ZEAL LOGISTICS (ZL)** consists of the logistic unit that provides integral services for the transportation and distribution of merchandise, providing added value to the logistics chain of ZEAL clients.

The ZEAL is a pioneering experience in the world, representing a quantitative leap in the modernization of Chilean port activity, thanks to its innovation in processes, infrastructure and information and communication technology. The ZEAL considerably increases port efficiency, allowing the spaces of the port to be used only for those activities strictly necessary for the direct attention of the ships. It also incorporates the function of receiving, coordinating and controlling the orderly dispatch of lorries to port terminals, avoiding congestion on access roads and in the port.

5.1.3. SI-ZEAL – Port of Valparaiso (Chile)

Initial Situation:

The implementation of the ZEAL as a solution to organized the road traffic in a constrained port such as the Port of Valparaiso also required the upgrade of the IT systems and because of this, the ZEAL was implemented together with advanced information systems and the incorporation of technological devices. This allowed a significant improvement in the different processes (e.g. planning, programming, control and coordination of cargo documentary management) as well as a follow-up of the transport flows from/to the port terminals, with greater security and transparency in the logistical-port activities.

Solution proposed:

The model of operation and logistics processes of the port required the design and implementation of a new technological platform, which included the Logistics Information System of the Port of Valparaiso, called SI-ZEAL. This technological platform allowed the control and coordination of cargo movements through the Port of Valparaiso in a fast, safe and efficient way:

- Web platform that facilitates simultaneous interaction of actors, reducing the time of the control and coordination processes.
- Security system that facilitates authentication and identification of users and vehicles that request access to the port premises.
- A set of ITS (Intelligent Transportation Systems) devices and technologies that allow interaction with information systems of the different actors of the logistics-port chain.

- Traceability and follow-up system, which allows the physical control and processes of cargo within the port and southern access enclosures.

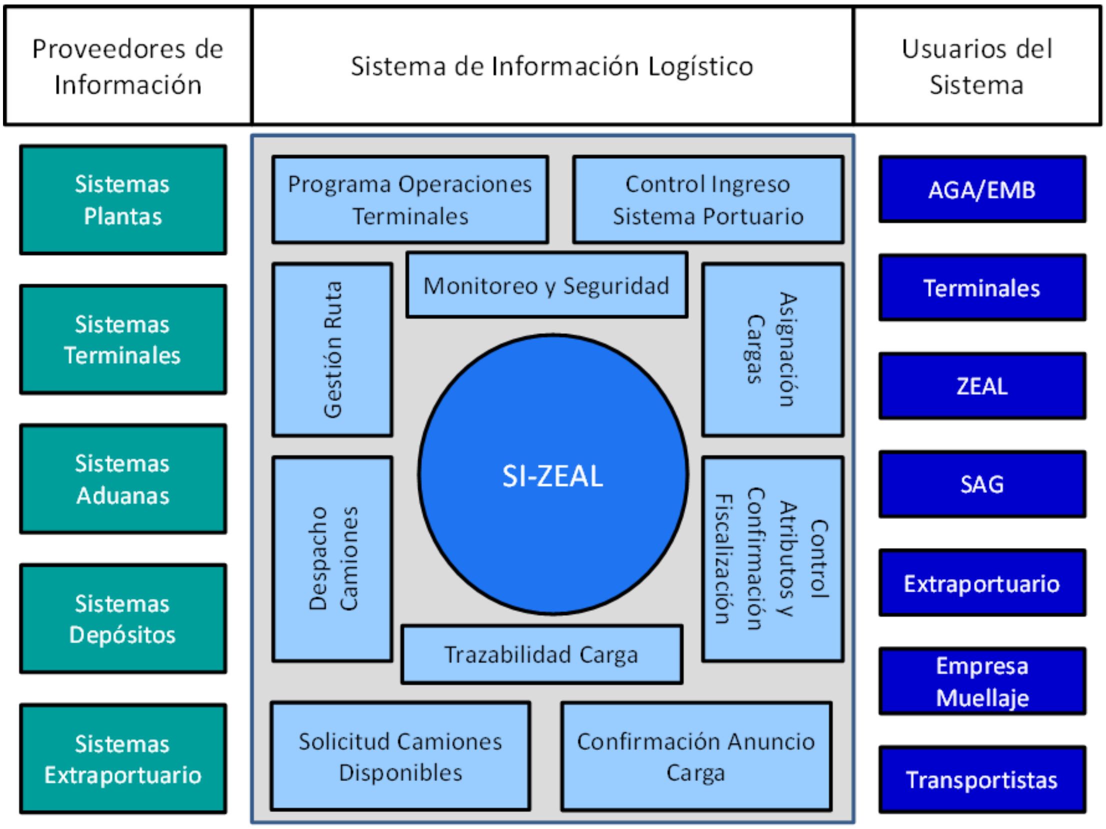

Figure 18. Technological platform of the Port of Valparaiso and IT systems linked
Source: Puerto Valparaíso

The SI-ZEAL allowed improved coordination and interaction among port users, providing high-value information and making possible to process cargoes in advance. The user or consignee of the goods can plan, schedule and control their operations by accessing SI-ZEAL and, for example, can monitor the processes carried out.

5.1.4. Intelligent Port Logistics Chain - Brazil

Initial Situation:

Brazilian ports are responsible for more than 90% of the country's exports, being the private terminals responsible of 64% of the total cargo. The most important type of cargo is the solid bulk, which represents more than 50% of total traffic. This type of cargo makes the current situation of the Brazilian Port Logistics Chain very particular and complex, distinguishing itself from other international realities due to the strong pressure that the growth of the agro-industry.

The analysis of the situation of the Brazilian port logistics system highlighted the lack of follow-up and a global regulation of the flow of cargoes and trucks from origin to port and vice versa. One of the main problems of the Brazilian port logistics chain was the queues of trucks at the port accesses, both for loading and for unloading goods. This situation generated several points of congestion along the two routes, such as parking lots, regulatory yards and access to ports and terminals. Therefore, it was evident that it was necessary to organize the arrivals of the different trucks and loads so that there would be no interference in the service of each one of them. Following aspects were diagnosed as the root of the logistics problem in the Brazilian port logistics chain:

- Uncoordinated actions of many bodies,
- Complex bureaucratic processes without transparency for users,
- Lack of adequate infrastructure in ports and modes of transport
- Enormous amount of information still processed on paper,
- Lack of a centralized database and an information technology system to organize and streamline processes.
- Lack of coordination in the arrival of the cargo at the port,
- No guarantee of the inviolability of the cargo,
- Lack of synchronization of the inspection bodies
- Lack of data for planning.

Solution proposed:

The Intelligent Port Logistics Chain initiative was studied and detailed to be implemented in several Brazilian ports. The main characteristic of the Intelligent Port Logistics Chain is the ability to adapt quickly and automatically to internal and external disturbances through the synchronization and articulation of the activities carried out by the different agents involved, thus promoting a more efficient performance of the system. In this sense, the availability of information in the right place, time and format for decision making is fundamental to guarantee the efficiency of port logistics chains and, undoubtedly, an essential component to manage more intelligently the port logistics chains are information and communication technologies, in addition to the integrated management of systems and infrastructures.

The operative solution of the Intelligent Port Logistics Chain is supported by different "Control Points" (computerized or automated), which are areas of logistical-port support with large parking space for trucks and infrastructure to support transporters (Figure 19). This control points located all along the logistics chain aim at promoting synchronization of operational processes, consequently increasing the efficiency of logistical-port operations.

This synchronization and control of the logistic chain that interacts with the port infrastructures is carried out by means of the PORTOLOG system. This system was developed ad hoc to meet the demands of CLPI, of its integration with other systems, as is the case of the Data Concentrator of the Paperless Port project, and of the support and use of information and communication technologies.

The PORTOLOG is a platform that enables the exchange of files via EDI, facilitating the fast and secure transfer of data with the other actors of the port community and their respective systems, ensuring that all the nodes of the port logistics chain work with the same information in an updated manner.

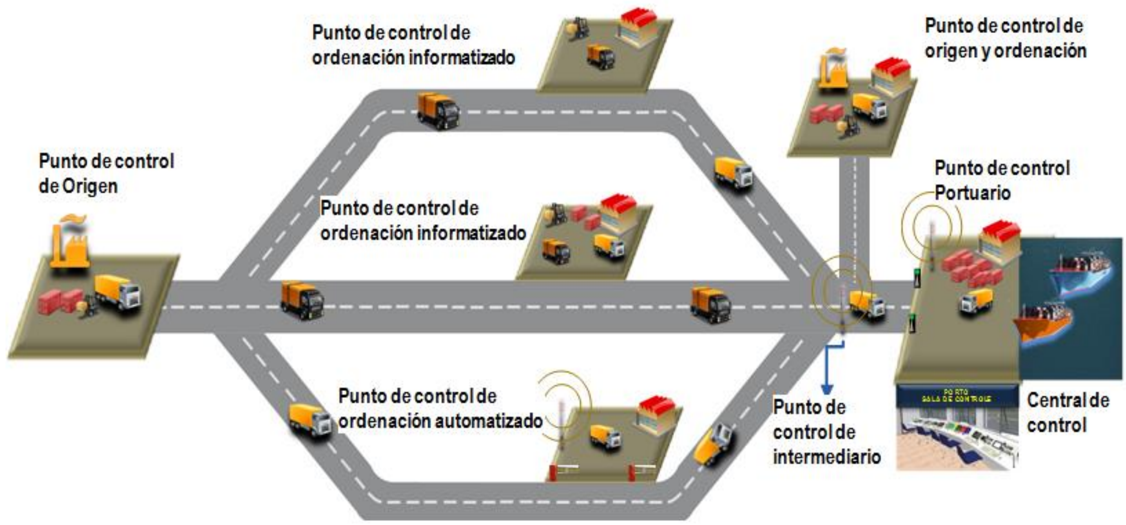

Figure 19. Conceptual schematic of the Intelligent Port Logistics Chain

The PORTOLOG manages the traffic of loads and vehicles to the port terminals in the processes of export, import and cabotage, anticipating the information of the arrival of the loads and vehicles to the port areas. In addition, the PORTOLOG must be integrated with other systems for its proper functioning, such as:

- Siscomex - Integrated Foreign Trade System;
- VTMIS - Vessel Traffic Information Management System;
- Operating systems of port terminals (TOS), two port operators and shipowners.

The main benefits expected with the implementation of the proposed system are:

- Synchronization of flows in the port logistics chain and reduction of inefficiencies;
- Rationalization of vehicle traffic in the port environment and reduction of vehicle queues;
- Rationalization of the dwell time of containers in the port and reduction of delays;
- Potential reduction in operational costs, vessel loading time and transport costs.

5.1.5. Closing Time – Port of Valencia

Initial Situation:

The road transport in the Port of Valencia is a key element for the hinterland connection, representing more than 90% of the import/export container movements. Due to its importance in the case of Valenciaport, the road transport requires efficient procedures and efficient information management due to the enormous volume of information generated. In this sense, smart procedures and technology are essential for the competitiveness of the Port of Valencia, which has been betting to be at the forefront of the development and implementation of efficient information systems and optimal procedures for the road transport.

ValenciaportPCS, the Port Community System of the Port of Valencia, is an electronic platform that enables the intelligent and secure exchange of information between public and private agents in order to improve the competitive position of its port community. It constituted an important technological and functional improvement, offering more than 20 transactional and informative services to nearly 600 companies and public bodies that speed up and make more reliable the way in which the actors involved transmitted the information.

Additionally to the information technology systems (PCS), the Port of Valencia implemented a complement to it, the Closing Time System. The aim of the closing time is to facilitate the management of the reception and delivery system of the terminals, avoiding or reducing the lines of trucks in the port area and speeding up the operation, both physical and documentary, of reception/delivery of the cargo.

Solution proposed:

A Closing Time System is a suitable solution for transport management in ports with high traffic of origin and destination in their area of influence and with difficulty in obtaining reliable information on the arrival times of trucks.

The Port of Valencia successfully applies land and sea closing time, establishing time limits for the reception of the information required by the different actors involved in the admission and delivery of containers. The land closing time procedure (Figure 20) establishes the limits to present the orders of admission and/or delivery of containers depending on the day foreseen to carry out these operations in the port terminal. On the other hand, the maritime closing time procedure (Figure 21) establishes the time limits for presenting information and delivering containers for the vessel's cargo operation. The procedure was established only for the case of containers because it was the most voluminous and important traffic in the port, in addition to being the one that generated necks in the accesses and roads. The figures below graphically present the details of these procedures.

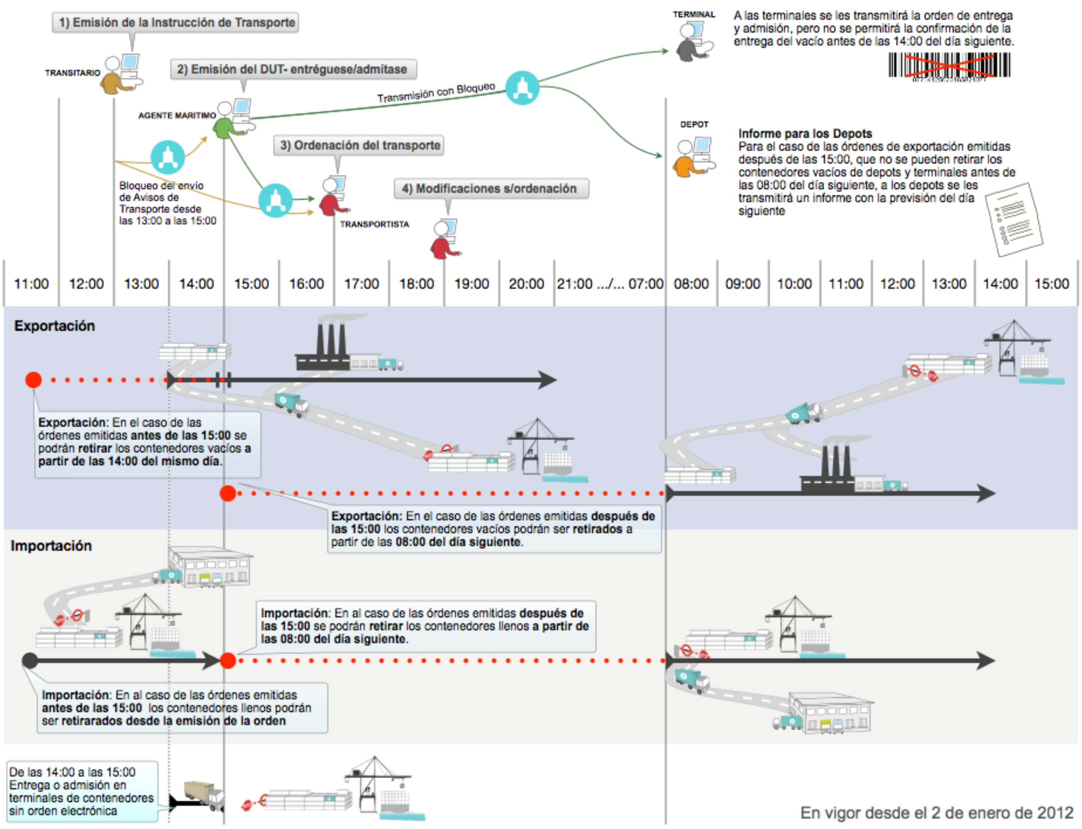

Figure 20. Functioning of the Closing time on land works in the Port of Valencia
Source: ValenciaportPCS.com [22]

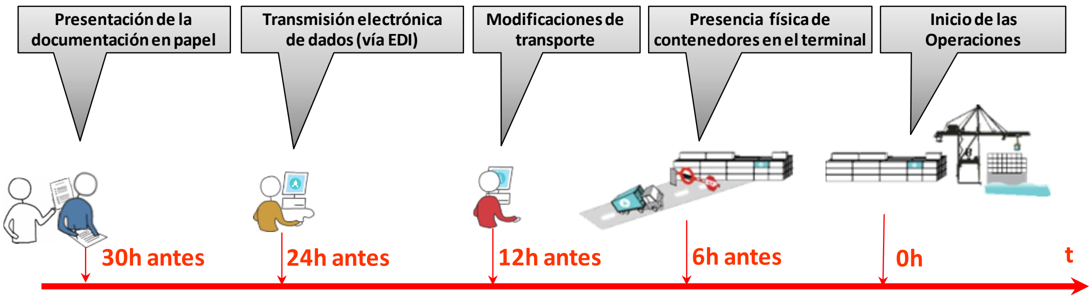

Figure 21. Functioning of the maritime Closing Time in the Port of Valencia
Source: ValenciaportPCS.com [22]

In order to implement Closing Time, a computer tool is needed that connects users and is capable of distributing the information in an adequate and secure way, which in this case is done with the PCS, without the need to present the paper documentation. The functioning of the closing time in Valenciaport follows the next steps:

1. Closing Time Operation:

- **Export:** In the case of export orders issued before 15:00, empty containers may be removed from depots and terminals starting at 14:00 on the same day. Orders issued after 15:00 may be removed empty containers from depots and terminals starting at 08:00 on the following day.
- **Import:** In the case of import orders issued before 15:00, full containers may be removed from the terminals immediately upon issuance. In the case of orders issued after 15:00, full containers may be picked up from 08:00 the following day.

2. Transmission of order data outside Closing Time

Report to the Depots:

For the case of export orders issued after 15:00, which cannot remove empty containers from depots and terminals before 08:00 the next day, depots will be transmitted a report with the forecast of the next day.

The report will include, in export, the quantity of containers by type and line. In import the containers foreseen for admission (without differentiating by line). When the container is assigned by the Maritime Agent, these containers will be included in the list.

The delivery and admission order will be transmitted to the terminals, but the confirmation of the delivery of the vacuum will not be allowed before 08:00 of the following day.

3. Trucks without orders issued through valenciaportpcs.net

Transfer of the window of time in which you can deliver or admit containers without an order transmitted through valenciaportpcs.net. It is reduced to a single hour, from 14:00 to 15:00.

5.1.6. Road Transport App – Port of Valencia

Initial Situation:

As previously stated, the road transport is a key element for the hinterland connectivity of Valenciaport. It represents more than 90% of the import/export container movements, which means more than 2 million of containers calling at the port gates annually. Due to its importance, the road transport requires efficient procedures and efficient information management and this is why the road transport is managed through the Port Community System (PCS) in the Port of Valencia.

As mentioned in section 5.1.5, the ValenciaportPCS is the electronic platform for information exchange of information between public and private agents. This tool aims at improving the competitive position the port of Valencia offering more than 20 transactional and informative services to its port cluster. In case of Road Transport Service, it allows the agents involved in the transportation of goods by land to:

- Generate and manage the transport orders
- Generate and manage cargo acceptance and delivery orders required
- Notify the delivery and acceptance of containers in the container terminals and/or depots through the PCS of the Port of Valencia (ValenciaportPCS)

In the Road Transport Management Service of ValenciaportPCS the forwarder or the shipper sends its transport instructions to the shipping agent and the truck company engaged to perform the haulage. The shipping agent issue the delivery and admittance orders to carrying out the transport. Then, the terminals and depots receive updated information of the delivery and admittance orders and then confirm the operations. This allows to standardize procedures, integrate within the “closing time” of the Port of Valencia, increase the level of control of the information and documentation processed, provide tracking and tracing information to all parties involved and automatic compilation of cargo acceptance and delivery orders.

Solution proposed:

The Valencia Port Authority (APV), within the framework of its policy of continuous improvement of the logistics-port chain, developed an application for mobile devices aimed at the optimize land transport service of ValenciaportPCS. The APP "Transporte Terrestre ValenciaportPCS" is free of charge and is available for Android and iOS devices through their respective application shops.

This tool, the first app developed through the ValenciaportPCS electronic platform, allows users to consult the real-time status of their delivery and admission orders from their mobile phones in real time and in order to be able to use this application it is necessary to be a registered user in the Land Transport Service of ValenciaportPCS as a carrier. However, it is possible the access for non-registered users if they have the identification number and a truck plate has been assigned through the system.

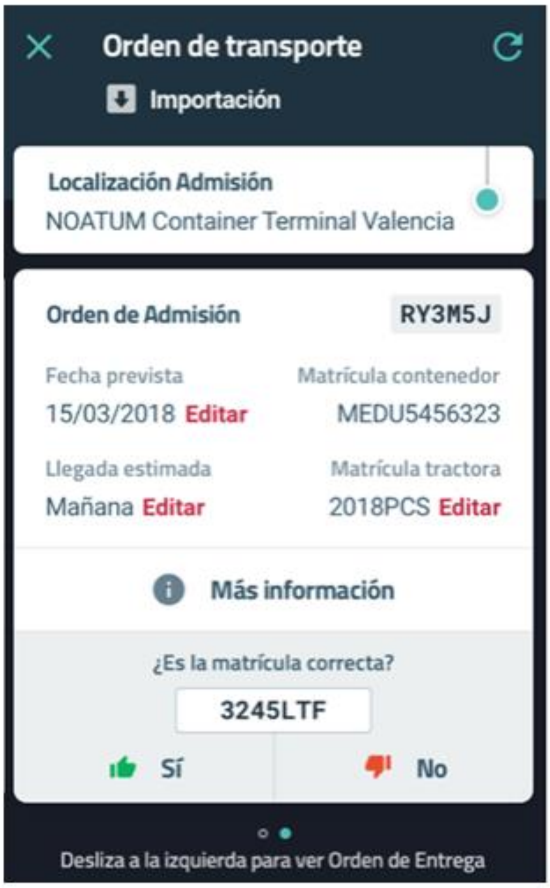

Figure 22. Design of the Transport APP for the land transport services of the Port of Valencia.
Source: ValenciaportPCS.com [22]

The APP incorporates options such as the assignment of the tractor license plate, or the option of verification of the license plate. In addition, in the case of delivery or admission orders, the latest version shows details with more information on the order consulted, with the incidents detected on it as well as the steps that the user must follow to manage them. The App also shows a barcode and the QR code to access the terminals and informs the user of the version installed. Main features of the App are listed below:

- Access for users not registered in ValenciaportPCS, as long as the locator number is available and the license plate has been assigned through the system.
- Possibility of displaying the barcode or QR.
- History of recent queries.
- The number plate of the vehicle's tractor head is indicated.
- Indicator for sending a VERMAS message with the declaration of Verified Gross Weight (VGM).
- The expiration date of the order appears.

5.1.7. Smart Port Logistics – Port of Hamburg

Initial Situation:

The port of Hamburg, one of the most important in the world, is located on the banks of the river Elbe, being an important commercial maritime connection of the country. It counts with important infrastructures and facilities: 140 km of roads, 142 bridges, 304 km of railways, 52 km of mooring line, 320 moorings for boats and 7,156 hectares of port area and moves annually near 9 million TEUs and more than 136 Million tonnes (2017).

With regard to traffic by transport mode, approximately 40,000 vehicles a day access the port's roads, about a third of which are trucks, which represents that 55% of traffic is made by road.

Modal split

Transport to/from hinterland (97,8 million tons)*		In hinterland container transport (5,5 billion TEU)*	
Rail	46.6 %	Rail	42.8 %
Inland waterway vessel	11.0 %	Inland waterway vessel	2.2 %
Trucking	42.5 %	Trucking	55.0 %

*Disparity in total caused by rounding

Figure 23. Traffic distribution by transport mode
Source: Hamburg Port Authority [25]

The enormous infrastructure of the Port of Hamburg and intense land traffic makes necessary an optimal organization and traffic management by the Hamburg Port Authority (HPA). In this sense, the vision of the HPA is to improve infrastructure services with the support of IT services.

Solution proposed:

The huge traffic of the port represented the motivation for the development of the Smart Port Logistics project, which seeks to optimise road traffic. The perspective is to broaden the objective for rail and inland navigation traffic, achieving an integral management of intermodal traffic that interconnects the different existing systems in the port with the new services available and offered by Intelligent Port Logistics. Once the information on the three modes of transport has been brought together, the HPA considers that the Port of Hamburg will find itself in a position of leadership with respect to the business processes supported by IT and with respect to its competitors.

In the port of Hamburg, as mentioned above, there are approximately 40,000 vehicles circulating through the port in daily basis. In order to ensure that this "chaotic" traffic does not hinder expansion plans, the Hamburg Port Authority (HPA) is implementing the initiative called Smart Port Logistics. This system, developed by the HPA together with the national telephone company (Deutsche Telekom) and SAP (provider of software and related services) and T-Systems (provider of innovative ICT solutions), is a traffic management system based on a "cloud" of private information (private cloud) that is being tested by some transport operators selected in a pilot test.

In this pilot project, several trucks were equipped with portable devices located in the cabs that were constantly connected to Internet. When these trucks entered the geofence by means of antennas, they were connected to the information system of the Smart Port Logistics and, from a central office, the visibility of the location of the trucks and their loads was obtained through the exchange of information with these devices. The system provided information to drivers on traffic and parking congestion at each parking lots, a solution that helps to alleviate the ever-increasing traffic in the port environment and to reduce the delivery/receipt time of goods.

