D.3.1.2 Cross-border inventory of projects' results

CONTENTS

1. INTRODUCTION

The main objective of this document is to gather the results of the IT-HR and other EU projects on ICT applied to multimodal freight transport as to feed the 2021-2027 Programming Period and transfer them at transnational level.

As a result, the main output based on this document is:

- O.3.1 – Cross-border inventory of projects' results, with the main outputs from the involved IT-HR Standard and Standard+ projects on ICT applied to freight transport.

PPs gather the already available results and knowledge in this field. With the support of all PPs, Port of Ploče Authority collects the main project results in this field achieved by IT-HR projects.

With the support of all PPs, project partners will develop project ideas supporting the implementation of IT-HR 2021-2027 priority 3.2 for improving the intramodality capacities of ports, including project objectives, expected results, outputs, list of activities, profiles of the most suitable PPs.

The aim of this document is to capitalize on the INTERREG projects TRANSPOGOOD PROMARES, INTESA, and DIGLOGS. The document consists of the following parts:

- Review, Comparison and discussion of the four projects along several dimensions: issues tackled, objectives, partners, envisaged barriers, pilot actions, results achieved, and lessons learnt.

2. REVIEW OF THE INTERREG PROJECTS TRANSPOGOOD PROMARES, INTESA, AND DIGLOGS

2.1 List of the partners involved within the projects

The most of the projects' partners are "Public / Body governed by public law" type partners and only three private partners were involved. A greater involvement of private partner, when compatible with the INTERREG project rules, either financed or without direct financing, should be considered. All supply chain stakeholders could be asked to collaborate to reach the projects' goals, with obvious preference to those involved in port operations (e.g., maritime and custom agents, terminal operators, warehouse operators, truck companies, railway companies, and shippers).

2.1.1 TRANSPOGOOD

- Intermodal Transport Cluster (LP – HR)
- CFLI – Intermodal Logistics Training Consortium (IT) - Public / Body governed by public law
- Istrian Development Agency – IDA LTD (HR)
- Unioncamere del Veneto (IT) - Public / Body governed by public law
- Agenzia di Sviluppo, Agenzia Speciale Di Sviluppo della Camera di Commercio di