Smart Port Logistics allows the Port Authority and transport and logistics companies to monitor their trucks and their respective routes in real time, optimizing their flows and increasing the satisfaction of end customers. This initiative has the following characteristics:

- Connection with the terminal operators' "appointment in advance" (gate in advance) systems;
- ETA service, which calculates and displays the estimated time of arrival (ETA) of trucks;
- Notification of the entry of trucks and their loads (containers) into the geographical area delimited (geofence) by the Smart Port Logistics;
- Optimization of traffic control: the truck driver obtains traffic and infrastructure information through the Logistics Infrastructure Service Provider (LISP);
- Planning and attribute verification

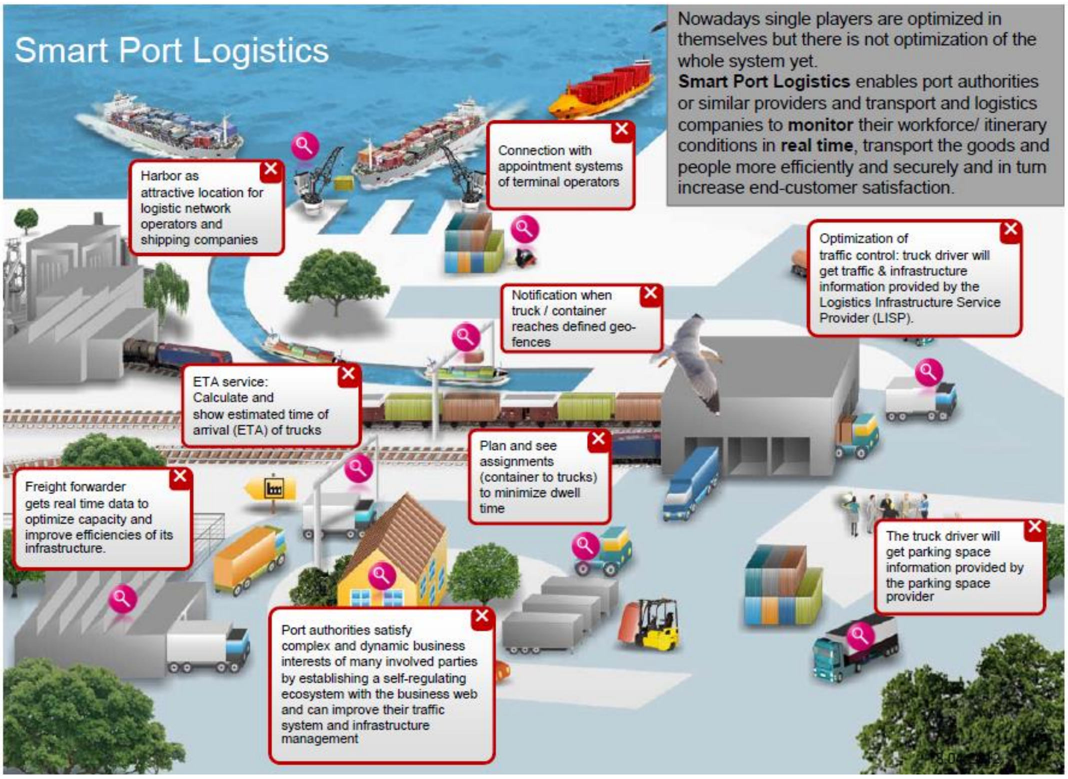

Figure 24. Schematic of Smart Port Logistics
Source: Hamburg Port Authority [26]

Smart Port Logistics is a system based on a computer platform that allows to control the entire logistic chain from end to end, integrating as many actors as possible so that everyone can have the necessary information in real time to make the best decisions at every moment. With Smart Port Logistics, the Port Authority is able to satisfy the complex and dynamic business interests of many actors involved in the logistics-port chain, establishing a self-regulatory system through a *webservice*, in addition to improving its traffic system and infrastructure management.

5.1.8. Off-Peak and Truck-Tag Program – Port of Los Angeles & Long Beach

Initial Situation:

The ports of Los Angeles and Long Beach, located in California, make up the largest container terminal complex in the United States and both ports together are among the top ten ports regarding container traffic in the world (17M TEUs in 2017).

On one side, the port of Long Beach has 1,295 hectares and 10 piers with 80 berths. It has 28 terminals, six of which are container terminals and counts with 51 km of roads, 4 km of mooring line and 25 bridges. On the other side, the Port of Los Angeles has 24 docks and has 9 large container terminals, 4 of them with intermodal railway stations, 2 cruise terminals, 7 liquid bulk facilities, 2 solid bulk terminals and 3 general cargo terminals that move steel products, fruits and meats.

Due to the large volume of traffic from both ports, there were many problems of congestion and local pollution and therefore, there was a huge concern with regards environmental issues. Thus, in 2005, the terminal operators of both ports created the company PierPASS (non-profit corporation) to resolve them.

Solution proposed:

Within this initiative, it is worth mentioning the Off-Peak program, in which a Traffic Mitigation Rate (TMF) was implemented, paid (except for exceptions) by trucks that access ports during peak hours (03:00-18:00, Monday to Friday). This was an incentive for cargo owners to use the off-peak period (18:00-03:00 from Monday to Friday and 08:00-18:00 on Saturdays) to carry out their operations. This fee is used to help cover the additional costs (overtime) of new working shifts.

The Off-Peak program serves approximately 55% of all container traffic in both ports, reaching its goals with a significant reduction of congestion and emissions in ports during the day. In addition, it helps to a better use of port assets and in the reduction of reception/delivery times of cargo and turnaround time -with an average of less than one hour- of trucks. However, the collection of TMF fees, since their creation, has never covered all the operating expenses of the Off-Peak program, but terminal operators assumed this revenue shortfall to ensure the benefits of reduced traffic and improved air quality.

Off-Peak is an outstanding private initiative, financed through tariffs and the port operators' own resources with the aim of offering a better service to their clients (reducing times and costs) and better local traffic conditions and air quality (social and environmental benefits), achieving a better level of global service in the logistics-port chain.

Another important point to be highlighted is the TruckTag program, which since 2007 required all trucks to be equipped with RFID tags and registered in eModal TruckerCheck to access port terminals, streamlining procedures and meeting government security requirements. The tags are installed in the driver's rear-view mirror and are automatically read at the doors, releasing, through system checks, the entry and exit of trucks. As part of this system, drivers' licenses and truck registrations are also validated to see if they are allowed access to the port. Tags can be purchased from eModal (www.emodal.com) and are only available to trucks that are registered in the TruckerCheck module of eModal. This program was one of the pioneers in the port sector in the use of RFID technologies in the automatic identification of vehicles.

The terminal operators that make up the PierPASS assumed the $1.2 million cost of the TrugTag software for data base development, tag acquisition and distribution. And the terminals paid to install the RFID readers on the doors. The cost of the program costs only a few cents per container and provides a valuable improvement in terms of security and agility of door processes.

5.1.9. Truck Appointment System – Port of Los Angeles & Long Beach

Initial Situation:

As previously mentioned in the section 5.1.8 the ports of Los Angeles and Long Beach, are the largest container terminal complex in the United States moving nearly 17M TEUs in 2017. The large traffic generated from both ports caused problems of congestion and local pollution so that there was a huge concern regarding environmental issues that lead to the co-creation of the company PierPASS to face them.

Solution proposed:

The adoption of a "truck appointment system" in California was motivated by a regulation that imposed penalties on terminals of $250 for each truck that was waiting more than 30 minutes. This situation could be changed by increasing the workload to 70 hours per week or by offering a "truck appointment system". Most terminals answered that question by offering a non-mandatory "truck appointment system" administered by an external provider called e-modal or by the terminal itself.

Founded in 1999, eModal became the largest "online" port organization in the United States. It offers to its customers a way to manage the records of trucks, appointments, dispatches, etc., through the various modules of the system available on its website (eModal.com). Among the eModal modules, the truck registry (also known as trucker check) and the appointments stand out.

The use of appointment systems is selective and not mandatory. They are mainly used for import containers, with a lower rate of use in export deliveries and in empty container delivery/receipt operations. Pre-appointments must be done 48 hours in advance and can be rescheduled or cancelled without additional charges. Time windows for trucks are 1 hour with a grace period of 30 minutes before and between 30 to 180 minutes after the scheduled time. According to the data provided by the terminals the average delay is less than thirty minutes and queues and congestion are negligible.

5.2. Railway Transport

5.2.1. Extended gateway inland platforms

As stated in the section 2, inland distribution is becoming more and more important and the efficiency and productivity of freight transportation is increasingly derived from port-hinterland relationships [27]. In such a context, logistics integration and network orientation in the port industry are redefining the functional role of ports in value chains, generating new patterns of freight distribution and new approaches to port hierarchy.

A solution to this terminal-hinterland relationship is the development of extended gateway inland platforms. This BP has been implemented in several dry ports and its study can help to identify ways of shifting freight volumes from road to rail, which is more energy efficient and less harmful to the environment. Some key facts to be considered in the implementation of this best practice to increase hinterland connections to ports are:

- **Study of the traffic volumes** to analyse the feasibility of the investment. The implementation of dry ports require certain level of cargo concentration, so the forecast of the container traffic volumes and a demand study is basic to analyse the project feasibility. In this sense, becomes essential the identification of the influence area before developing the dry port.
- **Comparison of rail transport services** and current truck services in the selected corridors in terms of time, costs, reliability and frequency.
- **Design of the inland platform**. The location of the dry port has to be selected considering potential traffic concentration but also the urban planning. The facility design and the services and functionalities become also essential for its success.

Inland terminals can be considered as ‘‘extended gates” for sea ports, through which transport flows can be better controlled and adjusted to match conditions in the port itself, helping to improve land accesses to the port. The land access to the port through this inland terminals can be used as a way of classifying dry ports, categorizing them based on the distance to the port terminal in distant, midrange and close dry ports [28].

- **Distant dry ports**, which is the most conventional because the distance and the size of the traffic flows make rail viable from a strict cost perspective
- **Close dry ports/Satellite terminals**: this dry ports are located close to seaport in order to help seaport to solve problems such as lack of space in maritime terminals or seaport congestion. This type of dry ports are commonly used in sea ports with important land restrictions, where the majority of the port space is dedicated to vessel loading/unloading operations.
- **Midrange dry ports**. This type of inland platforms are located within a distance from the port generally covered by road transport, which is generally accepted to be less than 500 km. The success of this type of dry ports is based on the high frequency achieved by consolidating flows together with the relatively short distance, which facilitates loading/unloading of containers for one single vessel in a unique train.

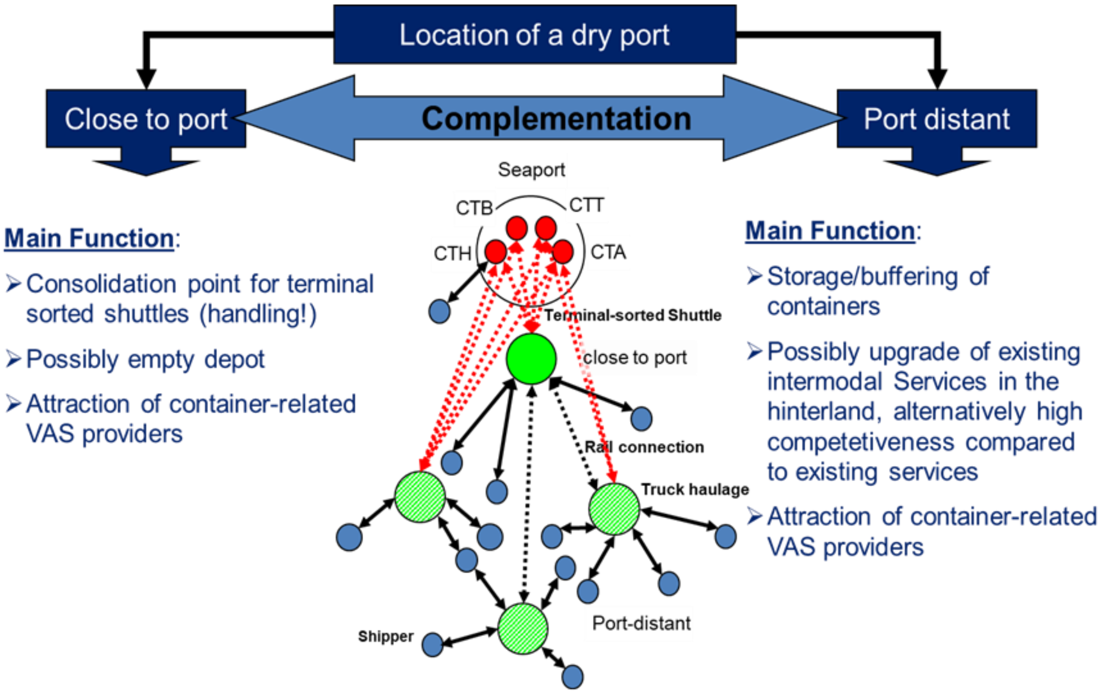

Figure 25. Different functions of dry ports [29]

5.2.2. Implementation of hinterland corridors

In the same manner than in the implementation of inland platforms, the setup of intermodal services between seaports and their area of influence through hinterland corridors is a key factor for the development of sustainable growth for the ports. Hinterland corridors can help to mitigate negative effects of the inland transport due to the increase of the railway modal split, which is cleaner and more environmentally sustainable than the road transport. Besides, the increase of the railway transport will potentially reduce congestion issues nearby seaports. Moreover, railway hinterland services will also increase the competition between inland transportation modes, which may lead to lower prices and more flexible transport solutions.

The implementation of new intermodal services at seaport-hinterland corridors is, in most of the cases, a complex and long-term action that require the collaboration of the entire port community. The proper design of these services requires de coordination of the main actors of the logistics supply chain, both from the railway industry (e.g. railway undertakings, railway operators, railway infrastructure management bodies) and also form the port sector (e.g. port authorities, terminal operators, freight forwarders, shippers or customs). Several of the actors involved can exercise the leadership of this collaboration process between different stakeholders of the port community. However, in the majority of the cases port authorities lead this process because they are interested in the development of competitive intermodal services as a strategy aligned with the landlord approach to connect them with their hinterland. Despite of the fact about who leads the process, the collaboration should start in early stages in order to design and implement solutions in accordance to stakeholders and market requirements. Finally, the collaboration between actors is especially necessary to concentrate efforts aiming at reaching potential customers.

Some of the main steps to be covered for the proper development of hinterland corridors are following listed:

1. Development of a market research analysis to identify potential traffics for new intermodal transport services at seaport-hinterland corridors including, firstly, port traffics and forecast, secondly, detailed hinterland analysis and identification of inland flows from/to the port and finally, identification of key corridors for intermodal transport (short, medium and large distances).
2. Identification of key stakeholders for new seaport-hinterland connections and development of working groups to design the new intermodal services. The working groups will include potential users of the service in order to include all different perspectives and needs in the process. As previously mentioned, port authorities can lead this organization due to their neutral position.
3. Analysis of different cooperation schemes to develop and implement the new intermodal transport services. The working groups will result in a set of actions to be undertaken by the different actors aiming at implementing the intermodal services previously analyzed.
4. Development of an economic feasibility study for the new intermodal transport services to be developed including a detailed cost comparison of the new intermodal transport service with current transport solution. In this step, it is also necessary to identify potential European, national and regional level to support the project that can make it financially sustainable in long-term basis.
5. Selection of the final business model to implement including cooperation agreements and roles of different partners. The organizational scheme may include different types of associations and agreements between the stakeholders involved such as shared services to distribute risks and costs, implementation of collaborative agreements to ensure attractive services and creation of new companies for the development of efficient intermodal services.
6. Continuous monitoring and improvement once the service has been implemented aiming at assessing the service evolution and detecting problems and opportunities for continuous improvement. Monitoring should include close customer validation to obtain feedback from the main users and key stakeholders, not only for continuous improvement objectives but also for marketing and sales purposes. Customer engagement and consolidation of the clients (satisfaction of clients needs in terms of service, price, frequency and reliability) becomes essential for the proper evolution of the hinterland corridors.

Some Examples:

- Antwer Intermodal solutions
- NTT Neutral Triangle Train
- Neutral Container Shuttle System (NeCoSS)
- Zaragoza (PLAZA)-Valenciaport railway corridor (this corridor will be analysed in detail in Task 2.4)
- Soufflet-SNTC
- Container trains from port of Tallin to Moscow, Central Asia and Black Sea Region
- Emons Rail Cargo
- Adria Transport d.o.o.
- Implementation of a new regular service of container-trains between Port of Barcelona and Puerto Seco Azuqueca
- Naples port logistics extended system

5.2.3. OCR Rail – Port of Hamburg (HHLA Burchdackay)

Initial Situation:

The port of Hamburg, as previously mentioned, is the third largest container port in Europe and one of the most important in the World. It handles annually near 9 million TEUs and more than 136 Million tonnes (2017) of which 42.8% (TEU) and 46.6% (tonnes) of the hinterland traffic is done by train, being the largest port of Europe in terms of railway traffic. The port counts with important railway infrastructures and facilities including 288 km of railways and 51 railway bridges. This means that on any given working day, around 200 goods trains arrive at or depart from the port

Besides, the Hamburg port railway is one of Germany's largest railway infrastructure companies. It is responsible for availability and safety across the entire infrastructure, acting as a link between terminals or loading points and the European railway network. More than 110 different rail operators use the infrastructure.

Solution proposed:

As the number of containers shipped via rail in the Port of Hamburg continued to grow, so did the need for automated inspection, identification and inventory of train containers. In order to streamline the railway processes, Camco's Rail OCR Portal provided a solution for remote visual inspection and automatic identification of containers and railcars. The solution came also with a Train Gate Operator application for further processing and exception handling, which was pioneer in OCR for trains in Europe in HHLA Burchdackay container terminal.

Figure 26. HHLA Burchdackay container terminal
Source: HHLA [30]

The Camco's Rail OCR Portal was set in HHLA Burchdackay container terminal, which counts with a railway terminal with 8 railway tracks, 5 rail gantry cranes and rail track lengths over 700 m. The implementation of this solution aimed at when a train drove through the camera portal, the line scans generated images of each container's left, right and top side, to ensure basic OCR. Optionally, images of the container's front and back were provided. OCR support is provided for container numbers, ISO codes, non-ISO container numbers, railcar and chassis numbers, IMDG and seal presence, and door direction. With this information, the rail OCR system was able to return the exact position of every container on an identified railcar.

Moreover, there was implemented a post processing thanks to the Train Gate Operator system, that allows that before the OCR data is sent to the TOS, operators can use the Train Gate Operator application to perform post-processing tasks. This application allows the operator to visually inspect the condition of each container and railcar, and verify, correct and validate the OCR-processed data. When the collected information is complete and correct, the processed data is sent to the TOS for further processing. The validation process takes only a few minutes, and can be easily performed by a gate clerk, locally or remote, for one or multiple sites.

The OCR rail solution allowed terminal and rail operators to automatically perform train inventories, associating container data with railcar and train positioning. This resulted in faster train loading and discharging, increasing productivity while reducing operating costs. The post processing of several rail portals can be performed on one centralized location. Some primary benefits of the OCR railway system include:

- Improve productivity through the elimination of data input and/or task confirmations thereby increasing the accuracy and velocity of the transactions resulting in higher throughput and improved container inventory accuracy.
- Centralized control over exceptions that occur from automatic inspection.
- Safer operations since all data capture of transactions is automatic.

5.2.4. Rail Port Shuttle – Port of Rotterdam

Initial Situation:

Port of Rotterdam is the largest container port in Europe and 10th in the world in terms of containers handled with an annual throughput of 13.7 million TEU and 467.4M tones in 2017 [31]. In the port there are line connections with over 1,000 ports across the world and excellent intermodal connections for the transport of containers to destinations within Europe, thanks to the 9 container terminals (6 for deepsea and 3 for shortsea) and 24 container depots.

The Port of Rotterdam has an extensive network of intermodal transport connections through rail, inland shipping, road and pipelines that ensures access to the main European destinations in the hinterland within 24 hour. Concerning these hinterland connections, cargo transported out of the Netherlands is mainly through six corridors: the highway A15, the Meuse River, the Rhine River, the Rotterdam–Antwerp Canal, the Rotterdam- Antwerp railway, and the BetuweLine railway.

In reference to the rail transport, over 250 international rail connections run from and to Rotterdam. The rail connections are mainly suitable for transporting containers, dry bulk, general cargo and chemical products. The transit times are short: cargo arrives at the German border within 3 hours and at other European destinations within 24 hours. Various terminals also have rail transshipment facilities, which means that cargo can be loaded directly onto a train at the terminal. However, the increasing number of containers moved by rail in the port of Rotterdam between the container terminals and the RSC Rotterdam, the terminal that carries out transhipment activities for the combined road/rail transport, required the implementation of solutions for the containers exchange between terminals.

Solution proposed:

PortShuttle Rotterdam was launched to serve the Euromax, RWG, APMT MVII, ECT, CTT and RSC Rotterdam terminals in September 2015 and it has expanded into the neutral rail solution connecting the whole port of Rotterdam. Railway operators, shipping companies and logistics service providers use the PortShuttle to transfer small or large numbers of transhipment containers from one Maasvlakte terminal to another but also is possible to use PortShuttle to connect the Maasvlakte terminals to the European hinterland by rail through the RSC Rotterdam.

Figure 27. Illustration of PortShuttle Rotterdam
Source: Port of Rotterdam – PortShuttle-Rotterdam [32]

PortShuttle Rotterdam is the neutral rail solution for the exchange of containers between terminals in the Port of Rotterdam that offers a daily rail shuttle from RSC Rotterdam and CCT Pernis to the deep sea terminals at Maasvlakte. PortShuttle enables shuttle operators, logistics service providers and shipping companies to consolidate cargo flows and optimise logistics within Rotterdam [32].

In principle, thanks to PortShuttle Rotterdam, containers can be moved from one Maasvlakte terminal to the next within 24 hours. Besides, upon request and provided that there is sufficient volume, PortShuttle can also provide connections to other terminals within the Port of Rotteradam, guaranteeing that together they will find a suitable solution and set up a rail link for customers.

5.2.5. Rail Incubator – Port of Rotterdam

Initial Situation:

As previously mentioned, the Port of Rotterdam is one of the largest container port in Europe and in the world in containers throughput with more 13.7 million TEU and a total of 467.4 million tonnes in 2017 [31]. This traffic implies an important pressure to hinterland connections and due to the expected growth in container throughput via Rotterdam, partly due to the construction of Maasvlakte 2, further expansion of the current 250 rail connections is desirable. Even though almost all of the container terminals have their own rail facilities and the Betuwe Route, a dedicated freight railway, provides a direct connection between the port of Rotterdam and Germany there was a lack in the past to join forces to create new rail connections.

Solution proposed:

With the Rail Incubator [33], the Port of Rotterdam Authority supports operators in establishing new rail connections and it allows the Port of Rotterdam Authority to remove a number of obstacles related to the creation of new rail connections. There are various options for cooperation and support. For instance, the Port of Rotterdam Authority is willing to co-invest in establishing new rail connections or increasing the frequency of already-existing rail shuttles. The Port of Rotterdam Authority is also willing to contribute to finding potential partners and if present, the Regional Representative can play a role. Marketing support is also part of Rail Incubator to make new connections a success.

The focus of the Rail Incubator is on European growth regions that currently have little or no connections to Rotterdam, such as Southern Germany and Central and Eastern Europe. The quality of the services resulting from the Rail Incubator is guaranteed for the end user. The services will have at least two years to prove their profitability. The fees and transit times will be competitive, and the services will be monitored and improved continuously.

5.2.6. Optimised distributed rail transport in the port: Railport – Port of Antwerp

Initial Situation:

Antwerp is one of the biggest European rail ports in Europe with over 18 million tonnes of cargo that are transported by rail every year. The port invests heavily in rail as a sustainable mode of transport following its Master Plan for Rail Transport in which the Port Authority outlined an ambitious policy for the further development of rail transport. As an example, the port authority is supporting the development of the rail network in and around the Antwerp port area with the construction of the Liefkenshoek rail tunnel. The Liefkenshoek rail link is a 16.2 km connection between the Left and Right banks of the Scheldt River. This rail link entered operation in December 2014 and has a capacity of 109 freight trains per day in each direction. It offers a time saving of more than half an hour while affording greater reliability of operation and improved rail access between the port and its hinterland.

Besides, Port Authority commitment, rail service providers are also investing heavily in rail to offer quick and flexible services that will allow a significant reduction of the ecological footprint. Rail services are a valid alternative to road transport the majority of cargo flows because the Port of Antwerp is a centrally located for the three main rail corridors in Europe:

- Corridor 1 (Rhine - Alpine Corridor): Antwerp – Duisburg – Cologne – Basel – Genoa

- Corridor 2 (North Sea - Mediterranean Corridor): Antwerp – Luxembourg – Lyon/Strasbourg - Basel
- Corridor 8 (North Sea - Baltic Corridor): Antwerp – Duisburg – Poland – Lithuania

Solution proposed:

In order to keep the pace of port worldwide trends with finding alternative solutions to the road transport, and aiming at optimizing container transport by rail within the port facilities, the port of Antwerp set up Railport. Railport is one specialised, neutral port rail operator responsible for the marshalling and transfer of cargo wagons between the Antwerpen-Noord marshalling yard, the different rail fans and the companies in the port [13]. As such, the operator bundles cargo and ensures a more efficient use of the existing rail infrastructure. This offers many advantages:

- Faster transit of rail cargo in the port
- Lower shunting costs
- Several services per day
- More flexibility for users

This pilot project initially covers two zones on the Right Bank of the Scheldt (zone Kanaaldok and zone Oosterweel) with B-Logistics making its transport network inside the port available to other rail operators. The expansion to the entire port area is possible after a positive evaluation of the pilot.

Railport Antwerpen NV is a joint initiative of the Port of Antwerp, Scheldt Left Bank Corporation, the Belgian Federation for Chemistry and Life Sciences Industries Essenscia and Alfaport – Voka Kamer van Koophandel Antwerpen-Waasland, the federation of port-related and logistics companies in the port.

5.3. Inland Waterway Transport

In this section a set of good practices for inland waterway transport (IWT) are presented, which have been collected mainly from the European Projects PLATINA and PLATINA2. Firstly, PLATINA project (2008-2012) aimed at implementing efficiently actions and measures to boost inland waterway transport. The project involved 22 partners from 9 European countries that wanted to serve as a platform for promoting the implementation of the European inland navigation programme NAIADES and some of the results of the first PLATINA were the reports "European Good Practices Report for Inland Waterway Transport[1]" [34] and the "Manual on Good Practices on Inland Waterway planning[2]" [35]. Secondly, PLATINA 2 project (2013-2016) supported the coordinated implementation of the NAIADES II Action Programme "Towards quality inland waterway transport". PLATINA 2 also wanted to foster the development of inland navigation towards a more sustainable and competitive part of the European transport network and one of its main results was the report on "Good Practice Manual on Waterway Maintenance" [36]. These three reports have been used as main references to identify and describe best practices on Inland Waterway Transport.

[1] https://trimis.ec.europa.eu/sites/default/files/project/documents/20130121_161011_41252_European_Good_Practices_Report_for_Inland_Waterway_Transport.pdf
[2] https://www.icpdr.org/flowpaper/app/#page=1

However, this deliverable will only present a selection of the ones related to the improvement of the hinterland connectivity.

5.3.1. River Information Services (RIS)

Initial Situation:

In the 1990s, countries with inland waterways started to work on information systems for inland shipping but their work was, in most of the cases, not very coordinated. This situation could potentially have led to the implementation of different technologies in each country so the European Union played a very important role in harmonising the development of RIS and officially set in 1998 the concept of River Information Services (RIS) to improve the reliability and availability of inland navigation. The policy development went hand in hand with European research and innovation implementation so they have contributed to technology, organisation and policy, and have helped to clear the obstacles to effective realisation of River Information Services. To this end, some European research projects like INCARNATION, INDRIS, COMPRIS and ALSO Danube, helped to develop the RIS concept. Finally, in 2005, the European Council and Parliament adopt the RIS Framework Directive of the European Union (2005/44/EC) and in 2006 the European Commission adopts the RIS guidelines, in order to ensure the interoperability of the RIS services.

Solution Proposed:

River Information Services [3](RIS) are information services designed to enhance safety and efficiency of inland waterway transport (IWT) by optimizing traffic and transport processes. Focal aspect is a swift demand oriented electronic data transfer between water and shore through real-time exchange of information. RIS therefore aim to streamline the exchange of information between all IWT stakeholders. Since 2005, an EU framework directive provides minimum requirements for RIS implementation and agreed RIS standards to enable cross-border compatibility of national systems. The European waterways affected by the RIS Directive are illustrated in the following picture:

[3] http://www.ris.eu/general/what_is_ris_

The development of RIS, in combination with cost-effective and environmentally friendly logistics operations, enhances the competitive edge of inland waterway transport in the supply chain. The policy importance of RIS is presented in various EU policy papers, i.e.EC White paper, TEN-T Guidelines, NAIADES, Logistics Action Plan. Besides, in 2015 the EC launched the Digital Inland Waterways Activity (DINA) initiative as part of the Digital Single Market (DSM) strategy of the Junkers Commission. Goal of the DINA initiative is to digitize information flows in IWT with the aim to allow for seamless integration of IWT in multimodal logistic chains.

Main RIS objectives:

- Enhancement of safety in inland ports and rivers.
- Enhance the efficiency of inland navigation - optimise the resource management of the waterborne transport chain by enabling information exchange between vessels, lock and bridges, terminals and ports.
- Better and more effective use of the inland waterway infrastructure - providing information on the status of fairways.
- Environmental protection - providing traffic and transport information for an efficient calamity abatement process.
- Better integration of IWT into multimodal supply chains trough accurate and timely information to support transport management.

River Information Services (RIS) enhance data exchange among the actors of inland waterway transport, making the communication between all parties more effective and efficient. Particularly to ports, the implementation of RIS has the following benefits for the inland waterway transport

- Enhancement of inland navigation safety in ports and rivers. It will provide local and regional traffic information for safety monitoring on a tactical as well as a strategical level.

- Enhancement of the efficiency of inland navigation. RIS will optimise the resource management of the waterborne transport chain by enabling information exchange between vessels, locks, bridges, terminals and ports.

Services provided by RIS:

- Information on fairways to plan, execute and monitor voyages by boat masters and fleet managers (e.g., water levels, aids to navigation, fairway information, opening hours of locks etc.). The information comprise geographical, hydro-meteo, and traffic related data;
- Traffic information services comprise information on vessel positions to allow for tactical or strategic planning;
- Traffic management aims at optimising the use of the infrastructure as well as facilitating safe navigation, especially at VTS Centers, as well as at locks and bridges;
- Calamity abatement services are responsible for registering vessels and their transport data at the beginning of a trip and updating the data during the voyage with the help of a ship reporting system. In case of an accident, the responsible authorities are capable of providing the data immediately to the rescue and emergency teams;
- Information for transport management includes estimated times of arrival (ETA's) provided by boat masters and fleet managers based on fairway information making it possible to plan resources for port and terminal processes. Information on cargo and fleet management basically comprises two types of information: information on the vessels and the fleet and detailed information on the cargo transported;
- Statistics and customs services: the RIS improves and facilitates the collection of inland waterway statistical data in the Member States;
- Waterway charges and port dues: the travel data of the ship can be used to automatically calculate the charge and initiate the invoicing procedure.

The development of RIS together with cost-effective and environmentally friendly logistics operations can make inland waterway transport more attractive and more competitive. However, to be able to fully exploit the benefits of RIS in Europe, harmonisation is needed. According to INE (Inland Navigation Europe) 2016 annual report [37], the RIS directive lays down the basic infrastructure and service requirements and their capability to enable the deployment of River Information Services across borders. However, today, the implementation is not complete mainly due to the lack of a clear legal basis for the international exchange of RIS-related data. INE advocates the review of the 2005 Directive on River Information Services (RIS) in 2018 as part of the EU Digital Transport package to make inland waterways easy-to-use and to enable digital integration with other modes of transport in logistics. This will require:

- EU-wide legal basis for cross-border data exchange of fairway, voyage, cargo & traffic information
- Proper management and maintenance of RIS systems and services
- Close gaps of shore-based Inland AIS infrastructure
- Introduction of carriage requirement for Inland AIS transponders on all main inland waterways
- Seamless corridor management services

- Links between RIS, eTools and other digital applications to ensure future compatibility
- Education and training of all involved staff
- EU support programs to reserve adequate budgets for effective implementation and further development.

5.3.2. Instream: smart and efficient inland navigation - Port of Antwerp

Initial Situation:

The port of Antwerp is one of the biggest European ports moving near 200 tons of import/export cargo and is the second largest port in Europe in terms of container handling. It acts as a gateway port for the European continent due to its geographical location deep inland at the centre of the Rhine-Mass-Scheldt delta region, in the heart of Europe, which makes it directly connected to the European network of inland waterways. Indeed, 60% of European purchasing power lies within a radius of 500 km from the port, which allows the port to reach 600 million of costumers effectively. In terms of inland shipping, more than 925 barges call at the port of Antwerp every week carrying goods (from project cargo to containers or dry and liquid bulk) to and from Germany, Netherlands, Belgium, North of France or even Switzerland. Thus, barge transport plays a fundamental role in Antwerp's Port to reach a sustainable and environmentally friendly hinterland transport.

The Port Authority of Antwerp follows the recommendations of the European Commission, which set a target of shifting 30% of road transport to rail and barge by 2030, and has the commitment to sift to a cleaner and more sustainable modal share. Under this purpose, the Port of Antwerp's aims closely mirror these targets and even though rail and barge already account for 51% of freight transport passing through the port, the Port of Antwerp's real target is to increase this figures up to 60% by 2030 as can be seen in section 3 (Figure 10).

Solution proposed:

Due to the importance of the inland waterway transport, Antwerp Port Authority and its Barge Master Plan aimed at creating the right conditions for inland navigation to develop into an even smarter, more efficient mode. The Port of Antwerp acts as a proactive and customer-oriented supply chain partner to that reinforce logistics chains carrying out inland navigation projects in collaboration with the main stakeholders. By combining forces, the port streamlines barge processes and facilitates knowledge and expertise transfer, which creates a positive environment among the stakeholders and results in more intense collaboration.

The inland waterway supply chain efficiency is based on the pillars of transparency, sustainability, fast and reliable connections, and high quality, tailor-made services. These priorities are trying to be accomplished by "***Istream: smart and efficient inland navigation***" thanks to three main group of projects:

- **Nautical coordination**: due to the higher number of barges calling the port, two main initiatives are being pursued to improved coordination and ensure safe and efficient vessel traffic management:
    - Automatic Identification System (AIS)
    - Barge Coordination

- **Efficient container handling** in order to ensure the optimal operations in the port, which is addressed by the following actions:
  - Barge Traffic System (BTS)
  - Central Barge planning and monitoring
- **Efficient distribution within the port**: to ensure rapid full and empty container transfer between terminals inside the port and increase the efficiency of the intra-port container distribution. This is done by:
  - Premium Barge Service (PBS)
  - Consolidation of small barge container volumes

The Automatic Identification System (AIS), and the specific case of the Port of Antwerp, is explained in following sections. The Barge Traffic System (BTs) and Central Barge planning and monitoring are developed bellow:

Barge Traffic System

The Barge Traffic System (BTS) offers a unique slot request and monitoring system for container barges and terminals operators. BTS was developed in consultation with the barge industry to optimise the handling of container barges and to maximise loading and unloading efficiency.

The process of BST starts after receiving online requests from barge operators. In this moment, the terminal operator prepares a schedule of loading and unloading operations in BTS and returns this to the barge operator via the system. Barge and terminal operators can both access BTS via C-Point, the network of electronic and information systems that supports logistics flows at the Port of Antwerp. Thanks to continuous monitoring possibilities including barge position and lock planning, the terminal operator’s schedule and barge sailing schedule can be adjusted quickly allowing better planning and efficient operations. The use of BTS is mandatory in the Port of Antwerp area and will lead to more efficient, safer and more sustainable management of barge traffic. The main advantages of the use of BTS are:

- One single communication channel
- Uniform and transparent procedure
- Detection of conflicts between planning
- Reliable lead times
- Cost savings
- Continuous monitoring possibilities

In combination with BTS, the port offers central barge planning and monitoring to guarantee efficient handling in the port. It permits loading and unloading schedules to be coordinated, with increased communication between the terminal operators. The central barge planning and monitoring works as a central unit that uses planning software and BTS to draw up a schedule of loading and unloading operations for all container terminals in the port, providing following advantages:

- Advantages
- Prompt and effective handling of container barges

- Short turnaround times for barges
- Accurate schedules
- Reduced idle time

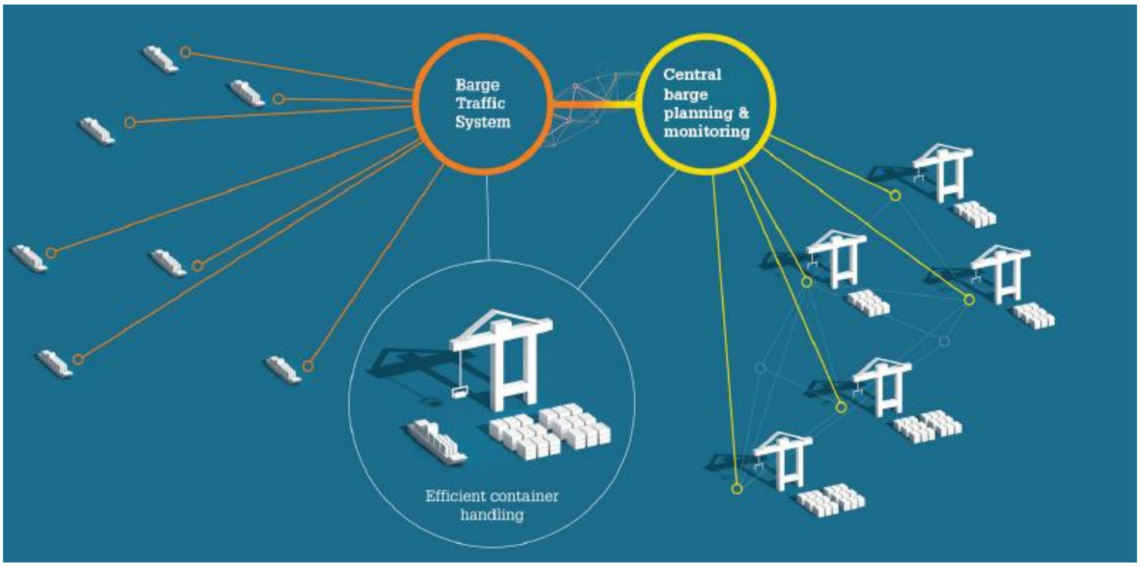

Figure 28. Schematic of the functioning of the Efficient Container Handling action.
Source: Port of Antwerp [13]

Premium Barge Service

The Premium Barge Service (PBS) is a shuttle service that works on the principle of a fixed bus service, the so-called milk run. The aim of the service is to reduce the number of containers carried around by truck. The system works with barge calls at the same container terminals at fixed times each day. There are two loops: a first loop connects the maritime container terminals, while a second connects these terminals with terminals on the left bank. This systems allows to reduce the container traffic by trucks in the port area but also offers reliable intra-port transfer service, increases the efficiency of transfer operations and offers an accurate scheduling and handling for barges.

Loop 1 - Connecting maritime container terminals

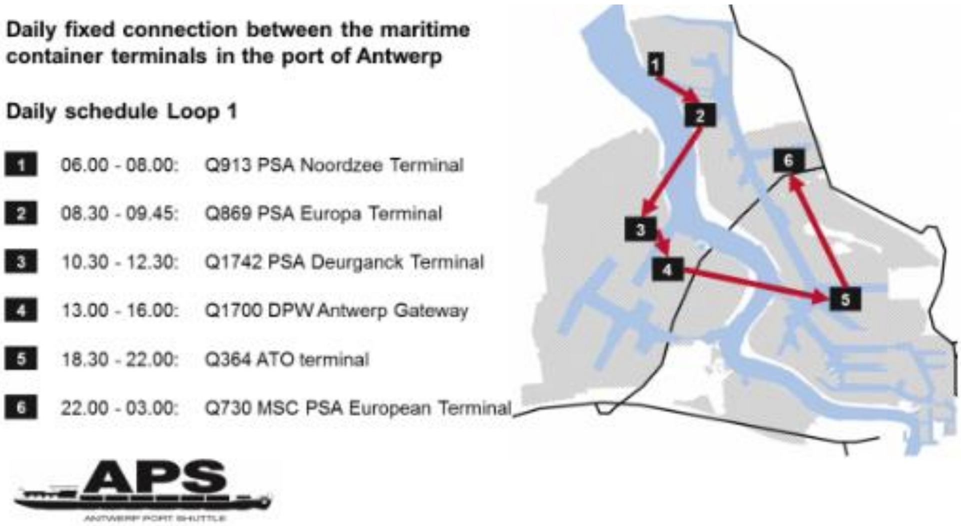

Figure 29. Schematic of the loop 1 of the premium barge service (Antwerp Port Shuttle)
Source: Port of Antwerp [13]

Loop 2 - Connecting with the Left Bank

Figure 30. Schematic of the loop 2 of the premium barge service (Antwerp Port Shuttle)
Source: Port of Antwerp [13]

5.3.3. Automatic Identification Systems (AIS)

As a part of the RIS Directive, AIS is a standard technology that allows Vessel Tracking and Tracing (VTT), enabling automatic exchange of data between ships and between ships and shore infrastructures such as ports. Barges are equipped with AIS transponders that allow automatic identification of the name, position, speed and course of the barges and this allows mutual visibility between barges, seagoing vessels, and infrastructures. Therefore, the use of AIS in port environments and in inland waterways clarifies the overall picture of the shipping traffic conditions facilitating nautical communication between different actors. The use of AIS in combination of radars allows more efficient traffic management and also contributes to enhance safety due to better incidents management. Besides, some other benefits of the AIS are:

- Better logistics management due to more reliable planning
- Law enforcement due to the knowledge of the location and speed of barges that allow the authorities to check the accomplishment of traffic regulations and the record of accidents and faults.
- Better information and statistics thanks to the recorded AIS data that enables detailed research in the use of inland waterway transport and traffic patterns.
- Lower fuel consumption and its related environmental benefits due to more accurate trip planning that allow barge operators to optimize speeds.

The Port of Antwerp, in the pursuit of a cleaner modal sift up to 60% by rail and barges by 2030 (20% rail and 40% barges), was the first European port to make AIS mandatory for barges. In this way, the port has a more comprehensive overview of the traffic inside the port area, aiming at increasing safety and improve traffic efficiency, especially in the use of the port locks.

This system is complementary to the previously mentioned Barge Traffic System (BTS) and APICS system about nautical information, which allows ports stakeholders (e.g. traffic controllers, barge operator and terminal operators) to monitor and schedule barge flows more efficiently. On one hand, the main advantages for shipping companies, barge operators and skippers are:

- Proactive traffic control
- Safety in port due to mutual visibility and recognisability
- Efficient berth management
- Better lock planning
- Optimization of lock capacity
- Speed adaptable according to lock passage time: economic and ecological benefits

On the other hand, for terminal operators the main advantages are:

- Clear picture of barge locations and identification
- Improved planning

The AIS together with the barge coordination - a single central point of contact for scheduling lock operations based on real time traffic situation in the port of Antwerp - will make possible to achieve a safer and more efficient shipping traffic in the port and optimize the use the locks. Thus, the used of these systems will lead to a reduction of the transit times and, consequently, to an increase of the port competitiveness.

5.3.4. Estuarial vessels in the region of Flanders: Deseo/Tripoli and Amberes

Initial situation:

The region of Flanders, in Belgium, counts with some of the busiest ports in Europe such as Antwerp and Zeebrugge. This region can be considered as a one of the main cargo gateways in Europe due to its privilege location at the centre of the Rhine-Mass-Scheldt delta region. The hinterland of the ports located in the area, as previously mentioned, covers countries from

Germany, Netherlands, Belgium, North of France to even Switzerland, which represent an important part of Europe's population. Besides, due to the large network of inland waterways and channels in the region, it represents a great opportunity for the development of the inland waterway transport instead of traditional cargo movement by truck.

Solutions proposed:

Due to the existing inland waterway networks in the Flanders region, it was decided to provide shuttle services between the main ports in the region (e.g. Antwerp and Zeebrugge) and their hinterland with inland container vessels ranging from 240 to 400 TEU. With this solution, it was aimed to provide a first-class service to large shipping companies and terminal operators in the Scheldt estuary.

Initially, the objective was to provide the following regular container liner services to shipping companies and terminal operators:

- Three estuarine barges connect the Port of Zeebrugge with Antwerp Container terminals as well as several Flemish inland terminals.
- Two estuarine vessels, carrying 400 TEU, or 5,000 tones, are active between Zeebrugge and the Antwerp region.
- One estuarine vessel with a capacity of 240 TEU sails between Zeebrugge and the WTC-terminal on the Albertcanal in Meerhout three times a week.

Thus, in total there were planned six estuarine barges with a target to ship 790,000 TEU yearly to the Flemish hinterland and Rhine region. This means that that could be avoided 500,000 trucks or 9,000 traditional barges passing the historic city of Bruges.

Since September 2010 PortConnect, the company that provides the service, has connected terminals in the estuary from Zeebrugge to Neuss and Duisburg. Currently, the company has a fleet of four estuary vessels up to 400 TEU(m/v Deseo, m/v Tripoli, m/v Amberes and m/v Polybotes), in which most type of containers can be taken on board and mainly connects maritime and inland terminals, even though they also provide shunts within ports.

The routes that they cover up to date are:

- Daily Zeebrugge-Antwerpen
- Weekly Zeebrugge – Rhine
- Vlissingen-Terneuzen-Gent
- Albertkanaal
- Amsterdam

Figure 31. Map of the Belgian canals and waterways including the main routes
Source: Port Connect Website [38]

5.3.5. LIVRA: Logistics Chain Information on the Fairway Rotterdam - Antwerp

<u>Initial situation:</u>

The region of Flanders, in Belgium, together with the fairway between the seaports of Rotterdam and Antwerp is one of the busiest inland shipping routes in Europe. Unlike the Rhine River from Rotterdam to the Ruhr area, this north-south corridor between the two ports consists of several locks that sometimes cause delays and queues. The fairway between the two regions has enough capacity and does not represents an issue itself. However, the locks were the main reason for waiting times and delays.

<u>Solution proposed:</u>

The LIVRA project aimed at achieving more reliable travel times on the Rotterdam - Antwerp route in order to optimise the logistic chain and the lock capacity, avoiding unnecessary queues and delays. Thus, the main objective of the project was to provide more and better information to shipping companies and individual ships about the status of the locks and travel times in the fairways.

In order to accomplish within this objective, the LIVRA project consisted of three different pilots:

- **Pilot 1 "Situation":** the project launched a website through which shipping companies access to a 'map' that included information about the status of the lock. This information was provided in real-time and showed the current situation at the lock. The information provided included: ships entering/exiting or locking through; number and size of ships in the locks; and direction of the vessels (locking to the north or to the south). In addition, the user could see through the web portal the number of ships that are waiting at the lock as well as the number of ships that have announced their arrival. Thanks to this information provided in real time, shipping companies and ships could get an indication of the waiting time, and whether they should adjust their navigation scheme or not (e.g. increase or decrease speed, other activities on his route).

- **Pilot 2 "Forecast":** the second phase was to develop a forecast of lock cycle times so that if the number of ships that are waiting or arriving to the lock is known, the logical lock allocation can be calculated in advance. In this pilot it was also used historical data about average time required for ships entering/leaving the lock that allowed forecasting when the next lock cycle will start, and what will be the usage level of that cycle. This information was useful for skippers because they could see if it made sense to speed up or slow down and readjust their overall trip planning.
- **Pilot 3 "Integration":** In this phase the time – route diagrams of the individual ships were forecasted. The forecast was based on the voyage planning of ships with actual data and forecast of lock cycles from the first two phases. After each lock-cycle or change in the voyage planning could be adjusted based on the actual lock passage time and the available forecast for the next lock. This allowed the shipping company to continuously update its voyage planning, and eventually also the terminal planning.

Figure 32. Map of the fairway between the seaports of Rotterdam and Antwerp
Source: Good Practices in Inland Waterway Transport, Platina Project [34]

5.3.6. ECT Extended gate concept – European gateway services

In the same manner than the concept of the extended gate approach for rail transport, Europe Container Terminal (ECT) started to extend its network with inland gates in 2009. These inland gates had a growth capacity of more than 200,000 TEU and also had warehouses close to the terminals, that give the client the opportunity to deliver or pick up containers at one of the inland terminals in Amsterdam, Moerdijk, Venlo, Duisburg (Germany), Avelgem or Willebroek (Belgium). So that, ECT then transfers the container on to a vessel or a freight train and transports it to the Port of Rotterdam. In 2010 a cooperation between ECT and LCT (Liège Container Terminal) further expanded the network of inland gates. This project was named 'European Gateway Services' and a scheduled shipping service between both terminals was part of the agreement.

This concept can only be introduced when there is a high quality network of inland waterways where inland terminals can be build next to it. Additionally, it is also important that the operator of this inland terminal has an important flow of cargo. The concept of extended gate concept requires a close cooperation of the main sea terminal with the related hinterland terminals located at relatively short distances from the seaport as a means of bypassing congested roads in the port city, relieving the terminal from larger volumes of containers and providing a cheaper storage area for empty containers. Despite the additional time and money required to transfer the container two times (once to the inland terminal and once in the Port of Rotterdam) the concept is faster and more reliable than the road transport and also increases the capacity of ECT and gives it the possibility to be more flexible,

The network of inland terminals was focused on reliable connections by IWT between inland terminals and ECT saving cost, time and creating new opportunities for ECT to grow. Nevertheless, as part of its European Gateway Services, ECT also offered the flow of containers with a number of additional services, ranging from Premium Service and Paperless Service to Release Service.

5.3.7. Vessel Traffic Services (VTS) in the Netherlands – focus on VTS Nijmegen

Initial Situation:

As previously stated, the Netherlands, and more specifically the fairway between the seaports of Rotterdam and Antwerp is one of the busiest inland shipping routes in Europe. Unlike the Rhine River from Rotterdam to the Ruhr area, this north-south corridor between the two ports consists of several locks that sometimes cause delays and queues. This traffic congestion in the area led to the implementation of Vessel Traffic Services (VTS) in some parts of the fairways of the Netherlands.

Solution proposed:

Vessel Traffic Services are marine traffic monitoring systems working 24 hours a day, 7 days a week that typically use radars, closed-circuit television (CCTV), VHF radiotelephony and automatic identification system to keep track of vessel movements and provide navigational safety in a limited geographical area. The Vessel Traffic Services (VTS) are usually implemented for safety reasons because of high traffic intensity, such as the case of the Netherlands, and/or complex traffic situations leading to vulnerability in the area. Vessel Traffic Services (VTS) was a common practice in seaports and coastal areas. However, its use in European inland waterways was not very extended and only some stretches in the Netherlands had inland VTS in operation. The centres with VTS were mostly situated at crossing of rivers/canals with dense and complex traffic flows where there was a need for traffic organisation and "guidance" of the traffic to ensure traffic safety.

The Principal basic functional equipment of VTS in the Netherlands consisted of:

- **Tactical Traffic Image** consisting of an integrated image of the whole VTS coverage based on Radar with a tracking mechanism allowing the labelling of vessels with their identification information. The tracking mechanism is able to differentiate vessels in spite of the short passing differences, the shading effects and multiple radar reflections in narrow waters. AIS networks complete the tactical traffic imaging and improve the reliability of the tracking mechanism as well as allow automatic labelling of vessels.
- **CCTV systems:** At special places in the fairway closed circuit, television is used to monitor ship movements under special circumstances, which provides the possibility to monitor special traffic situations.
- **Communication system:** The VTS operators have a VHF communication system to interact with the traffic in order to inform ships on the evolving traffic situation and to monitor the communication between vessels. They have a complex set of VHF channels available for:
  - a. traffic information on dedicated channels
  - b. to interrupt on ship-ship communication channels and to interrupt on locking-channels (if available)
  - c to collect reporting information on vessels, cargo and voyage characteristics on dedicated VHF channels
- **Information management system IVS90** for identification of the vessels, their cargo and their intended voyage. The system is also used in case of calamities. The IVS90 is a national system used in traffic centres and locks.
- **Recording facilities** that record the traffic images and the voice communication in case of incidents and accidents to be used in legal procedures in court.

The use of VTS provides improvements in efficiency, safety and environmental protection as well as increases the capacity of the fairways reducing congestion issues. They are essential for traffic organisation and for the improvement of the efficiency of the transport chain. In the specific case of the VTS of the Netherlands, it was unique in Europe and since it was deployed, different tools have been developed and employed, such as the use of River Information Services (RIS) and tools like Electronic Reporting and Information Management Systems like IVS90 and VHF communication.

5.3.8. ELWIS – Electronic Waterway Information Service

Initial situation:

In order to plan and perform efficient voyages, skippers are in need of up-to-date information on nautical, traffic-related and logistical aspects. Waterway administrations collect and generate such data, but in many cases there is no single platform where this data can be accessed. On the contrary, different tools are in use for different purposes. In order to solve this issue, ELWIS (Electronic Waterway Information Service) was launched in 1999 as the German Waterways and Shipping Administration (WSV) aiming to:

- Develop a consolidated portal that enables skippers and other user to access easily to information for voyage planning.
- Increase efficiency, safety and environmental sustainability of inland navigation by providing updated information.
- Fulfil the requirements of Regulation 416/2007/EC concerning the technical specifications for vessel tracking and tracing systems (Notices to Skippers).

Solution Proposed:

ELWIS (Electronic Waterway Information Service) has been the Internet service of the German Waterways and Shipping Administration since 1999, providing data for all German waterways, but also Notices to Skippers (NtS) from selected additional countries. In this regards, an e-mail and short message service (SMS) was also implemented.

The use of ELWIS is free of charge and data is accessible to all fairway users and interested parties. In this sense, ELWIS offers data for nautical and operational purposes via internet, SMS and e-mail, supplementing traditional information methods (e.g. journal of nautical information). The online service consists of static and dynamic internet pages, e.g. for water levels, water level forecasts, ice situation reports, Notices to Skippers in 10 European languages, traffic management information, classification of inland waterways, and regulations and notes on shipping laws.

The ELWIS subscription is independent from access to Internet browsers. According to individually indicated interests, regular or event-controlled updates are sent automatically via e-mail or SMS. Customers may subscribe to relevant information updates on the above-described services.

In order to improve the exchange of internationally standardized Notices to Skippers, a dedicated web service was introduced. This standardized data exchange is currently applied between several European countries and its extension is planned as soon as the NtS web service will be implemented in other countries.

5.3.9. Bottleneck information on the Danube FIS Porta

Initial situation:

The Danube River is one of the longest rivers in Europe and the most international river in the world, crossing ten states, nine of which being responsible for waterway maintenance and management. As an environmentally friendly and safe transport mode, inland waterway transport (IWT) is an important enabler for economic growth and competitiveness in the Danube Region. Thus, a transnational harmonisation of smart traffic infrastructure information for the Danube as an entire transport corridor was an important prerequisite for public authorities in order to be capable of satisfying user needs of IWT sector. This is why it was crucial to provide the users updated information about the fairway status, as this is the basis on which they decide how much cargo can be loaded onto a vessel.

In the free-flowing sections of the Danube River, the sediment transport changes the riverbed dynamically. Those changes influence the available fairway depth in bottlenecks, which can lead to restrictions for navigation with regard to the available fairway parameters. In this respect, fairway depth at critical river sections is the most important information and the reason behind The Danube Fairway Information Services (FIS).

Solution Proposed:

The Danube FIS is a portal that contains a joint and coordinated representation of bottlenecks in the fairway of Danube River and other fairway-related information from most relevant countries. The solution proposed was to provide updated information to the users via a web portal for the users of the waterway in all relevant Danube languages. This portal was developed for the use of skippers, shippers, logistical users and other interested parties and contain information about fairway bottlenecks, water level information (incl. forecast), notices to skippers, ice messages, waterway objects (e.g. bridges, ports, locks), authorities and most important downloadable information from river administrations.

Through FIS, the users now have guidance about the available actual water depth in bottleneck areas and they do not need to calculate themselves for each route during their voyage planning. The website also provides a list about the most relevant bottlenecks from Austria to Romania, which details can be downloaded in PDF format. Additionally, the portal contains a general plan about the surveying information referenced to low navigation and regulation level (LNRL) or gauge zero of reference water levels.

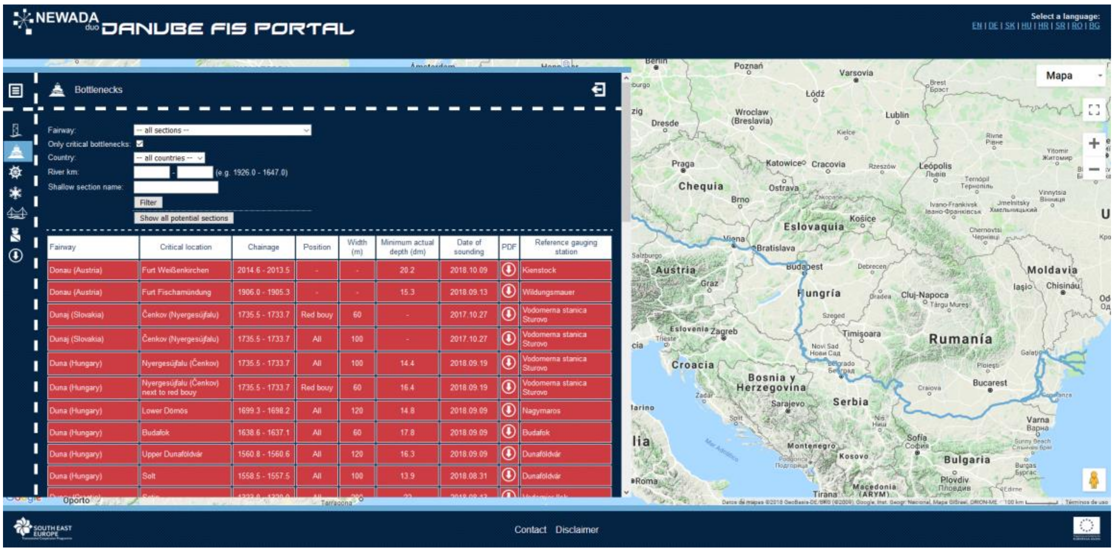

Figure 33. Screenshot of the NEWADA Portal - Danube Fairway Information System Portal
Source: NEWADA Danube Portal Website [39]

One the key successful factors of the solutions is that this visualization is a summary of the information on bottlenecks from seven riparian countries. This makes voyage planning more comfortable for waterway users. However, one lesson learned was that the visualization of bottlenecks and database structure needed to be harmonized and the display of bottleneck information (in table form and a PDF of the latest available hydrographic survey) needed additional harmonization to serve the needs of all administrations/countries.

5.4. Other best practices for hinterland connectivity

5.4.1. Navigate – Port of Rotterdam

Navigate is a state-of-the-art online route planner that will help users to find the best and most efficient way to transport container cargo via Rotterdam. It includes shortsea and deep-sea schedules, covering 550 ports around the world, as well as rail and barge connections to more than 150 inland terminals in Europe that enables to optimise the efficiency of freight flows.

Navigate works based on departure and arrival points, presenting the user various options and expected transit times, so that they can choose the one that suits better to their preferences. Navigate also contains a list of more than 1,600 companies in and around the port of Rotterdam that can provide a wide range of products and services. On top of this, a so-called 'empty depot tool' is also part of Navigate – indicating where empty containers can be repositioned.

The port of Rotterdam recommends to use Navigate as:

- The smartest way to find the best transport routes via Rotterdam
- Quickly find locations in Europe to reposition your empty containers
- Connect with companies in and around the port of Rotterdam

Navigate is a dynamic tool and the Port of Rotterdam will continue to further improve it. The next planned step will be to gain more insight into the carbon footprint of container transport in order to make it more environmentally friendly. Besides, Navigate will soon be expanded to include real-time data on the Estimated Times of Arrival and Departure (ETA and ETD) of sea-going vessels to keep adding more operational data, so that Navigate will become an increasingly valuable tool to improve transport efficiency.

5.4.2. Connectivity Platform – Port of Antwerp

The Port of Antwerp Connectivity Platform is a free online transport-planning tool that indicates the most appropriate intermodal transport options for your destination in the European hinterland and displays all deep sea and shortsea services with the Port of Antwerp. The Platform already displays information about 185 container terminals and more than 60 rail and barge operators in the European hinterland. More are about to follow.

The Port of Antwerp Connectivity Platform is developed to provide customers of the port with even more information about the various transport options and the most optimal way they can transport their goods to their destination, according to their needs. Convenient online search functions consistently chart the maritime and intermodal connections between Antwerp and overseas and European destinations.

This online tool allows the user to entry to all information on the port's maritime and intermodal solutions. It offers a free service, which includes an overview of all deep sea and short sea departures from and arrivals to the Port of Antwerp with an interactive map that gives an overview of all container terminals and their services in the port of Antwerp. Besides, an online route planner offers visibility on intermodal connections between the Port of Antwerp, 200 European inland terminals and 70 intermodal transport operators from 15

European countries. The module indicates the most adapted transport modes, schedules and operators to reach your destination in the European hinterland.

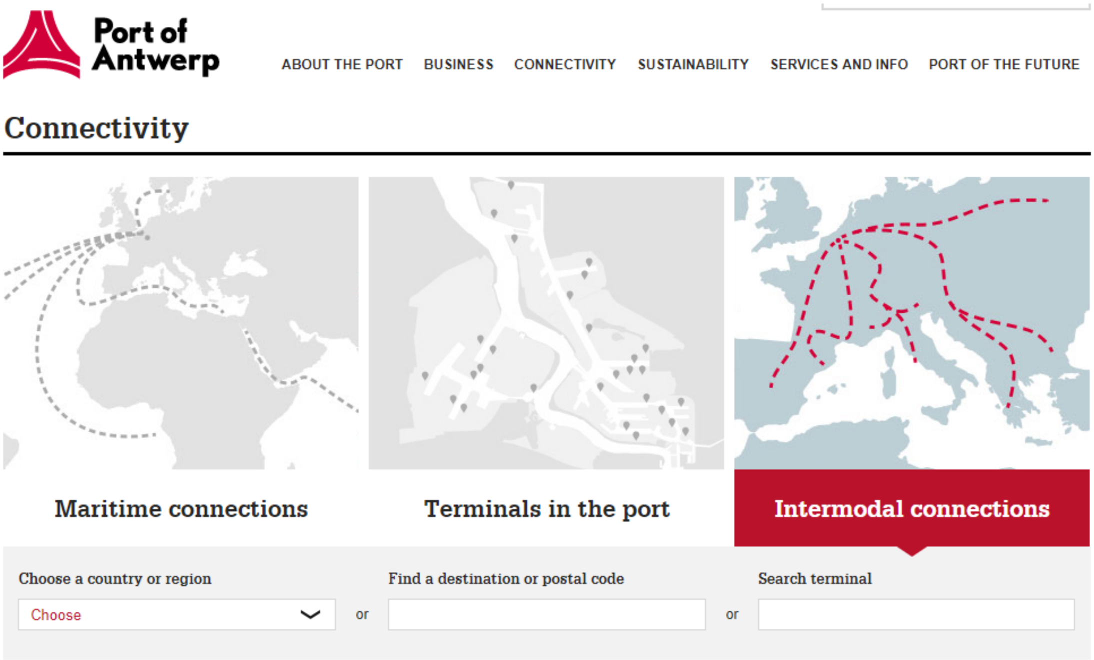

Figure 34. Screenshot of Port of Antwerp Connectivity platform website
Source: Port of Antwerp website [13]

6. Conclusions

The work carried out in the Task 2.1 including a review of the most important problems that ports are facing - and their related impacts in terms of hinterland connectivity - but also identifying some key emerging technologies and already implemented solutions clearly illustrate that the modernization of ports goes hand in hand with the adoption of state-of-the-art ICT tools. The implementation of innovative solutions, the digitalization of port processes, the adoption of collaborative schemes and new business models becomes essential to keep ports' competitiveness based on operational efficiency and sustainable growth.

Hinterland connectivity has been demonstrated as one of the most important drivers for port competitiveness and it is clear that there are important differences within the COREALIS ports, which can be explained due to the variety of ports assessed and the location and potential hinterland accessibility of each of them. However, despite representing a complete range of ports within the European framework there can be identified some key facts for each of them in terms of hinterland connections:

- **Port of Antwerp**: The Port of Antwerp is the second largest port in Europe, and due to its privilege location in central Europe is well connected, both by rail and by inland waterways, to a huge and powerful hinterland that covers in 500 kilometres countries such as France, Belgium, Netherlands, Germany and Switzerland. The port has invested heavily in intermodal transport and has implemented several initiatives for rail and IWT pursuing a more sustainable modal share, prove of which is its strategic plan to sift to rail and inland transport up to 60% of the gateway traffic by 2030. In reference to the use of cutting-edge technologies and new business models, the Port of Antwerp is enhancing its port community to share existing data amongst the port's players in order to unlock the potential of data sharing and find new opportunities for the increase of the operational efficiency, safety and revenues.

- **Port of Valencia**: The Port of Valencia has become in the lasts 20 years the most important port of the Mediterranean Sea, in terms of container traffic. Compared to other ports in the West Med, it has a privileged location in the Iberian Peninsula, being the closest port to Madrid. However, its potential hinterland to the rest of European countries is limited. Despite this fact, the port is currently under a huge expansion plan that will double its capacity and will realise important investments in terms of hinterland connections. In this sense, after implementing several innovations to optimize the road transport, the Port Authority is investing heavily in railway infrastructure. The main objective of these investments is to gain traffics from other Spanish regions as well as reduce the current share of the road transport that might cause potential congestion issues in the port area. Additionally to infrastructures investments, the PAV is seeking for synergies between the innovation cluster that it is being located nearby the port area and the port community in order to foster digitalization port processes and find new solutions and business models that can increase the efficiency of port operations.

- **Port of Piraeus**: In the same manner, the port of Piraeus has also invested heavily to become the major hub of the East Mediterranean. Its location, being one of the first major ports after the Suez Canal in the Far-East routes, as well as its infrastructure, makes it a hub port for international trade. The port is a transhipment point for the main commercial routes and the ports of the Black Sea as well as a link for the Greek islands and the mainland. However, it does not keep specific track of hinterland destinations, only keeps data about the origin of import and the destination of export cargoes. In this sense, it has been identified room for potential improvement in terms of hinterland knowledge. Finally, the Port of Piraeus is not only a busy port in terms of international trade; it is also one of the most important ports of the Mediterranean Sea for cruises. Thus, traffic nearby the port area is a common issue.

- **Port of Livorno:** The Port of Livorno, located in the north-west of Italy, is a core port of the TEN-T network and the most important port of the Harbour System Authority of the North Tyrrhenian Sea with 33.7 million tons, which means 82% of the global traffic of the System Authority. It is a multi-purpose port in which RORO and the container cargo are the most relevant traffics. The port is well connected by road and rail and it moves annually more than 1700 trains, representing 11% of the modal share. The port hinterland connection is supported by two inland railway terminals and the port is currently involved in the expansion of the railway network nearby the port area aiming at reaching 20% of rail modal share in 2025. Besides this, the port is also involved in several IT innovations projects among which the implementation of 5G network stands out.

- **Port of HaminaKotka**: The Port of HaminaKotka is the largest Finnish seaport and a gateway for the Finnish imports and export with regular connections to main trade lines. Besides, its location near the Russian border benefits Russian imports and exports, especially serving the Russians' regions of St Petersburg and Moscow. The port counts with an extended rail network of about 80 kilometres that has the same track gauge than Russia and is supported by several railway terminals from which regular rail services provide efficient cargo transport of goods in an efficient way. In terms of road traffic, the drive to Helsinki takes around an hour and is located at 250 kilometres from St. Petersburg, Currently, there are no congestion issues nearby the port area, however, the port is interested in implementing IT systems that could allow terminals to estimate truck arrival times in order to plan better their operations.

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Annex 1: Port Hinterland Connectivity Template of the COREALIS Ports

Port of Antwerp

Questionnaire on "Port-Hinterland Connectivity"

INTRODUCTION – PORT GENERAL INFORMATION	
Port Name	ANTWERP
Institution / Authority	Havenbedrijf Antwerpen NV van publiek recht
Country	Belgium
Port governance model	☑ Public ☐ Mixed Public/Private ☐ Private ☐ Other____________________________________
Owner of the port and its name	☑ Local (Municipality) ☐ Regional ☐ National Name: ____________________________________
Port general description	As the 2nd largest port in Europe, the Port of Antwerp is an important transit port in Europe: more than 300 scheduled calls to more than 800 destinations. The port handles an annual amount of 210 Mtonnes of international maritime freight. Antwerp is the biggest port area in the world: the area grew to exactly 12,068 hectares. In this area, the Port Authority gives land, warehouses, covering and quays in concession to companies to develop their commercial activities. The central position of Antwerp provides its customers a vital link among biggest maritime and to Europe's centres of production and consumption. Compared to neighbouring ports, Antwerp is the furthest inland (80 kms), allowing it to handle large volumes of freight. The Antwerp Port Authority seeks to achieve a better balance among the various modes of transport by switching to more sustainable options: rail and inland shipping, where further growth is anticipated. Antwerp is at the junction of three major railway lines in Europe. Moreover Antwerp's location in the heart of the Rhine-Meuse-Scheldt delta means it has a direct link to the pan-European inland shipping network.

SECTION I. PORT TRAFFIC INFORMATION DATA

1.1. HINTERLAND AND FORELAND TRAFFIC

1.1.1. HINTERLAND TRAFFIC

N/A

1.1.2. FORELAND TRAFFIC

Tons DISCHARGED	2016	2017	Dif. 16/17	%
Russia	9.481.529	11.731.735	2.250.206	23,73%
United States	11.236.812	11.704.708	467.896	4,16%
United Kingdom	8.627.168	7.700.781	-926.387	-10,74%
China	7.233.707	6.874.968	-358.739	-4,96%
India	3.924.659	4.796.742	872.083	22,22%
Finland	3.969.258	4.373.864	404.605	10,19%
Saudi Arabia	4.470.678	4.135.337	-335.341	-7,50%
Turkey	3.885.981	4.000.061	114.080	2,94%
Norway	3.904.989	3.819.137	-85.852	-2,20%
Spain	3.101.217	3.479.442	378.225	12,20%
Other countries	50.571.509	51.639.687	1.068.178	2,11%
TOTAL	**110.407.508**	**114.256.463**	**3.848.955**	**3,49%**

Tons LOADED	2016	2017	Dif. 16/17	%
United States	11.063.083	11.423.874	360.791	3,26%
Turkey	6.518.359	7.049.557	531.198	8,15%
China	6.893.244	6.331.788	-561.456	-8,15%
United Kingdom	6.308.633	6.057.439	-251.194	-3,98%
Nigeria	3.914.601	5.756.187	1.841.586	47,04%
Brazil	2.671.227	3.944.703	1.273.476	47,67%
Singapore	3.879.514	3.941.727	62.213	1,60%
Togo	4.627.765	3.459.298	-1.168.468	-25,25%
Spain	3.031.620	3.453.087	421.467	13,90%
Canada	2.131.849	2.664.182	532.333	24,97%
Other Countries	52.696.157	55.323.123	2.626.966	4,99%
TOTAL	**103.736.053**	**109.404.965**	**5.668.912**	**5,46%**

1.2. TRAFFIC EVOLUTION

1.2.1. FREIGHT TRAFFIC

in tons	2015	2016	2017
Discharged	102.456.562	103.736.053	109.404.965
Loaded	105.967.624	110.407.508	114.256.463
Total	**208.424.186**	**214.143.561**	**223.661.429**

%	2015	2016	2017
Discharged	49,2%	48,4%	48,9%
Loaded	50,8%	51,6%	51,1%
Total	**100,0%**	**100,0%**	**100,0%**

in tons	2015	2016	2017
General cargo	127.958.190	132.286.482	138.296.613
Containers	113.301.618	117.909.606	122.969.439
Ro/ro	4.658.281	4.573.037	5.052.990
Conventional	9.998.291	9.803.839	10.274.184
Bulk	80.465.996	81.857.079	85.364.816
Liquid bulk	66.679.751	69.215.125	73.174.099
Dry bulk	13.786.245	12.641.953	12.190.717
Total	**208.424.186**	**214.143.561**	**223.661.429**

1.2.2. CONTAINER TRAFFIC (TEU)

TEU	2015	2016	2017
Discharged	**4.646.869**	**4.815.545**	**4.969.248**
Full	3.608.658	3.795.774	3.976.258
Empty	1.038.211	1.019.771	992.990
Loaded	**5.006.969**	**5.221.796**	**5.481.652**
Full	4.485.482	4.673.956	4.925.580
Empty	521.486	547.841	556.072
Total	**9.653.838**	**10.037.341**	**10.450.899**

1.2.3. PASSENGER & RORO TRAFFIC

Number	2015	2016	2017
Passengers	2.892	3.529	3.188

Source: Maritime police

Number of cars	2015	2016	2017
Discharged	487.753	490.492	538.904
Loaded	819758	700179	699224
Total	**1.307.511**	**1.190.671**	**1.238.128**

1.2.4. HINTERLAND TRAFFIC

Modal split total without pipeline	2016	2017
Road	54,2%	52,2%
Rail	7,8%	8,7%
Barge	38,1%	38,8%

Modal split total with pipeline	2016	2017
Road	52,0%	50,6%
Rail	7,8%	8,7%
Barge	36,8%	37,6%
Pipeline	3,4%	3,2%

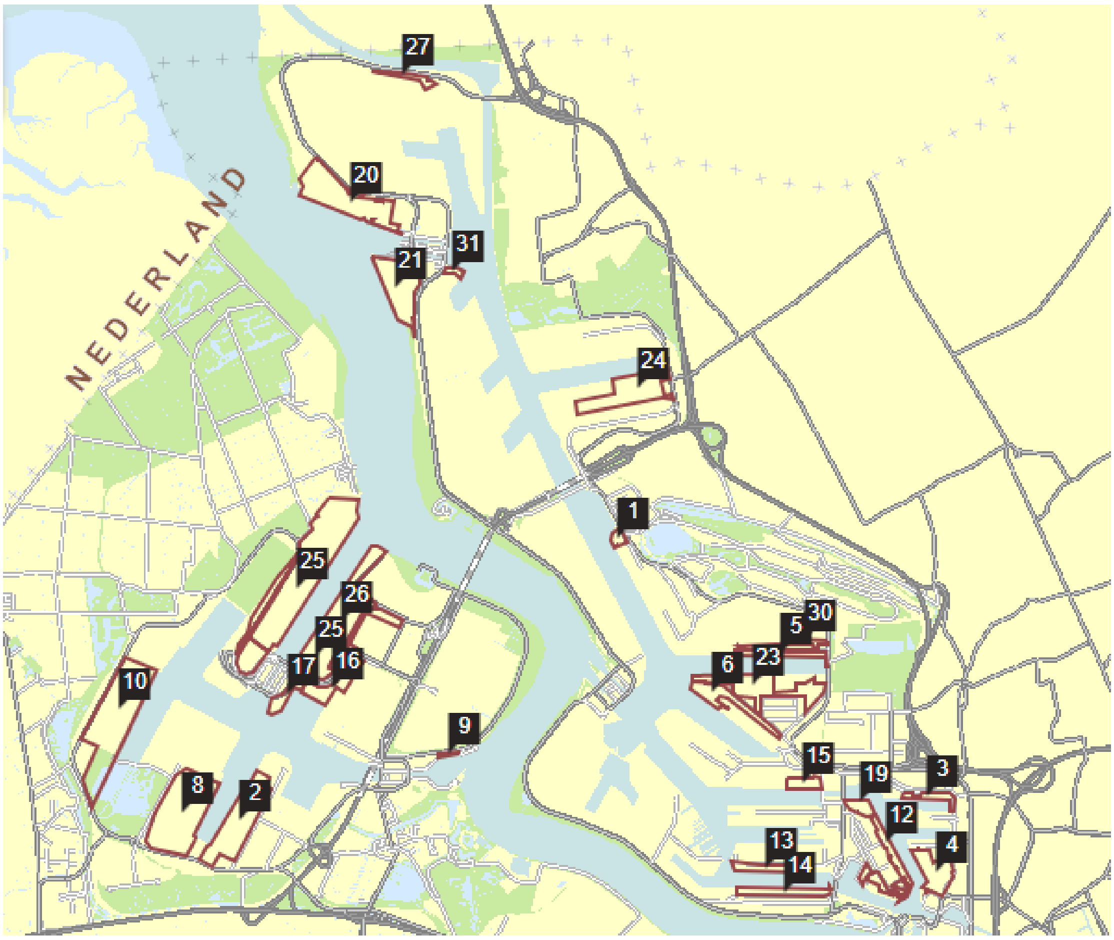
Modal split containers (based on TEU)	2016	2017
Road	56,3%	54,8%
Rail	5,9%	7,4%
Barge	37,71	37,82

SECTION II. PORT INFRASTRUCTURE AND SERVICES

2.1. PORT INFRASTRUCTURE

2.1.1. Port of Antwerp

The Port Authority itself does not own terminals; they are all privately owned companies. The number of terminals within the port is very extensive, information can be found here: https://www.portofantwerp.com/en/intraport-terminal-tool



Container Terminals in the Port of Antwerp:

- Antwerp Container Terminal
- Antwerp Euroterminal NV0
- AST
- ATO (Associated Terminal Operators)
- BNFW
- Combinant nv
- DP World Antwerp Gateway
- DP World Antwerp Global
- Container Services - GCS
- Euroports Antwerp Leftbank K1207
- Euroports Containers 524
- Euroports Terminals Antwerp K168
- Hupac Intermodal BVBA
- Katoen Natie Terminals NV

- Katoennatie Terminals
- Katoennatie Terminals K1510
- Mexiconatie nv
- MSC PSA European Terminal
- PSA Antwerp Churchill Terminal
- PSA Antwerp Europa Terminal
- PSA Antwerp K667
- PSA Antwerp Noordzee Terminal
- Shipit
- Terminal Zuid
- Wijngaard Natie Terminals
- Zuidnatie Breakbulk

2.2. MARITIME & RAIL SERVICES

All maritime & intermodal services can be consulted on the Connectivity Platform https://www.portofantwerp.com/en/connectivity

2.2.1. FREIGHT RAIL SERVICES (update from July 2018)

Destination Country	Destination City	Intermodal operator	Train frequency per week Direct	Train frequency per week Indirect
Germany	Duisburg	Duisport Agency	3	
		Optimodal Kombiverkehr	3	
	Neuss	MSC Medlog	5	
	Köln	Lineas Intermodal	5	
	Wanne Eickel	DB Cargo	5	
	Frankfurt	MSC Medlog	3	
	Marl	Optimodal Kombiverkehr		3
	Andernach	Haeger & Schmidt	2	
	Ludwigshafen	Hupac Intermodal	6	
		Lineas Intermodal	4	
		Optimodal Kombiverkehr		3
	Mannheim	DB Cargo	5	
		Lineas Intermodal	3	
	Germersheim	MSC Medlog	5	
	Wörth am Rhein	MSC Medlog	3	
	München	Optimodal Kombiverkehr		3
	Burghausen	DB Cargo		3
	Leipzig	Lineas Intermodal	3	
		Optimodal Kombiverkehr		3
	Schwarzheide	Hupac Intermodal	3	
		Optimodal Kombiverkehr		2
France	Lyon	Naviland Cargo		7
		CFL Intermodal		6
		Greenmodal		5
		Optimodal Kombiverkehr		3

	Bordeaux	Naviland Cargo		5
	Dijon	Naviland Cargo		5
	Dourges	Shuttlewise	5	
		Greenmodal	5	
	Marseille	Naviland Cargo	5	
	Strasbourg	Naviland Cargo	7	
		Greenmodal		6
	Hendaye	Lineas Intermodal	4	
	Le Boulou	CFL Intermodal		5
	Metz	Multi Modal Rail	2	
	Nancy	Vignéron		3
	Perpignan	Hupac Intermodal	3	
	Mouguerre	Transfennica	3	
Belgium	Athus	TCA Athus	11	
	Zeebrugge	Lineas	3	
	Liège	Lineas	3	
	LAR/Rekkem	Delcatrans	3	
	La Louvière	MSC Medlog	5	
Luxembourg	Bettembourg	CFL Intermodal	6	
Netherlands	Rotterdam	Shuttlewise	4	
Italy	Busto Arsizio	Hupac Intermodal	21	
	Bari	Lineas Intermodal		9
		Optimodal Kombiverkehr		1
	Domodossola	Lineas Intermodal	6	
	Milano	Lineas Intermodal	9	
	Nola	Lineas Intermodal		9
	Novara	Move Intermodal	6	
		Lineas Intermodal	6	
	Trieste	CFL Intermodal		6
	Verona	CEMAT	6	
		Hupac Intermodal	5	
Spain	Barcelona	Hupac Intermodal	6	
		Lineas Intermodal	3	
		Transfennica	5	
	Madrid	Lineas Intermodal		3
	Tarragona	Lineas Intermodal		3
	Granollers	Lineas Intermodal	3	
Austria	Linz	Rail Cargo Logistics	5	
	Vienna	Lineas Intermodal	4	
		Hupac Intermodal		3
	Wels	Lineas Intermodal	2	
		Optimodal Kombiverkehr		3
Switzerland	Basel	Hupac Intermodal	8	
		Lineas Intermodal	5	
	Frenkendorf	Swiss terminal	2	
	Niederglatt	Swiss terminal		2
	Birsfelden	Lineas Intermodal		5
Czech Republic	Lovosice/Usti	Lineas Intermodal	3	
		Optimodal Kombiverkehr		3
	Prague	Metrans		3
Poland	Warsawa	Hupac Intermodal	6	
	Kutno	PCC Intermodal		3

		Optimodal Kombiverkehr		2
	Poznan	Optimodal Kombiverkehr		2
	Gadki	Optimodal Kombivekehr		3
	Slawkow	Hupac Intermodal		3
Slovakia	Bratislava	Lineas Intermodal	3	
Hungary	Budapest	Hupac Intermodal		6
	Budapest	Rail Cargo Logistics		3
Sweden	Malmö	Lineas	3	

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2.2.2. SHORT-SEA-SHIPPING SERVICES

Antwerp offers weekly fixed shortsea and feeder services from and to 200 destinations in Europe and North Africa.

2.2.3. INLAND WATERWAY SERVICES

There are 215 container shuttles a week from and to 85 destinations in Europe. This sustainable and cost-efficient mode of transport is actively supported and developed by the port.

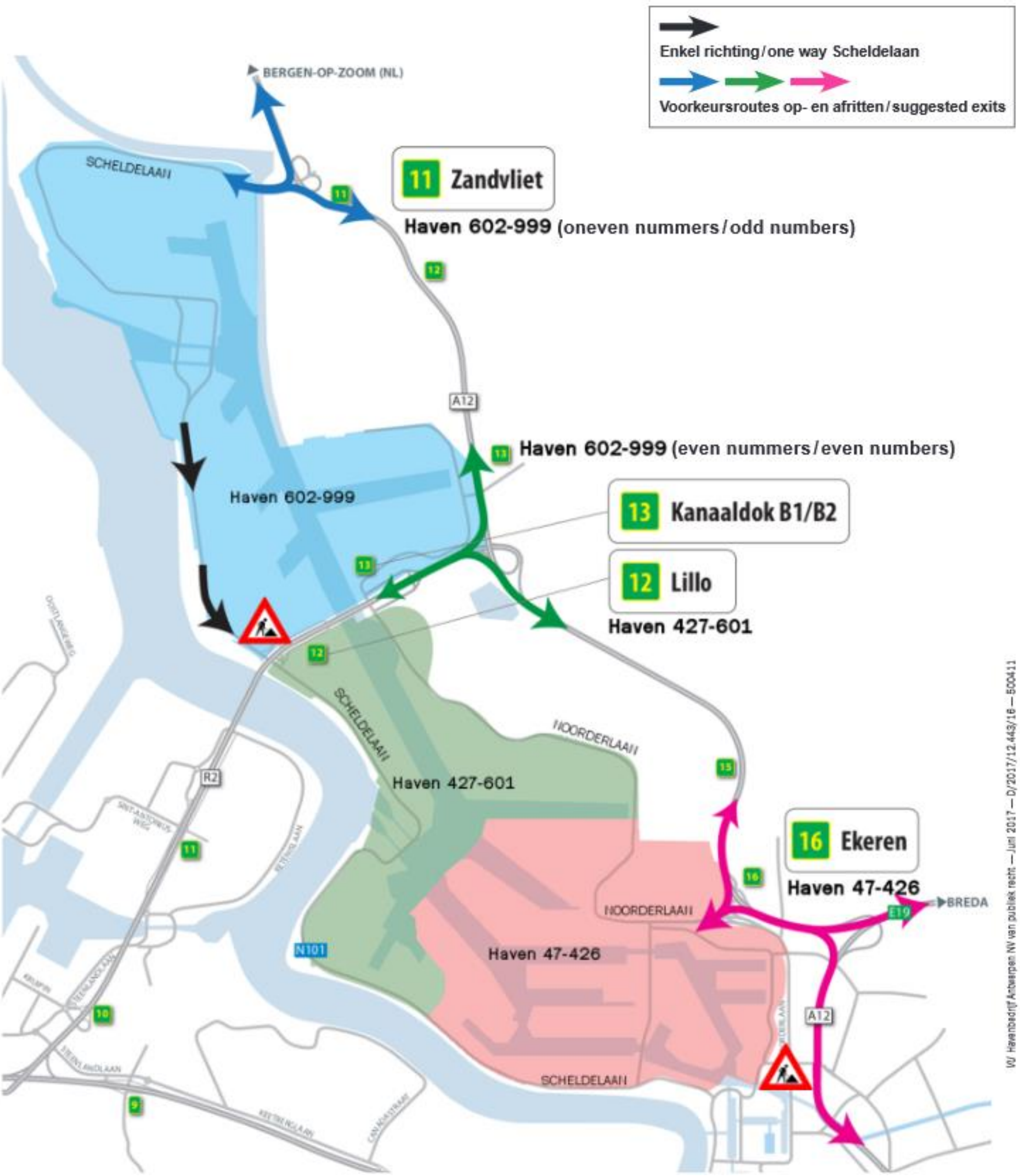
2.3. HINTERLAND INFRASTRUCTURE: LAND ACCESS AND LINKS TO THE PORT

2.3.1. PORT ACCESSES

The port is growing all the time and more work is required to ensure smooth traffic. To improve accessibility, PoA is focused on three key areas: infrastructure, sustainability and efficient transport.

Current traffic flows in the port can be consulted below:
https://www.portofantwerp.com/en/working-maximise-port-accessibility

2.3.2. ROAD ACCESSES



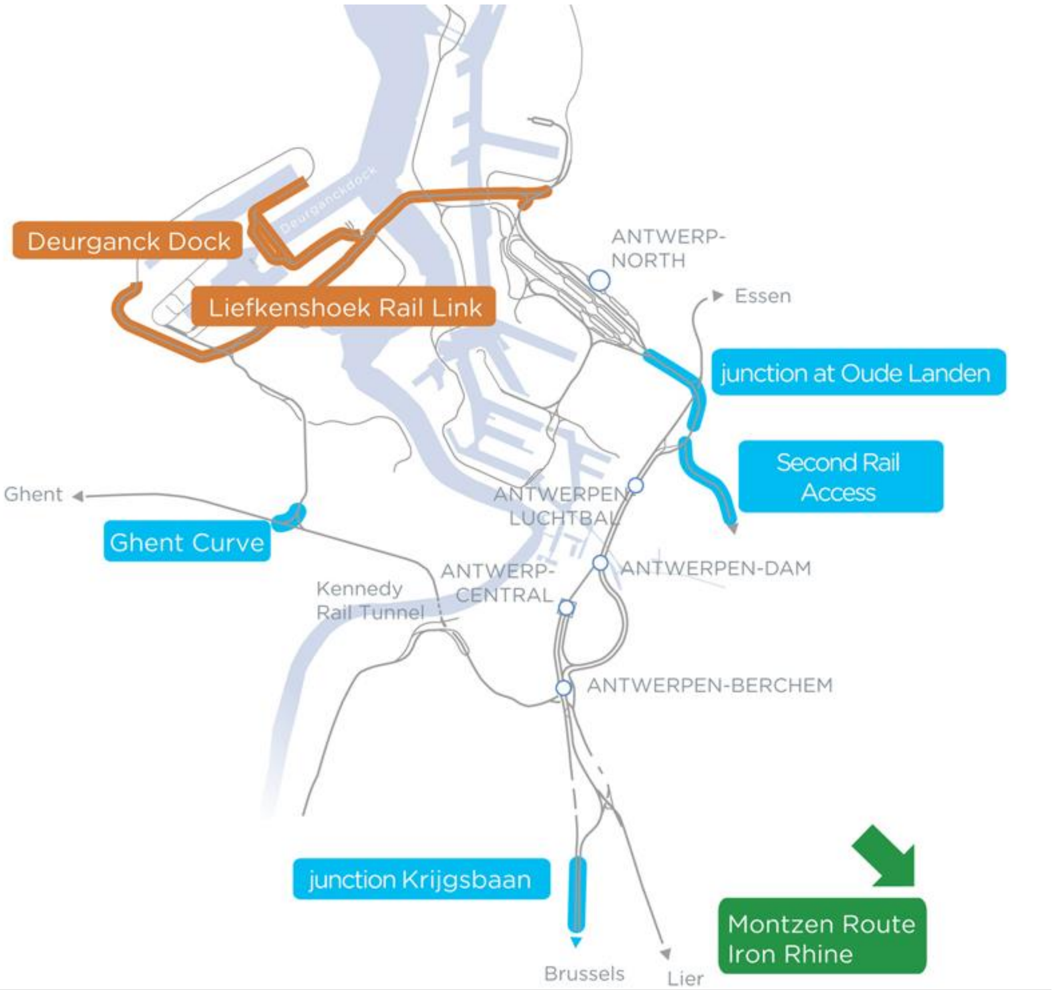
2.3.3. RAIL ACCESSES

The port is connected to the main rail network via two main rail access tracks:

- Line 27A (double track electrified) on the right bank to the south-east of Belgium, Germany, the Netherlands, Luxemburg and central and southern France
- Line 10 (double track, electrified) on the left bank to het northern side of Belgium (including the ports of Ghent and Zeebrugge) and northern France.

The connection between both sides of the port (the left and the right bank) is provided by the Liefkenshoek Rail tunnel, a 6km long double track rail tunnel dedicated to freight transport and suitable for the passage of dangerous (RID) goods.

The port is part of three European Rail Freight Corridors:
- (1) Rhine - Alpine corridor
- (2) North Sea – Mediterranean corridor
- (8) North Sea - Baltic



2.3.4. INLAND WATERWAY

The Port of Antwerp is connected to the European hinterland via:
- Scheldt
- Scheldt-Rhine canal
- Albert canal
- Brussels-Sea canal
- Canal Ghent Terneuzen

The figure below shows the above canals:


Rotterdam
Waal
Schelde-
Rijnverbinding
Kanaal
Gent-Terneuzen
Zeebrugge
Antwerp
Albertkanaal
Schelde
Gent
Brussel-Zeekanaal
Brussels
Liège

SECTION III. PORT IT SYSTEMS & COMMUNICATION AND INFORMATION EXCHANGE

3.1. IT PORT SYSTEMS

3.1.1. Road, Rail and Inland waterway Transport

IT Systems		Port Agents				
		Freight Forwarders	Shipping Agencies	Port terminals	Transport companies (*)	Other (Indicate)
Business portals, online shops or on-line access portals	y/n	y	y	y	y	Shippers 3PLs
Sectorial portals, e-marketplaces or service aggregators	y/n					
Intelligent Transport System (ITS)	y/n	y		y	y	
Port Community Systems (PCS)	y/n	y	y	y	y	Shippers 3PLs
Electronic CMR	y/n				y	
Blockchain applications	y/n	y		y	y	Shippers NPPO
Cargo Community System (CCS)	y/n	y	y	y	y	
Automated Gate Systems (AGS)	y/n			y	y	
Truck Plate identification	y/n					
Container ID identification	y/n			y		Port Authority
Driver identification software	y/n			y	y	
Truck Appointment System	y/n	y		y	y	
Traffic/Fleet Management System	y/n					
Electronic payment, funds transfer or credit system solutions	y/n					
Vessel Traffic Management			y	y		Port Authority Government agencies
Dangerous Goods Management		y	y	y	y	Port Authority

(*) Transport companies include road, rail and barge transport companies.

3.1.2. Port Community System (PCS)

If there is a PCS implemented in your port, please answer the following questions:

Ownership

☐ Public
☑ Mixed Public/Private
☐ Private
Company: Port Authority & NxtPort

Exploitation

☐ Public
☑ Mixed Public/Private

☐ Private
Company: Port Authority & NxtPort

Services provided

☑ Port Operations transport management (Port calls management, loading/dicharge orders, etc.)
☑ Maritime transport management (Departures, arrivals, bookings, etc.)
☐ Road transport management
☑ Rail transport management
☑ Inland Waterway transport management
☑ Customs (Goods declaration, customs information)
☐ Trak and Trace (Cargo tracking, equipment status, etc.)
☑ VGM management (Verified Gross Mass)
☑ Inland waterway transport management

PCS Community (Who can operate with the PCS)

☑ Shipping Agents
☑ Port Terminals
☑ Freight Forwarders
☑ Haulage Companies
☑ Shippers
☑ Official Bodies
☐ Depots

Main services provided by the PCS for <u>Road Transport</u>

☐ Generation of Transport Orders
☐ Management of Transport Orders
☐ Cargo Acceptance & Delivery Orders
☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots)
Other: *Marketplace with offer and demand, Truck appointment system.*

Main services provided by the PCS for <u>Rail Transport</u>

☐ Generation of Transport Orders
☐ Management of Transport Orders
☐ Cargo Acceptance & Delivery Orders
☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots)
☑ Generation of loading/unloading lists to Rail Terminals
Other: *Terminal slot allocation and train/wagon position, train composition information (communication between rail- and terminal operator)*

Main services provided by the PCS for <u>Inland Waterway Transport</u>

☑ *Management of barge voyage schedules (by barge operators)*
☑ *Management and execution of barge planning requests (by terminals)*
☑ *Exchange of discharge- and load-lists*
☑ *Central barge planning, jointly for all container terminals*
☑ *Customs reporting*

SECTION IV. IDENTIFICATION OF HINTERLAND BEST PRACTICES

Best Practice	***Connectivity Platform***
Description	The public website of Port of Antwerp shows all the hinterland connections for rail and barge for cargo going to and coming from the port of Antwerp. All website visitors can see possible connections to and from a hinterland terminal, or a city or postal code anywhere in Europe.
Barriers	Collecting the data and keeping them up to date
Objectives	Informing the (professional) public for moving cargo to the hinterland via rail and barge.
Main Beneficiaries	Transport companies, freight forwarders, shippers, 3PLs, …

Best Practice	***Extended gateways***
Description	Software (built by privately owned software companies, promoted via PCS) to extend your customs clearance from the port area to a location in the hinterland.
Barriers	
Objectives	More efficient throughput of cargo within the port area, faster handling of cargo at the port terminals.
Main Beneficiaries	Customs agents, terminal operators, transport operators

Best Practice	***Barge Traffic System***
Description	PCS-service that engages barge operators and terminal operators for more efficient planning of barge operations
Barriers	Human investments needed to engage with your Community stakeholders
Objectives	Safe barge traffic in the port area (around 200.000 barge movements, combined with around 15.000 sea vessels arriving each year). More efficient planning and operations for barges at the container terminals
Main Beneficiaries	terminal operators, barge operators, port authority

Best Practice	***Rail Traffic System***
Description	PCS-service that engages rail operators, rail companies and terminal operators for more efficient planning and offering visibility of rail operations
Barriers	Human investments needed to engage with your Community stakeholders
Objectives	Offering visibility to all the stakeholders, and to increase the modal split for rail. More efficient planning and operations for trains at the terminals
Main Beneficiaries	terminal operators, rail operators, rail infrastructure company, freight forwarders, port authority

Port of Haminakotka

Questionnaire on “ Port-Hinterland Connectivity”

INTRODUCTION – PORT GENERAL INFORMATION	
Port Name	HaminaKotka
Institution / Authority	Steveco Oy (Port Operator in Kotka Container Terminal)
Country	Finland
Port governance model	☐ Public ☐ Mixed Public/Private ☑ Private ☐ Other_______________________
Owner of the port and its name	☐ Local (Municipality) ☐ Regional ☑ National Name: Stora Enso Oyj, UPM KYmmene Oyj, Finnlines Oy, Ahlstrom Oy and Myllykoski Oy
Port general description	The Kotka Container Terminal (KCT) is the leading container terminal in Finland and the main transit port to Russia. Also leading export terminal for Finnish export goods. The container stuffing capacity is abt. 160 000 teu/year (pulp, paper and sawn timber) at the moment, but it will be expanded at the end of 2018.

SECTION I. PORT TRAFFIC INFORMATION DATA

1.1. HINTERLAND AND FORELAND TRAFFIC

1.1.1. HINTERLAND TRAFFIC

Finnish industrial customers (paper, pulp and sawn timber etc) located within about 350-500 km from the city of Kotka.
Transit customers are mainly located in St. Petersburg and Moscow in Russia.

1.1.2. FORELAND TRAFFIC

Regular liner traffic:

- Rotterdam 5 x week
- Bremerhaven 3 x week
- Bremerhaven – Hamburg 2 x week
- Le Havre – Antwerp-Bremerhaven 1 x week
- Antwerp 1 x week
- Antwerp – Felixstowe 1 x week
- Hamburg 1 x week
- Wilhelmshaven-Felixstowe 1 x week
- Gdansk 1 x week

Source: HaminaKotka Port Authorities

1.2. TRAFFIC EVOLUTION

1.2.1. FREIGHT TRAFFIC

Type of traffic:

Traffic Structure	2015	2016	2017
Import/Export (teu)	**81,78 %**	**86,46 %**	**88,38 %**
Export	50,49 %	49,52 %	50,15 %
Import	31,29 %	36,94 %	38,23 %
Transhipment (teu)	**18,22 %**	**13,54 %**	**11,62 %**

	2015	2016	2017
General Cargo (tons)	3 604 793	4 837 378	6 158 010
Total (tons)	**3 604 793**	**4 837 378**	**6 158 010**

Source: Steveco Oy

1.2.2. CONTAINER TRAFFIC (TEU)

	2015		2016		2017	
Export	50,49 %	171 920	49,52 %	234 679	50,15 %	306 700
Full	96,10 %	165 222	96,35 %	226 105	96,63 %	296 365
Empty	3,90 %	6 698	3,65 %	8 573	3,37 %	10 336
Import	31,29 %	106 537	36,94 %	175 079	38,23 %	233 768
Full	12,05 %	12 839	8,13 %	14 229	7,46 %	17 447
Empty	87,95 %	93 697	91,87 %	160 850	92,54 %	216 320
Transhipment	18,22 %	62 037	13,54 %	64 166	11,62 %	71 051
Total TEUs	100,00 %	340 493	100,00 %	473 924	100,00 %	611 519

Source: Steveco Oy

1.2.3. PASSENGER & RORO TRAFFIC

No passanger- or RoRo traffic, only containers.

1.2.4. HINTERLAND TRAFFIC

Transport Mode	Export	Import	Total	Modal share
Railway	1 497 124		1 497 124	**24,31 %**
Road	3 275 374	1 385 512	4 660 886	**75,69 %**
Total	4 772 498	1 385 512	6 158 010	**100,00 %**

Railway Traffic	Export	Import	Total
Total trains	2 475		2 475
Total wagons	39 398		39 398
Total Cargo (t)	**1 497 124**		**1 497 124**
Total TEU			

Railway Traffic	2015	2016	2017
Goods entering or leaving the port by road			
Total (tonnes)	**2 421 359**	**3 438 370**	**4 660 886**
TEUs	**243 811**	**336 635**	**451 362**

SECTION II. PORT INFRASTRUCTURE AND SERVICES

2.1. PORT INFRASTRUCTURE

2.1.1. Port HaminaKotka

Terminal	Use	Public/Private	Automated terminal	Automated gates	Rail infrastructure
Kotka Container Terminal	Containers	☐ Public ☑ Private	☐ Yes ☑ No	☑ Yes ☐ No	☑ Yes ☐ No

2.2. MARITIME & RAIL SERVICES

2.2.1. FREIGHT RAIL SERVICES

NATIONAL/ INTERNATIONAL	DESTINATION	RAILWAY COMPANY	TRAFFIC	Nº TRAINS PER WEEK
National	Finland; every location	VR, Fennia Rail	General cargo (for stuffing of containers)	50
International	Russia	VR	Containers	

2.2.2. SHORT-SEA-SHIPPING SERVICES

- vessel loading operations (export/import)
- depot, empty container operations
- warehousing
- forwarding
- inland transports (truck/rail)
- ships clearance

2.2.3. INLAND WATERWAY SERVICES

- vessel loading operations (export/import)
- depot, empty container operations
- warehousing
- forwarding
- inland transports (truck/rail)
- ships clearance

2.3. HINTERLAND INFRASTRUCTURE: LAND ACCESS AND LINKS TO THE PORT

2.3.1. PORT ACCESSES

Port accesses are displayed in the below figure:

Source: HaminaKotka Port Authorities

SECTION III. PORT IT SYSTEMS & COMMUNICATION AND INFORMATION EXCHANGE

3.1. IT PORT SYSTEMS

3.1.1. Road, Rail and Inland waterway Transport

Please, complete the following table with the IT systems for the management of the road, rail and inland waterway transport implemented in your port. Indicate also the agents that can interact with each IT systems. If there are other IT systems that are not included in the table, please add them at the bottom.

IT Systems		**Port Agents**				
		Freight Forwarders	**Shipping Agencies**	**Port terminals**	**Transport companies (*)**	**Other (Indicate)**
Business portals, online shops or on-line access portals	**y/n**	y		y	y	
Sectorial portals, e-marketplaces or service aggregators	**y/n**					
Intelligent Transport System (ITS)	**y/n**					
Port Community Systems (PCS)	**y/n**					
Electronic CMR	**y/n**	y		y	y	
Blockchain applications	**y/n**					
Cargo Community System (CCS)	**y/n**					
Automated Gate Systems (AGS)	**y/n**	y		y	y	
Truck Plate identification	**y/n**			y	y	
Container ID identification	**y/n**			y	y	
Driver identification software	**y/n**					
Truck Appointment System	**y/n**					
Traffic/Fleet Management System	**y/n**			y		Working machines
Electronic payment, funds transfer or credit system solutions	**y/n**	y	y			y
Steveco Flow (Real-time terminal operating system)						
Steveco VTS (visual port operations planning)						
Navis, VISY (Container and gate operations)						

(*) Transport companies include road, rail and barge transport companies.

3.1.2. Port Community System (PCS)

Steveco does not have a PCS.

Port of Livorno

Questionnaire on “ Port-Hinterland Connectivity”

INTRODUCTION – PORT GENERAL INFORMATION	
Port Name	Livorno Port
Institution / Authority	The North Tyrrhenian Sea Port Authority
Country	Italy
Port governance model	☑ Public ☐ Mixed Public/Private ☐ Private ☐ Other____
Owner of the port and its name	☐ Local (Municipality) ☐ Regional ☐ National Name: ____
Port general description	The North Tyrrhenian Sea Port Authority encompasses these ports: • Livorno • Piombino • Capraia • Portoferraio • Rio Marina The last two belong to the Island of Elba. The port of Livorno looks out onto the North Tyrrhenian Sea and is located at 43°32’.6 North latitude and e 010°17’.8 longitude East in the North-west of Tuscany. It is mainly set back from the coastline where it is well protected from southern and western winds. The port of Livorno is classified as a Core port (first level port) along the Scandinavian-Mediterranean TEN-T corridor, and is a multipurpose port, namely it has infrastructures and equipment that can berth any vessel and handle any type of goods traffic (LO-LO, RO-RO, dry and liquid bulk, new cars, cruises, ferries, forestal products, machinery, etc.). These infrastructures connect the port to the main national rail and road networks and the airports of Pisa and Florence as well. It relies on a large hinterland comprising Tuscany, Emilia Romagna, Umbria and the Marche Regions, which have many businesses and industries, what implies the Port of Livorno handles a large amount of manufactured goods.

SECTION I. PORT TRAFFIC INFORMATION DATA

1.1. HINTERLAND AND FORELAND TRAFFIC

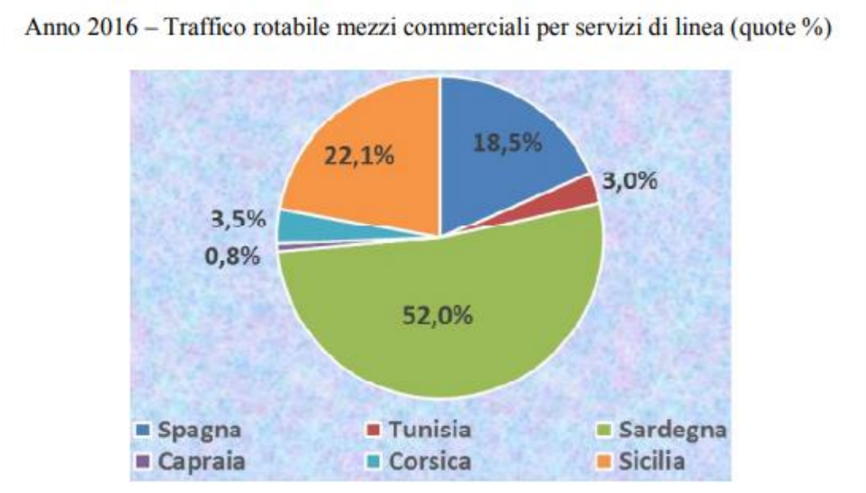
1.1.1. HINTERLAND TRAFFIC

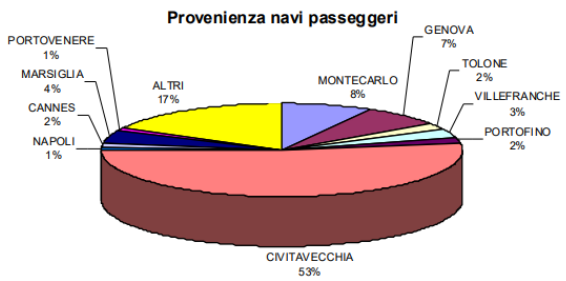
Distribution of inland export and import flows (source: prf. Vittorio Torbianelli analysis, 2017)

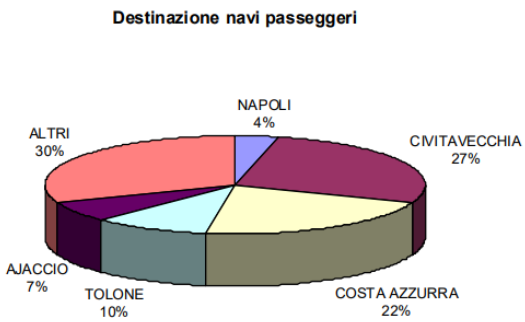
Lombardia	29%	Liguria	8%
Veneto	13%	Toscana	7%
Emilia Romagna	12%	Friuli-Venezia Giulia	5%
Piemonte	9%	Trentino Alto Adige	2%
		Other regions	15%

1.1.2. FORELAND TRAFFIC

Last data is from 2016 and it is described in the below figure:







1.2. TRAFFIC EVOLUTION

1.2.1. FREIGHT TRAFFIC

Port of Livorno	2016	2017	∆ 2016 /2017
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%**

1.2.2. CONTAINER TRAFFIC (TEU)

Containers (TEU)	**800.475**	**734.085**	**-8,3%**

Of which 21.2 % are empties.

1.2.3. PASSENGER & RORO TRAFFIC

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%**

1.2.4. HINTERLAND TRAFFIC

Data is referred to 2013.

	Observed data (TEUs)
Road	492 078
Rail	67 102
Rail modal share	*12.0%*
Total traffic in the Livorno Port	559 180

SECTION II. PORT INFRASTRUCTURE AND SERVICES

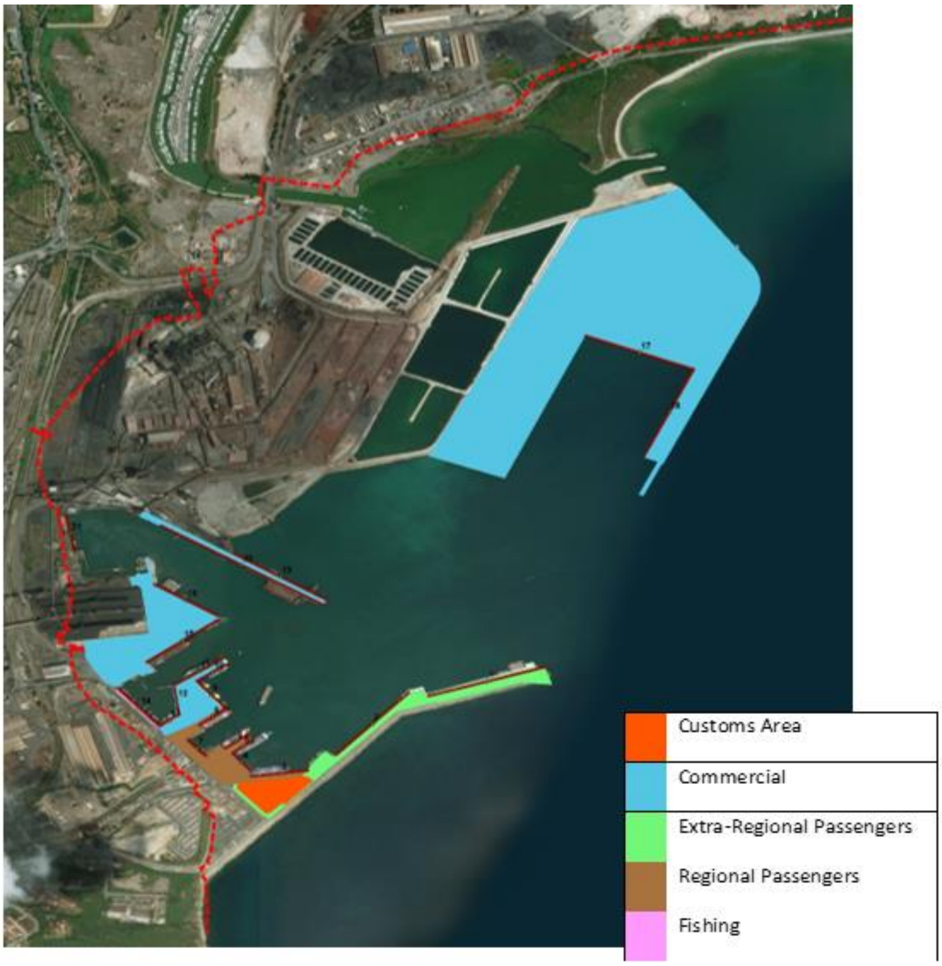
2.1. PORT INFRASTRUCTURE

2.1.1. Port of Livorno

Terminal	Use	Public/Private	Automated terminal	Automated gates	Rail infrastructure
Terminal Darsena Toscana	Containers	☐ Public ☑ Private	☐ Yes ☑ No	☑ Yes ☐ No	☐ Yes ☑ No
Lorenzini	Containers, General Cargo	☐ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☑ Yes ☐ No
F.lli Bartoli	Forestal Products	☐ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☐ Yes ☑ No
Compagnia Impresa Lavoratori Portuali	New Cars, General Cargo, Project Cargo	☐ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☐ Yes ☑ No
Livorno Terminal	Containers,	☐ Public	☐ Yes	☐ Yes	☐ Yes

Marittimo	Ro-Ro	☑ Private	☑ No	☑ No	☑ No
Terminal Calata Orlando	General Cargo	☐ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☐ Yes ☑ No
Neri (ex Scotto)	Forestal product, project cargo	☐ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☑ Yes ☐ No
Porto Livorno 2000	Passengers, Ro-Ro	☐ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☐ Yes ☑ No

2.1.2. Port of Piombino



Light blue area is being built.

Terminal	Use	Public/Private	Automated terminal	Automated gates	Rail infrastructure
Passenger terminal	Ro-ro and passengers	☑ Public ☐ Private	☐ Yes ☑ No	☐ Yes ☑ No	☐ Yes ☐ No

2.2. MARITIME & RAIL SERVICES

2.2.1. FREIGHT RAIL SERVICES

NATIONAL/ INTERNATIONAL	DESTINATION	RAILWAY COMPANY	TRAFFIC	Nº TRAINS PER WEEK
NATIONAL	VERONA QUADRANTE EUROPA	MERCITALIA	EXPORT	Twice
NATIONAL	LIVORNO TDT (CONTAINER)	MERCITALIA	IMPORT	Three times
NATIONAL	VERONA QUADRANTE EUROPA	MERCITALIA	EXPORT	Once
NATIONAL	LIVORNO GUASTICCE (FREIGHT VILLAGE)	MERCITALIA	IMPORT	Three times
NATIONAL	PADOVA FREIGHT VILLAGE	MERCITALIA	EXPORT	Five times
NATIONAL	LIVORNO TDT (CONTAINER)	MERCITALIA	IMPORT	Four times
NATIONAL	BOLOGNA FREIGHT VILLAGE	LOGTRAINER	EXPORT	Twice
NATIONAL	PADOVA FREIGHT VILLAGE	LOGTRAINER	EXPORT	Twice
NATIONAL	RUBIERA TERMINAL	LOGTRAINER	EXPORT	Nine times
NATIONAL	LIVORNO CALAMBRONE	LOGTRAINER	IMPORT	Eight times
NATIONAL	LIVORNO CALAMBRONE	LOGTRAINER	IMPORT	Twice
NATIONAL	LIVORNO CALAMBRONE	LOGTRAINER	IMPORT	Twice
NATIONAL	LIVORNO SINTERMAR	CAPTRAIN	IMPORT	Three times
NATIONAL	LIVORNO LORENZINI TERMINAL	SPINELLI	IMPORT	Three times

2.2.2. SHORT-SEA-SHIPPING SERVICES

- Genova – Livorno – Palermo
- Livorno – Bastia
- Livorno – Catania
- Livorno - Olbia
- Livorno – Barcellona – Tangeri
- Livorno – Savona – Valencia

- Livorno – Savona – Barcelona – Valencia
- Genova – Livorno – Catania – Malta

Source: http://ramspa.it/

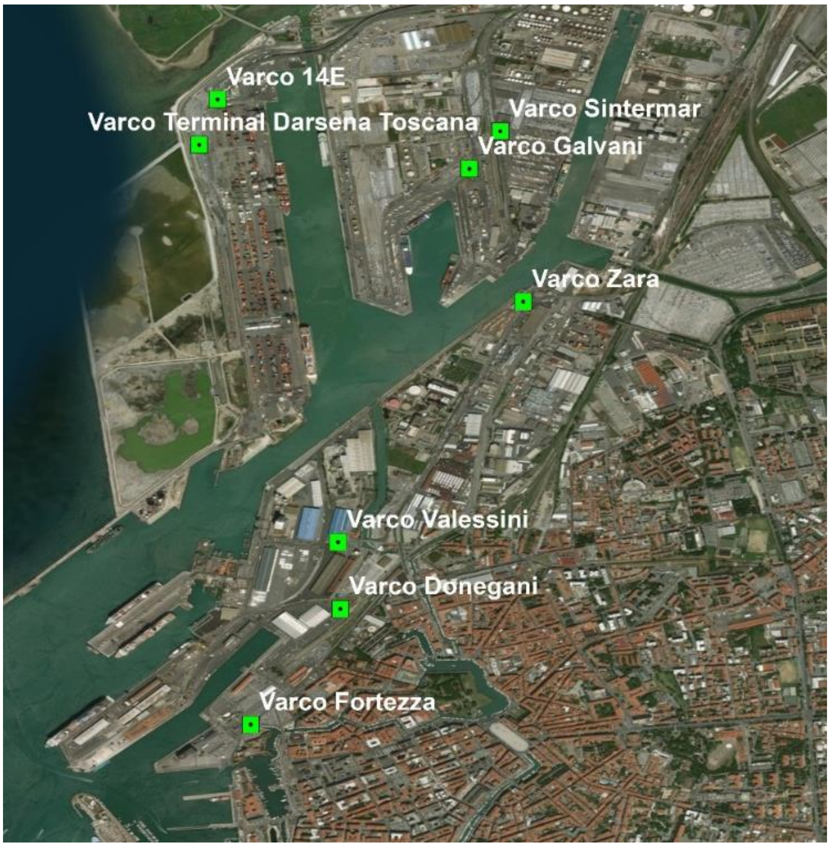
2.2.3. INLAND WATERWAY SERVICES

No inland services.

2.3. HINTERLAND INFRASTRUCTURE: LAND ACCESS AND LINKS TO THE PORT

2.3.1. PORT ACCESSES

Port of Livorno



Port of Piombino

2.3.2. ROAD ACCESSES

Port of Livorno

Port of Piombino

2.3.3. RAIL ACCESSES

Port of Livorno

Port of Piombino

2.3.4. INLAND WATERWAY

No inland waterway

SECTION III. PORT IT SYSTEMS & COMMUNICATION AND INFORMATION EXCHANGE

3.1. IT PORT SYSTEMS

3.1.1. Road, Rail and Inland waterway Transport

IT Systems		Port Agents				
		Freight Forwarders	Shipping Agencies	Port terminals	Transport companies (*)	Other (Indicate)
Business portals, online shops or on-line access portals	y/n					
Sectorial portals, e-marketplaces or service aggregators	y/n					
Intelligent Transport System (ITS)	y/n					
Port Community Systems (PCS)	y/n	y	y		y	
Electronic CMR	y/n					
Blockchain applications	y/n					
Cargo Community System (CCS)	y/n					
Automated Gate Systems (AGS)	y/n					
Truck Plate identification	y/n					
Container ID identification	y/n					
Driver identification software	y/n					
Truck Appointment System	y/n					
Traffic/Fleet Management System	y/n					
Electronic payment, funds transfer or credit system solutions	y/n					

(*) Transport companies include road, rail and barge transport companies.

3.1.2. Port Community System (PCS)

If there is a PCS implemented in your port, please answer the following questions:

Ownership

☑ Public
☐ Mixed Public/Private
☐ Private
Company: ______________________________

Exploitation

☑ Public
☐ Mixed Public/Private
☐ Private
Company: ______________________________

Services provided

☑ Port Operations transport management (Port calls management, loading/dicharge orders, etc.)
☑ Maritime transport management (Departures, arrivals, bookings, etc.)
☐ Road transport management
☐ Rail transport management
☐ Inland Waterway transport management
☑ Customs (Goods declaration, customs information)
☑ Track and Trace (Cargo tracking, equipment status, etc.)

☑ VGM management (Verified Gross Mass) ☐ Inland waterway transport management Other: containers release, vehicle booking system, terminal conditions (congestions, weather), automatic reports, phytosanitary management (clearance requests).
PCS Community (Who can operate with the PCS) ☑ Shipping Agents ☑ Port Terminals ☑ Freight Forwarders ☑ Haulage Companies ☑ Shippers ☑ Official Bodies ☐ Depots Other: ____
Main services provided by the PCS for <u>Road Transport</u> ☐ Generation of Transport Orders ☐ Management of Transport Orders ☐ Cargo Acceptance & Delivery Orders ☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots) Other: ____

SECTION IV. IDENTIFICATION OF HINTERLAND BEST PRACTICES

Best Practice	***Vehicle Booking System – PCS module***
Description	The Vehicle Booking system (VBS) implementation is ongoing. This module is being part of the the TPCS (Tuscan Port Community System) and it is managing the vehicle booking information. The module is designing to overcome the infrastructural problems of the Port of Livorno (in particular considering the Galvani port gate, used for access to different port terminals as LIVORNO TERMINAL MARITTIMO and LORENZINI terminal). The VBS forecasts the identification of time slots for both the release and the delivery of containers. Each slot has a specific capacity, considering the time frame, the condition (weather and physical conditions) of the terminal and the "peak time". Haulers can select the free time slots.This mechanism enables to better plan the terminal operations. The OCR camera placed at the Port Gate enables to identify the actual arrival of the truck (date and time).
Barriers	Identification of time slots in order to really smooth the operations.
Objectives	- Better and more effective terminal operations - Reduction of queues at port gates (in particular during the peak time) - Better and more effective management of trucks voyages (avoiding congestions and waiting time at port gate) - Better "sea-road" process integration
Main Beneficiaries	Transport companies, terminals

Port of Pireaus

Questionnaire on "Port-Hinterland Connectivity"

INTRODUCTION – PORT GENERAL INFORMATION	
Port Name	Piraeus Container Terminal
Institution / Authority	PCT SA
Country	Greece
Port governance model	☐ Public ☐ Mixed Public/Private ☑ Private ☐ Other______________________
Owner of the port and its name	☐ Local (Municipality) ☐ Regional ☐ National Name: COSCO Shipping Ports Limited
Port general description	Container port located on the south part of the ORIENT/EAST-MED TEN-T corridor currently ranked at position 6 among European Container Ports. It is mainly a transhipment port with road and rail hinterland connectivity.

SECTION I. PORT TRAFFIC INFORMATION DATA

1.1. HINTERLAND AND FORELAND TRAFFIC

1.1.1. HINTERLAND TRAFFIC

Serving mainly the Balkans and Central Europe

1.1.2. FORELAND TRAFFIC

Ranking	Import Origins	Containers	TEUs
1	CN - China	48470	83620
2	NL - Netherlands	5792	9643
3	TR - Turkey	5336	9473
4	ES - Spain	4948	7870
5	EC - Ecuador	3281	6554
6	DE - Germany	4298	6287
7	GB - United Kingdom	3432	5271
8	US - United States	2951	5261
9	IT - Italy	2564	4196
10	FI - Finland	2093	3659
11	IN - India	2241	3086
12	EG - Egypt	1895	3048
13	CY - Cyprus	1595	2745
14	SE - Sweden	1572	2691
15	FR - France	2010	2668
16	ID - Indonesia	1688	2496
17	KR - Republic of Korea	1896	2481
18	PT - Portugal	1198	2159
19	TH - Thailand	1322	2116
20	VN - Viet Nam	1331	2039

Ranking	Export Destination	Containers	TEUs
1	CY - Cyprus	9367	16857
2	US - United States	7458	13643
3	CN - China	5864	10537
4	IL - Israel	4174	7253
5	GB - United Kingdom	4075	6551
6	ID - Indonesia	3142	6176
7	ES - Spain	2307	4247
8	TR - Turkey	2362	4210
9	AE - United Arab Emirates	2259	3251
10	IN - India	1889	2807
11	SA - Saudi Arabia	1536	2634
12	CA - Canada	1238	2152
13	AU - Australia	1603	2122
14	DZ - Algeria	1063	1994
15	VN - Viet Nam	1000	1884
16	BE - Belgium	922	1559
17	KR - Republic of Korea	740	1349
18	MY - Malaysia	671	1272
19	EG - Egypt	757	1266
20	TH - Thailand	612	1170

1.2. TRAFFIC EVOLUTION

1.2.1. FREIGHT TRAFFIC

N/A

1.2.2. CONTAINER TRAFFIC (TEU)

CONTAINER TRAFFIC (in TEUs)							
	2010	**2011**	**Yearly Difference%**	**2012**	**Yearly Difference%**	**2013**	**Yearly Difference%**
Imports / Exports	229.457	52.797	-76,99%	42.555	-19,40%	48.884	14,87%
Transshipments	172.959	378.196	118,66%	483.972	27,97%	520.722	7,59%
Empty Containers	110.903	59.911	-45,98%	99.387	65,89%	74.449	-25,09%
TOTAL	**513.319**	**490.904**	**-4,37%**	**625.914**	**27,50%**	**644.055**	**2,90%**

2014: 2.985.711
2015: 3.032.531
2016: 3.467.774
2017: 3.688.251

1.2.3. PASSENGER & RORO TRAFFIC

CAR TERMINAL TRAFFIC (number of cars)							
	2010	2011	Yearly Difference%	2012	Yearly Difference%	2013	Yearly Difference%
Imports and Exports	133.545	88.663	-33,61%	54.785	-38,21%	61.817	12,84%
Transshipments	246.801	328.996	33,30%	403.970	22,79%	386.865	-4,23%
TOTAL	**380.346**	**417.659**	**9,81%**	**458.755**	**9,84%**	**448.682**	**-2,20%**

(Number Of Passengers)							
	2010	2011	Yearly Difference%	2012	Yearly Difference%	2013	Yearly Difference%
DOMESTIC	**10.100.697**	**9.351.135**	**-7,42%**	**7.729.778**	**-17,34%**	**7.642.760**	**-1,13%**
CABOTAGE	7.233.328	6.883.249	-4,84%	5.778.688	-16,05%	5.741.167	-0,65%
SARONIC GULF	2.867.369	2.467.886	-13,93%	1.951.090	-20,94%	1.901.593	-2,54%
OVERSEAS	**1.864.657**	**2.517.371**	**35,00%**	**2.066.925**	**-17,89%**	**2.296.457**	**11,10%**
CRUISE	426.147	454.284	6,60%	329.168	-27,54%	308.705	-6,22%
TRANSIT	1.438.510	2.063.087	43,42%	1.737.757	-15,77%	1.987.752	14,39%
TOTAL	**11.965.354**	**11.868.506**	**-0,81%**	**9.796.703**	**-17,46%**	**9.939.217**	**1,45%**
SALAMIS TRAFFIC	**8.371.064**	**8.304.999**	**-0,79%**	**8.186.932**	**-1,42%**	**7.730.555**	**-5,57%**
GRAND TOTAL	**20.336.418**	**20.173.505**	**-0,80%**	**17.983.635**	**-10,86%**	**17.669.772**	**-1,75%**

1.2.4. HINTERLAND TRAFFIC

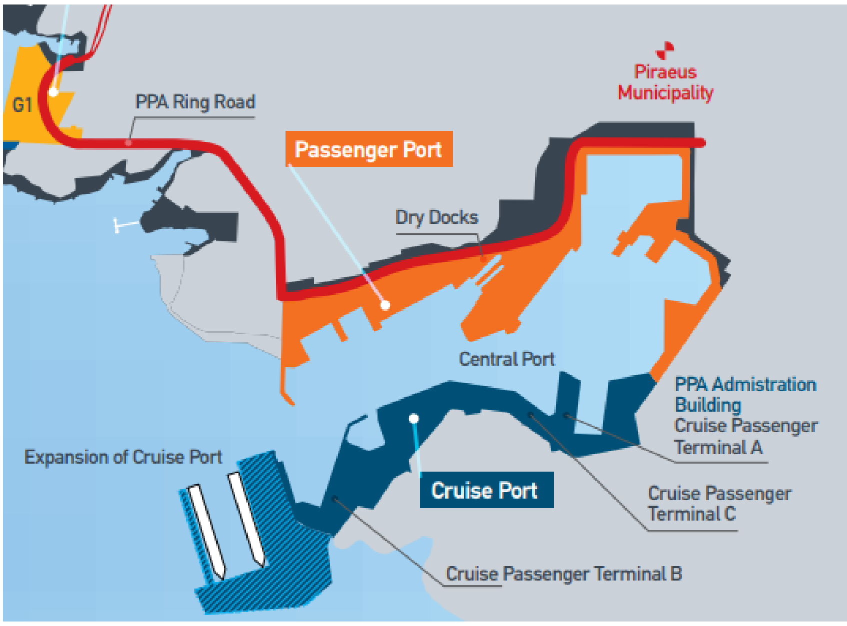
N/A

SECTION II. PORT INFRASTRUCTURE AND SERVICES

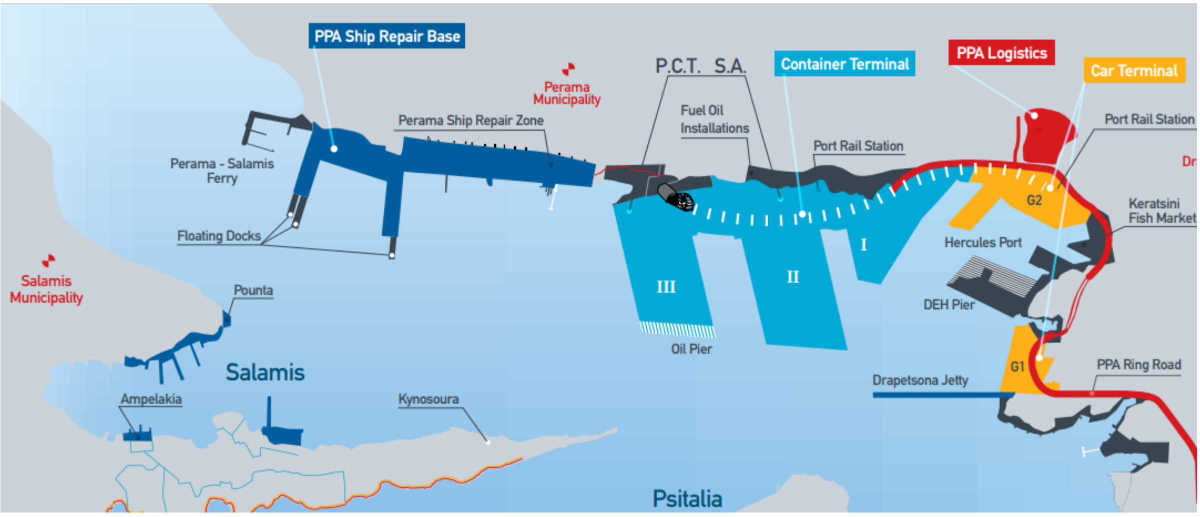
2.1. PORT INFRASTRUCTURE

2.1.1. Port of Piraeus

Passenger Port

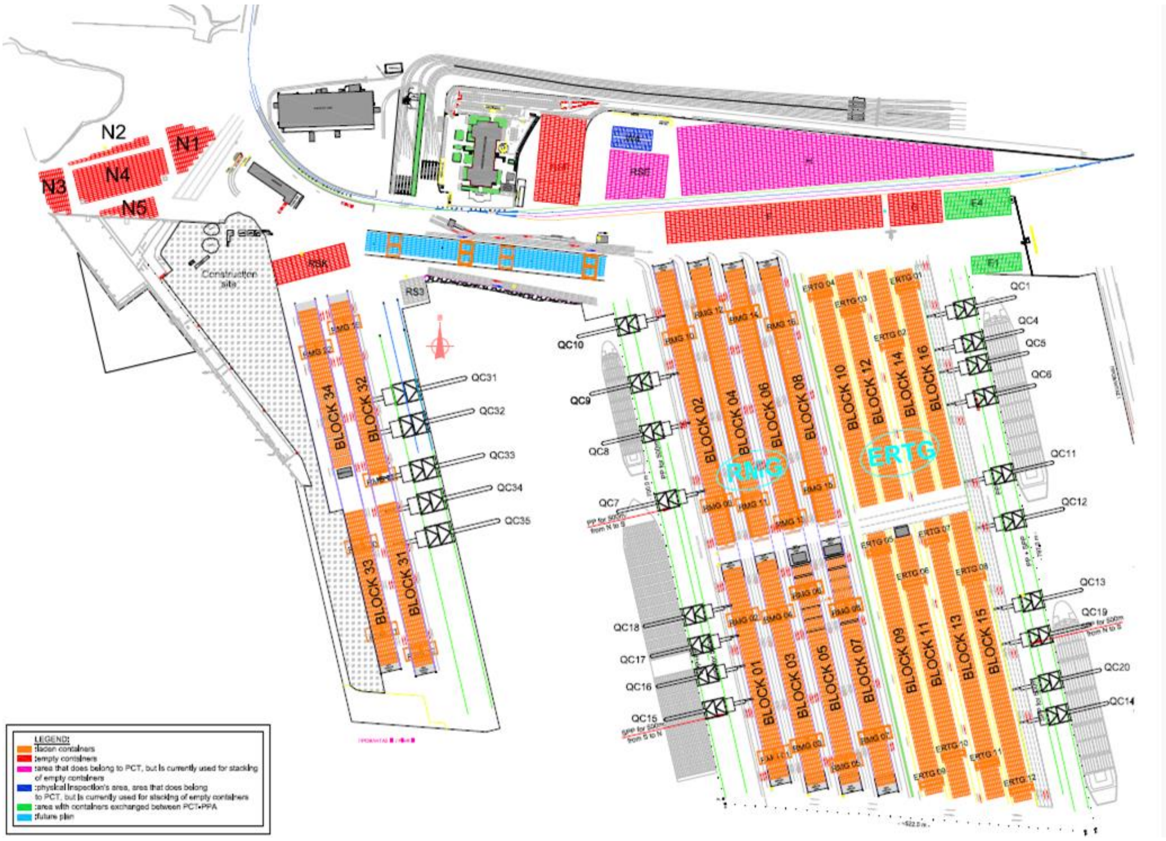


Commercial Port

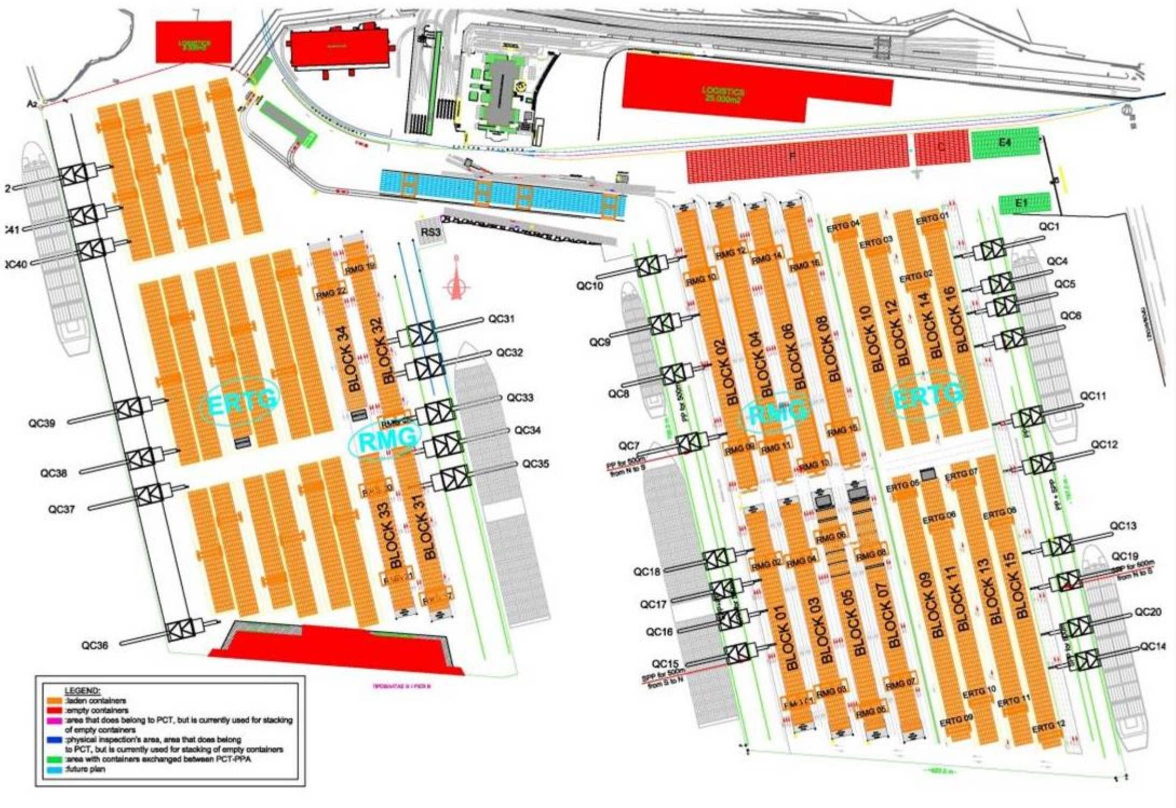


Terminal	Use	Public/Private	Automated terminal	Automated gates	Rail infrastructure
Piraeus Container Terminal	Containers	☐ Public ☑ Private	☐ Yes ☑ No	☑ Yes ☐ No	☑ Yes ☐ No
Piraeus Port Authority	Containers; General Cargo; RO/RO; Passenger	☑ Public ☑ Private	☐ Yes ☑ No	☐ Yes ☑ No	☑ Yes ☐ No

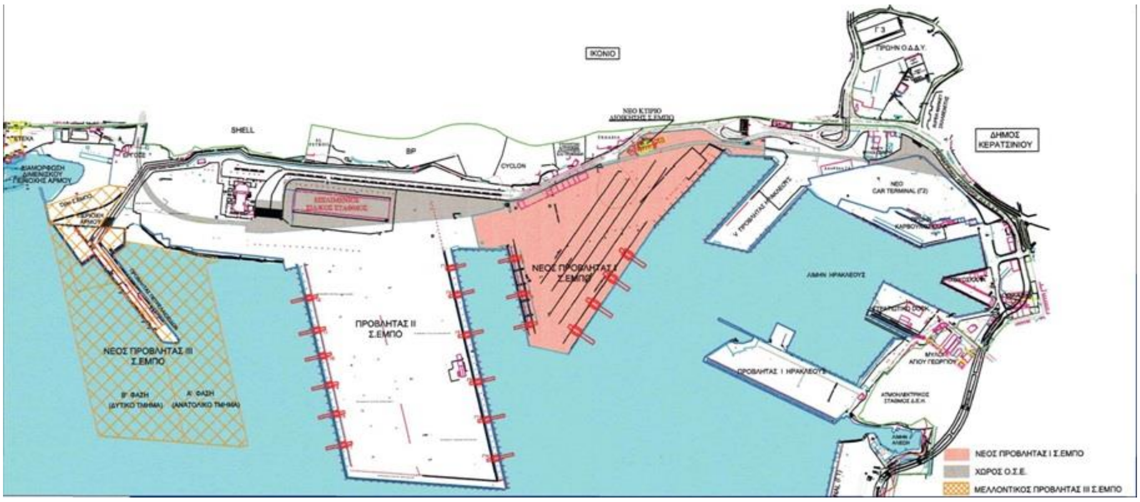
PCT Layout before the expansion plan



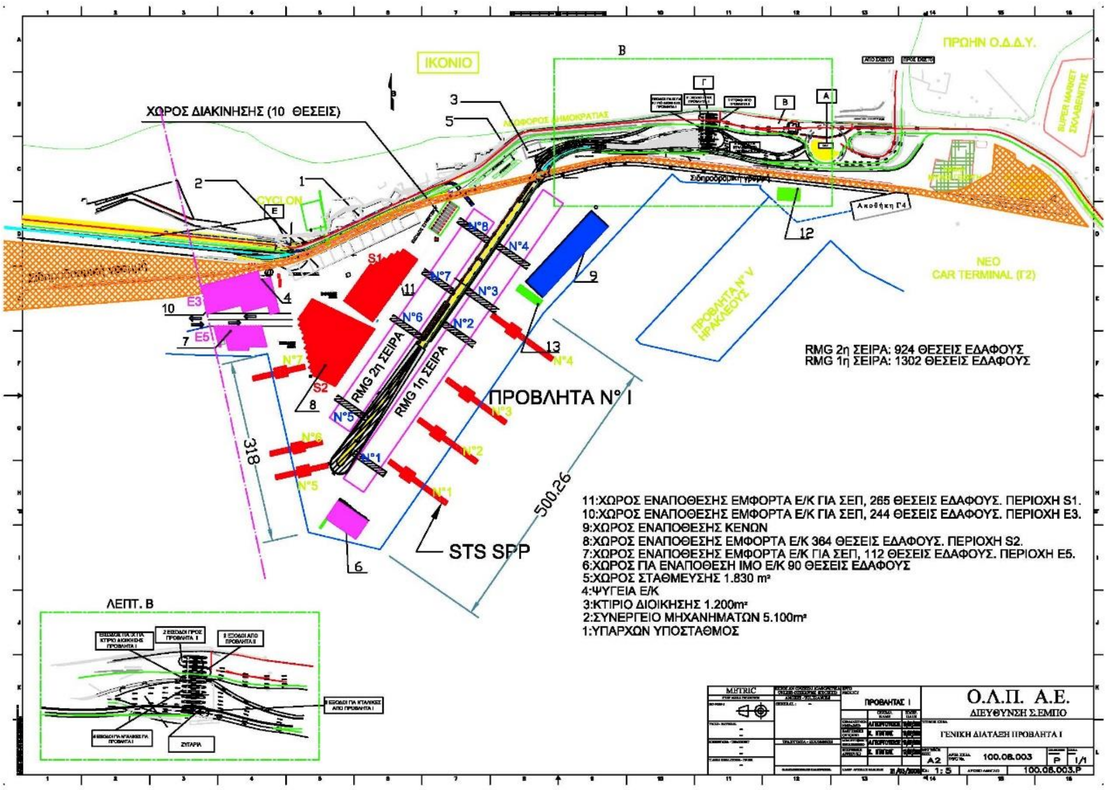
PCT Layout after the expansion plan (2018)



Layout of the Piraeus Port Container Terminals



Layout of the Piraeus Port Authority Container Terminal



2.2. MARITIME & RAIL SERVICES

2.2.1. FREIGHT RAIL SERVICES

NATIONAL/ INTERNATIONAL	DESTINATION	RAILWAY COMPANY	TRAFFIC	Nº TRAINS PER WEEK
International	Czech Republic	PEARL/TRAINOSE	N/A	2
International	Hungary	PEARL/TRAINOSE	N/A	1

2.2.2. SHORT-SEA-SHIPPING SERVICES

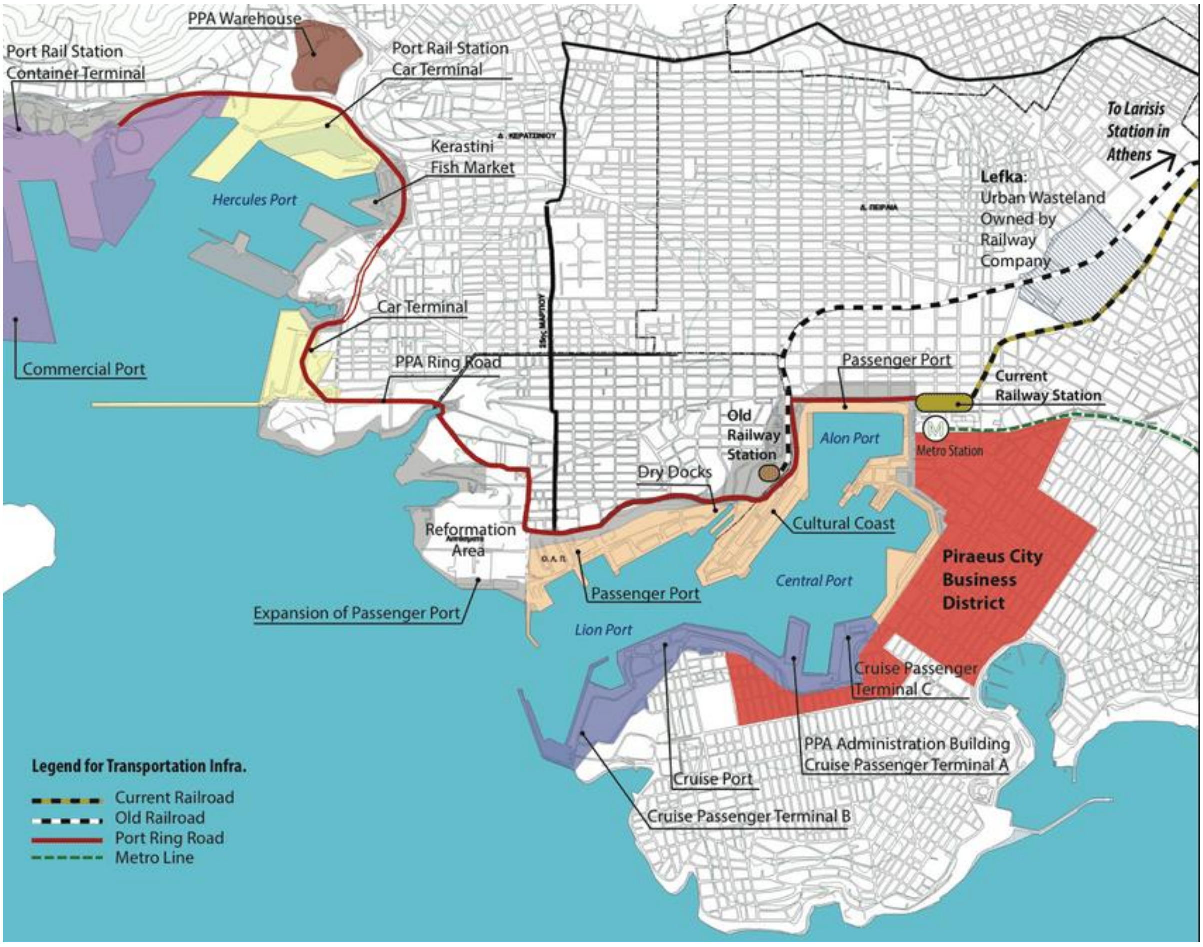
N/A

2.2.3. INLAND WATERWAY SERVICES

N/A

2.3. HINTERLAND INFRASTRUCTURE: LAND ACCESS AND LINKS TO THE PORT

2.3.1. PORT ACCESSES



2.3.2. ROAD ACCESSES

Yes

2.3.3. RAIL ACCESSES

Yes

2.3.4. INLAND WATERWAY

N/A

SECTION III. PORT IT SYSTEMS & COMMUNICATION AND INFORMATION EXCHANGE

3.1. IT PORT SYSTEMS

3.1.1. Road, Rail and Inland waterway Transport

Please, complete the following table with the IT systems for the management of the road, rail and inland waterway transport implemented in your port. Indicate also the agents that can interact with each IT systems. If there are other IT systems that are not included in the table, please add them at the bottom.

IT Systems		Port Agents				
		Freight Forwarders	Shipping Agencies	Port terminals	Transport companies (*)	Other (Indicate)
Business portals, online shops or on-line access portals	y/n		Y	Y		
Sectorial portals, e-marketplaces or service aggregators	y/n					
Intelligent Transport System (ITS)	y/n	Y	Y	Y		
Port Community Systems (PCS)	y/n			Y		
Electronic CMR	y/n					
Blockchain applications	y/n					
Cargo Community System (CCS)	y/n			Y		
Automated Gate Systems (AGS)	y/n			Y		
Truck Plate identification	y/n			Y		
Container ID identification	y/n			Y		
Driver identification software	y/n			Y		
Truck Appointment System	y/n					
Traffic/Fleet Management System	y/n			Y		
Electronic payment, funds transfer or credit system solutions	y/n			Y		

(*) Transport companies include road, rail and barge transport companies.

3.1.2. Port Community System (PCS)

If there is a PCS implemented in your port, please answer the following questions:

Ownership

☐ Public
☐ Mixed Public/Private
☑ Private
Company: Piraeus Port Authority SA

Exploitation

☐ Public
☐ Mixed Public/Private
☑ Private
Company: PPA SA, PCT SA, PCDC SA

Services provided

☑ Port Operations transport management (Port calls management, loading/dicharge orders, etc.)

☑ Maritime transport management (Departures, arrivals, bookings, etc.) ☑ Road transport management ☑ Rail transport management ☐ Inland Waterway transport management ☑ Customs (Goods declaration, customs information) ☑ Trak and Trace (Cargo tracking, equipment status, etc.) ☑ VGM management (Verified Gross Mass) ☐ Inland waterway transport management Other: ____
PCS Community (Who can operate with the PCS) ☑ Shipping Agents ☑ Port Terminals ☑ Freight Forwarders ☑ Haulage Companies ☑ Shippers ☑ Official Bodies ☑ Depots Other: ____
Main services provided by the PCS for <u>Road Transport</u> ☑ Generation of Transport Orders ☑ Management of Transport Orders ☑ Cargo Acceptance & Delivery Orders ☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots) Other: ____
Main services provided by the PCS for <u>Rail Transport</u> ☑ Generation of Transport Orders ☑ Management of Transport Orders ☑ Cargo Acceptance & Delivery Orders ☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots) ☑ Generation of loading/unloading lists to Rail Terminals Other: ____

SECTION IV. IDENTIFICATION OF HINTERLAND BEST PRACTICES

Best Practice	***Assignment of Container Job Orders to Driver IDs***
Description	Online portal that allows shipping agencies, freight forwarders and custom brokers to dispatch transport jobs to transport companies which in turn can assign specific jobs to drivers carrying an RFID ID card issued by PCT
Barriers	No control over arrival times
Objectives	ISPS Compliance
Main Beneficiaries	Shipping agents, Freight forwarders, Custom Brokers, Transport companies and Importers

Port of Valencia

Questionnaire on " Port-Hinterland Connectivity "

Port Name:	**Valenciaport**
Institution / Authority:	**Port Authority of Valencia**
Country	**Spain**

SECTION I. GENERAL INFORMATION: TRAFFIC EVOLUTION AND PORT INFRASTRUCTURE

1.1. TYPE OF PORT

Port governance model

☑ Public
☐ Mixed Public/Private
☐ Private
☐ Other: ____

Owner of the port and its name

☐ Local (Municipality)
☐ Regional
☑ National
Name: Port Authority of Valencia (Ministerio de Fomento)

1.2. TRAFFIC EVOLUTION

1.2.1. FREIGHT TRAFFIC

Type of traffic:

Traffic Structure	2015	2016	2017
Import/Export	**53,9%**	**54,1%**	**53,4%**
Import	30,6%	30,0%	30,3%
Export	23,3%	24,1%	23,1%
Transhipment	**46,1%**	**45,9%**	**46,6%**

Source: Statistical annual report, Port Authority of Valencia

	2015	2016	2017
General Cargo (Tonnes)	63.102.097	64.536.320	67.767.129
Containerised (Tonnes)	52.267.244	53.786.327	55.978.616
Non-Containerised (Tonnes)	10.834.853	10.749.993	11.788.513
Liquid Bulk (Tonnes)	3.814.375	3.803.068	3.203.487
Solid Bulk (Tonnes)	2.684.864	2.478.928	2.278.857
Other	482.641	462.668	310.404
Total	**70.083.977**	**71.280.984**	**73.559.877**

Source: Statistical annual report, Port Authority of Valencia

1.2.2. CONTAINER TRAFFIC (TEU)

	2015		2016		2017	
Export	22,8%	1.053.245	23,4%	1.109.389	23,3%	1.127.231
Full	17,7%	814.869	18,1%	854.702	18,7%	903.920
Empty	5,2%	238.376	5,4%	254.687	4,6%	223.311
Import	22,8%	1.053.017	23,4%	1.108.495	22,2%	1.073.177
Full	12,4%	569.981	13,1%	618.189	13,7%	659.883
Empty	10,5%	483.036	10,4%	490.306	8,6%	413.294
Transhipment	54,4%	2.508.934	53,1%	2.514.252	54,5%	2.631.748
Total TEUs	100,0%	**4.615.196**	100,0%	**4.732.136**	100,0%	**4.832.156**

Source: Statistical annual report, Port Authority of Valencia

1.2.3. PASSENGER & RORO TRAFFIC

Passengers:

	2015	2016	2017
Passengers	**748.115**	**910.200**	**1.062.580**
Regular line	373.549	506.936	650.252
Cruises	374.566	403.264	412.328
Nº of Cruises	**174**	**181**	**203**
Nº of Regular Lines	**1.250**	**1.424**	**1.612**

Source: Statistical annual report, Port Authority of Valencia

RORO:

Wheeled Transport	2015	2016	2017
Total Traffic (t)*	**8.544.804**	**8.939.023**	**9.452.523**
UTI (units)	319.973	330.113	344.907
Containers (units)	49.271	77.013	68.442
Vehicles (as goods)	689.426	776.130	794.954
Tons RoRo (net weight)	4.671.227	4.409.605	4.703.572

* Includes the gross weight of the UTI and the weight of vehicles as goods

Source: Statistical annual report, Puertos del Estado

1.2.4. HINTERLAND TRAFFIC:

Modal share (t):

Transport Mode	Export	Import	Total	Modal share
Railway	1.185.221	1.362.037	2.547.258	**6,8%**
Road	19.614.683	13.371.096	32.985.779	**88,7%**
Barges	0	0	0	**0,0%**
Others (e.g. pipelines)	0	1.656.006	1.656.006	**4,5%**
Total	20.799.904	16.389.139	37.189.043	**100%**

Source: Statistical annual report (year 2016) , Port Authority of Valencia

Railway traffic:

Railway Traffic	2015	2016	2017
Goods entering or leaving the port by rail			
Loaded (tonnes)	691.271	1.002.497	359.629
Unloaded (tonnes)	1.055.586	1.508.149	1.262.050
Total (tonnes)	**1.746.857**	**2.510.646**	**1.621.679**
TEUs	**146.688**	**151.346**	**171.250**

Source: Statistical annual report, Puertos del Estado

Railway Traffic	Export	Import	Total
Total trains	1.438	1.460	2.898
Total wagons	38.090	3.833	41.923
Total Cargo (t)	**953.062**	**570.761**	**1.523.823**
Total TEU	**76.302**	**75.044**	**151.346**

Source: Statistical annual report (year 2016) , Port Authority of Valencia

Road traffic:

Railway Traffic	2015	2016	2017
Goods entering or leaving the port by road			
Total (tonnes)	**32.979.081**	**33.424.674**	**34.824.859**
TEUs	**1.959.574**	**2.066.538**	**2.029.158**

Source: Statistical annual report, Puertos del Estado

1.3. PORT INFRASTRUCTURE

1.3.1. Port of Valencia:

Terminal	Use	Public/Private	Automated terminal	Automated gates	Rail infrastructure
NOATUM Container Terminal Valencia	Containers	☑ Public ☐ Private	☐ Yes ☑ No	☑ Yes ☐ No	☑ Yes ☐ No
MSC Container Terminal	Containers	☐ Public ☑ Private	☐ Yes ☑ No	☑ Yes ☐ No	☐ Yes ☑ No
APMT Valencia	Containers; General Cargo;	☑ Public ☐ Private	☐ Yes ☑ No	☑ Yes ☐ No	☑ Yes ☐ No
Valencia Terminal Europa (Grimaldi Group)	RORO Cargo	☐ Public ☐ Private	☐ Yes ☑ No	☑ Yes ☐ No	☑ Yes ☐ No

01. Lighthouse
02. Chemical and Oil Terminal
03. Ro-ro and Vehicle Terminal 2
04. Solid Bulk Terminal 1
05. Container Terminal 3
06. Multipurpose Terminal
07. North Extension (under construction)
08. Moveable bridge
09. Access to Juan Carlos I Royal Marina
10. Varadero building
11. Customs gate
12. Customs administration
13. Foreign Health Department
14. Port Authority of Valencia/ Valencia 2007 Consortium
15. Clocktower building
16. Press centre
17. Fish market (provisional location)
18. Ferry Terminal / Passenger and Cruise Terminal
19. Shipyard
20. Port Police
21. Valenciaport Foundation / VPI / Quality Mark
22. Port Authority of Valencia
23. Plant Disease Station / CCE / Infoport Valencia
24. General and bulk cargo
25. Passenger Terminal
26. Solid Bulk Terminal 2
27. PIF (Border Inspection Post)
28. Harbourmaster's Office
29. Cold storage warehouse
30. SEVASA Stevedoring Company
31. Logistics Activities Area (ZAL)
32. Royal Valencia Yacht Club
33. Ro-ro and Vehicle Terminals
34. Container Terminal 2 (MSC)
35. Public container terminal
36. Maritime Civil Guard building
37. Logistics warehouses

- Container Terminals
- Multipurpose Terminal
- Solid Bulk
- Ro-ro and Vehicle Terminals
- Passenger Terminals
- Liquid Bulk

Source: Annual Report of Valenciaport

1.3.2. Port of Sagunto:

Source: Annual Report of Valenciaport

1.3.2. Port of Gandia:

Source: Annual Report of Valenciaport

SECTION II. HINTERLAND CONNECTIONS

2.1. HINTERLAND AND FORELAND TRAFFIC

2.1.1. HINTERLAND TRAFFIC

Geographical distribution of export and import flows (Top 15)

Descripción Modo	MARÍTIMO
Año	2017
Descripción Aduar	VALENCIA

Peso - TM	**Descripción Flujo**
Descripción Pro	**Exportación o Expedi**
CASTELLON	34,69%
VALENCIA	24,13%
MADRID	9,35%
ALICANTE	6,47%
MURCIA	4,91%
BARCELONA	2,14%
TOLEDO	2,08%
GUIPUZCOA	1,81%
ZARAGOZA	1,75%
CIUDAD REAL	1,25%
BURGOS	1,17%
ALBACETE	0,99%
CUENCA	0,92%
NAVARRA	0,82%
ALAVA	0,52%

Descripción Modo	MARÍTIMO
Año	2017
Descripción Aduai	VALENCIA

Peso - TM	**Descripción Flujo**
Descripción Pro	**Importación o Intro**
VALENCIA	56,86%
MADRID	15,49%
ALICANTE	4,97%
MURCIA	3,66%
BARCELONA	3,58%
CASTELLON	2,59%
ALBACETE	1,37%
TOLEDO	1,25%
ZARAGOZA	0,86%
ALMERIA	0,75%
Desconocido/a	0,62%
NAVARRA	0,58%
TARRAGONA	0,53%
SEVILLA	0,50%
VIZCAYA	0,45%

Source: own elaboration based on the foreign trade data provided by the Spanish Tax Agency

2.1.2. FORELAND TRAFFIC

Exports

(TONNES)	2010	2011	DIFF. 10/11	%
CHINA	1,154,415	1,302,158	147,743	12.80%
ITALY	899,293	1,24,5013	345,720	38.44%
SAUDI ARABIA	665,509	702,346	36,837	5.54%
THE USA	359,432	432,794	73,362	20.41%
UNITED ARAB EMIRATES	344,792	389,236	44,444	12.89%
RUSSIA	319,701	374,312	54,611	17.08%
ALGERIA	308,373	304,804	-3,569	-1.16%
MOROCCO	281,414	305,818	24,404	8.67%
ISRAEL	303,509	267,506	-36,003	-11.86%
UNITED KINGDOM	214,281	210,411	-3,870	-1.81%
TURKEY	201,330	221,632	20,302	10.08%
MEXICO	170,890	202,498	31,608	18.50%
INDIA	174,770	179,335	4,565	2.61%
BRAZIL	151,027	178,427	27,400	18.14%
OTHER COUNTRIES	3,564,043	3,984,929	420,886	11.81%
TOTAL	**9,112,779**	**10,301,219**	**1,188,440**	**13.04%**

Imports

(TONNES)	2010	2011	DIFF. 10/11	%
CHINA	2,373,466	2,066,186	-307,280	-12.95%
ITALY	1,123,989	1,007,922	-116,067	-10.33%
ALGERIA	834,860	1,140,418	305,558	36.60%
FRANCE	958,905	934,515	-24,390	-2.54%
QATAR	1,145,110	648,125	-496,985	-43.40%
EGYPT	971,717	643,309	-328,408	-33.80%
THE USA	673,433	823,150	149,717	22.23%
NIGERIA	567,054	358,179	-208,875	-36.84%
TURKEY	354,163	419,705	65,542	18.51%
HOLLAND	248,147	270,229	22,082	8.90%
BULGARIA	237,481	175,112	-62,369	-26.26%
RUMANIA	233,168	172,281	-60,887	-26.11%
OTHER COUNTRIES	3,647,387	3,703,161	55,774	1.53%
TOTAL IMPORTS	**13,368,880**	**12,362,292**	**-1,006,588**	**-7.53%**

Source: Annual Report of Valenciaport

2.2. MARITIME & RAIL SERVICES

2.2.1. SHORT-SEA-SHIPPING SERVICES

Route	Shipping Line	Type of Traffic	Frequency	Transit time
Valencia-Barcelona-Livorno-Savona	Grimaldi	RORO	6 x week	36-51h
Valencia-Cagliari	Grimaldi	RORO	3 x week	22-41h

Valencia-Savona	Grimaldi	RORO	3 x week	22-41h
Valencia-Salermo	Grimaldi	RORO	3 x week	22-41h

2.2.2. FREIGHT RAIL SERVICES:

NATIONAL/ INTERNATIONAL	DESTINATION	RAILWAY COMPANY	TRAFFIC	Nº TRAINS PER WEEK
National	Valenciaport-Madrid Coslada/Azuqueca	CONTINENTAL RAIL	CONTAINER	10
National	Valenciaport-Madrid Coslada/Abroñigal	RENFE MERCANCÍAS	CONTAINER	8
National	Valenciaport-Zaragoza Plaza	LOGITREN	CONTAINER	2
National	Valenciaport-Burgos Miranda de Ebro	RENFE MERCANCÍAS	CONTAINER	1

Source: Supply of SSS and rail freight services, Fundación Valenciaport

The Valencia - Madrid Corridor is the most important for Valenciaport with more than 150,000 TEUs and a modal share of 25% of container traffic via railway transport mode.

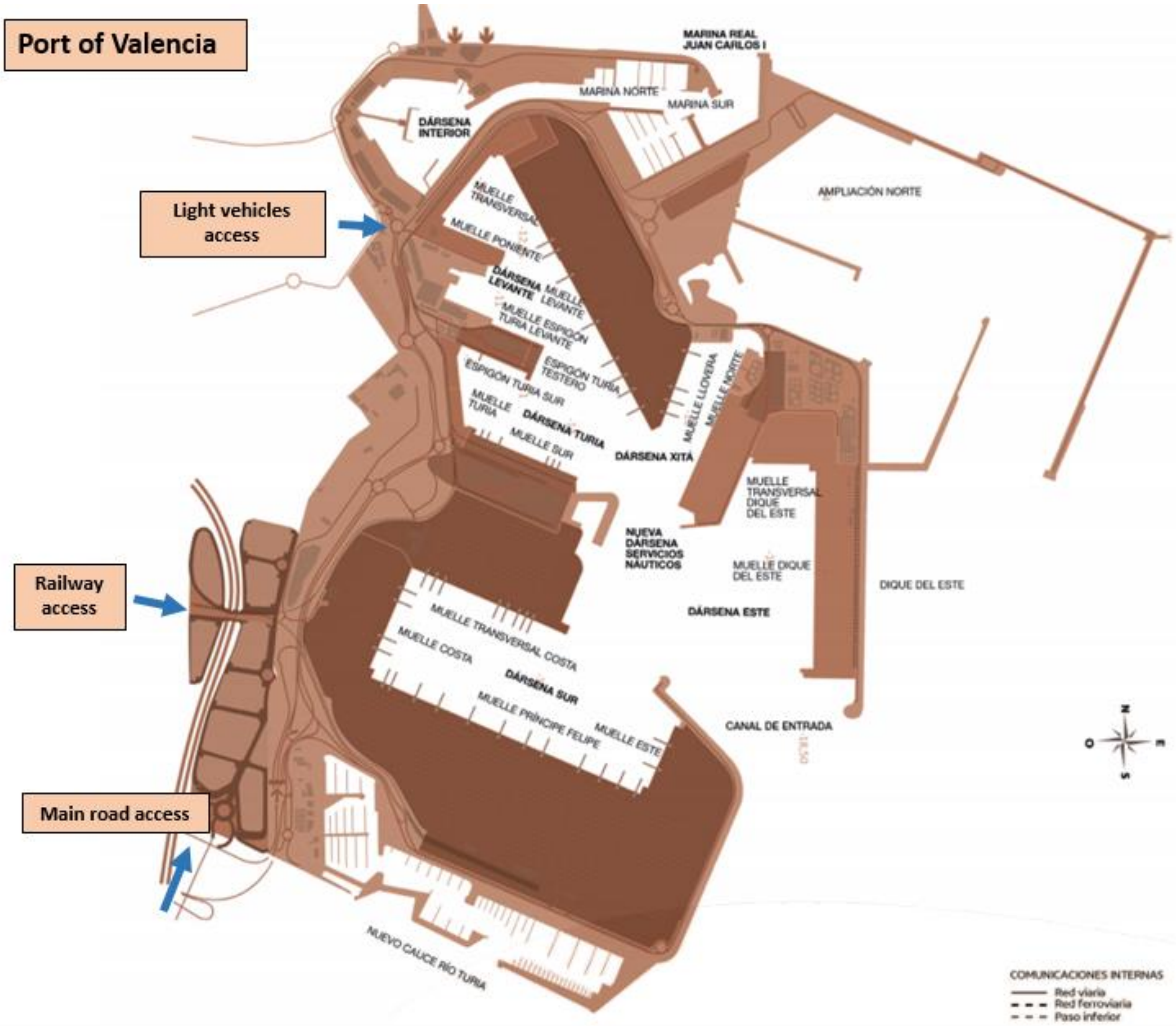
2.2.3. INLAND WATERWAY SERVICES

N/A

2.3. HINTERLAND INFRASTRUCTURE: LAND ACCESS AND LINKS TO THE PORT

2.3.1. PORT ACCESSES:

Port of Valencia



2.3.2. ROAD ACCESSES

Port of Valencia and Sagunto:

The Port of Valencia is connected through the V-30 Valencia's ring road to the General Interest Road Network. The V-30 is directly linked to Mediterranean Motorway A-7, which allows the port to connect with its most significant hinterland nodes:

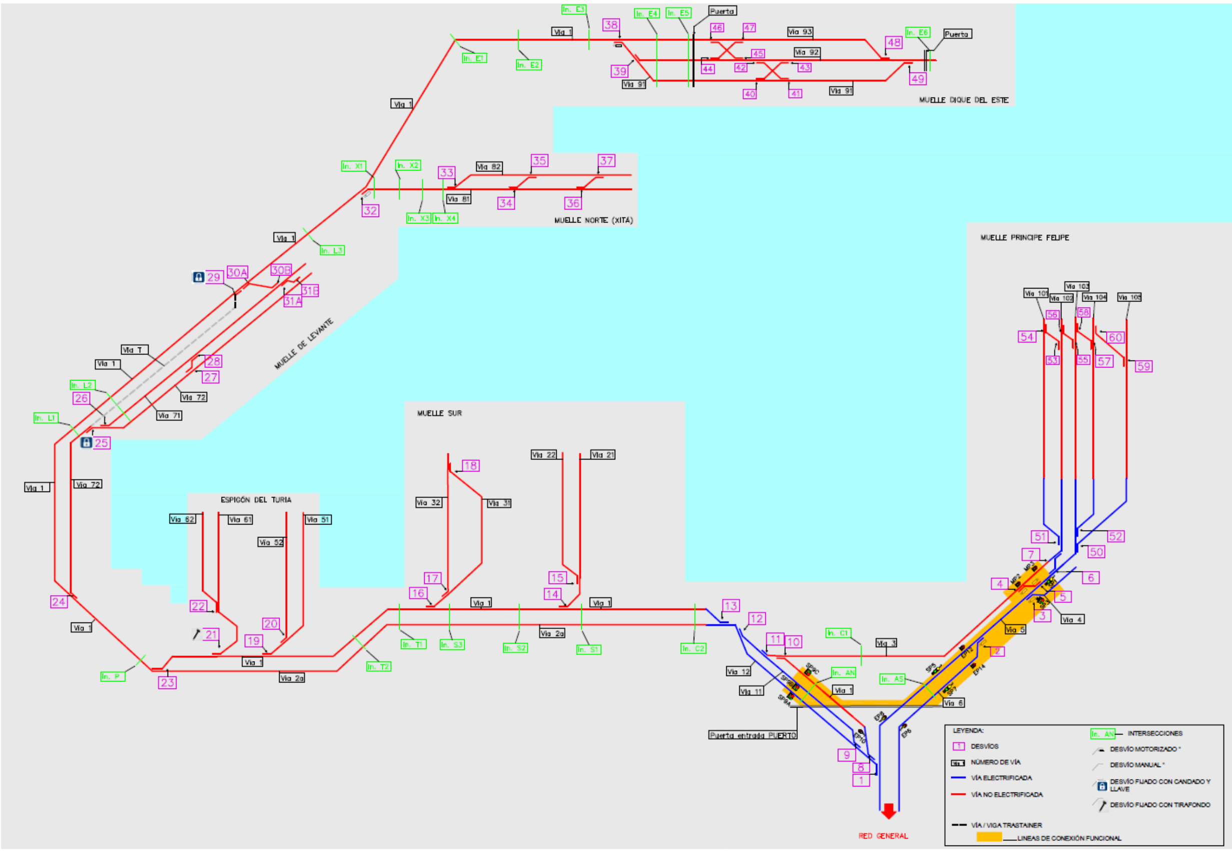
- V-21 in the north to connect with the corridor Valencia-Sagunto
- V-31 in the south to connect with the corrido Valencia-Silla
- North-South corridor through the A-38 Motorway (Valencia-Cartagena) and the A-7 in its southern section until Algeciras.
- Corridor East-West via the free motorway A-3 that links Valencia and Madrid and later on connects with Lisbon through the A-43.
- A-7 in the section that connects with the A-23 to Aragon and the rest of the regions in the north of Spain.

In reference to the Port of Sagunto, which is 30 kilometres northern to Valencia, it is connected with the following main roads:

- To the north, the Mediterranean Motorway A-7 (France-Barcelona-Tarragona-Castellon-Sagunto)
- To the south, the Mediterranean Motorway A-7 until Algeciras and the V-21 to Valencia
- To the North-West via the motorway A-23 to Aragon

2.3.3. RAIL ACCESSES

Internal railway layout at the Port of Valencia :



The railway connections from Valencia ensure access to any manufacturing area on the Iberian Peninsula and Europe. The rail links from the Port of Valencia are as follows:

- Valencia – Barcelona – Port Bou
- Valencia – Zaragoza – Basque Country
- Valencia – Cuenca – Madrid
- Valencia – Albacete – Madrid. rom Madrid, there are links to Extremadura and Portugal, as well as the north and northwest areas of Spain.
- Valencia – La Encina – Alicante, which provides connections to other destinations from Alcazar de San Juan (Andalusia), Alicante (Murcia), Madrid (north and northeast Spain, Extremadura).

Concerning the Port of Sagunto, it has a private infrastructure, owned by ARCELOR, which from the South Pier connects to the General Interest Railway Network. On February 2014, the favourable Environmental Impact Statement (EIS) of the Railway Access to the Port of Sagunto was published in the Official State bulletin (BOE). It is expected to finish the construction works in 2020 with a total budget of 31.5 million €. In tune with this access, the APV has already designed its internal railway network that will allow the terminals to have a public connection to the general network. It should be noted at this point that only 5 km from the Port of Sagunto is located the Public Railway Terminal managed by ADIF.

2.3.4. INLAND WATERWAY

N/A

SECTION III. PORT IT SYSTEMS & COMMUNICATION AND INFORMATION EXCHANGE

3.1. IT PORT SYSTEMS

3.1.1. Road Transport

Please, complete the following table with the IT systems for the management of the railway transport implemented in your port. Indicate also the agents that can interact with each IT systems. If there are other IT systems that are not included in the table, please add them at the bottom.

IT Systems		Port Agents				
		Freight Forwarders	Shipping Agencies	Port terminals	Transport companies	Other (Indicate)
Management of transport Orders	X	X	X	X	X	
Management of Cargo Acceptance & Delivery Orders	X	X	X	X	X	
Notification of Containers Acceptance & Delivery Orders (Terminals and Depots)	X	X	X	X	X	
Automatic Gates	X			X		
Truck Plate identification	X			X	X	
Container ID identification	X			X	X	
Driver identification						
Truck Appointment System						
Traffic Management System	X					
Closing Time	X	X		X	X	
Other IT systems (add lines)						

3.1.2. Railway Transport

Please, complete the following table with the IT systems for the management of the railway transport implemented in your port. Indicate also the agents that can interact with each IT systems. If there are other IT systems that are not included in the table, please add them at the bottom.

IT Systems		Port Agents				
		Freight Forwarders	Shipping Agencies	Port terminals	Railway companies	Other (Indicate)
Management of transport Orders	X	X	X	X	X	
Management of Cargo Acceptance & Delivery Orders	X	X	X	X	X	
Notification of Containers Acceptance & Delivery Orders (Terminals and Depots)	X	X	X	X	X	
Automatic Gates	X			X		
Train identification	X			X	X	
Container ID identification	X			X	X	
Driver identification	X			X	X	
Rail Traffic Management System						
Other IT systems (add lines)						

3.1.3. Inland Waterway Transport

N/A

3.1.4. Port Community System (PCS)

Is there a Port Community System implemented in your port?
☑ Yes
☐ No

Owner
☑ Public
☐ Mixed Public/Private
☐ Private
Company: Port Authority of Valencia

Exploitation
☑ Public
☐ Mixed Public/Private
☐ Private
Company: ValencieportPCS

Services provided
☑ Port Operations transport management (Port calls management, loading/dicharge orders, etc.)
☑ Maritime transport management (Departures, arrivals, bookings, etc.)
☑ Road transport management
☑ Rail transport management
☐ Inland Waterway transport management
☑ Customs (Goods declaration, customs information)
☑ Trak and Trace (Cargo tracking, equipment status, etc.)
☑ VGM management (Verified Gross Mass)
☐ Inland waterway transport management
Other: ____

PCS Community (Who can operate with the PCS)
☑ Shipping Agents
☑ Port Terminals
☑ Freight Forwarders
☑ Haulage Companies
☑ Shippers
☑ Official Bodies
☑ Depots
Other: ____

Main services provided by the PCS for Road Transport
☑ Generation of Transport Orders
☑ Management of Transport Orders
☑ Cargo Acceptance & Delivery Orders
☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots)
Other: ____

Main services provided by the PCS for Rail Transport
☑ Generation of Transport Orders
☑ Management of Transport Orders
☑ Cargo Acceptance & Delivery Orders
☑ Notification of Containers Acceptance & Delivery Orders (Terminals and Depots)

☑ Generation of loading/unloading lists to Rail Terminals
Other: ____

Main services provided by the PCS for Inland Waterway Transport
N/A
Other: ____

SECTION IV. IDENTIFICATION OF HINTERLAND BEST PRACTICES

Complete this section with best practices and solutions related for the hinterland connectivity that are implemented your port. Please include:

- *Title/name*
- *Short Description of the Best Practice*
- *Barriers*
- *Objectives*
- *Main beneficiaries*

Best Practice	*(Title)*
Description	*(Short description of the BP)*
Barriers	*(Initial issues to be overcome)*
Objectives	
Main Beneficiaries	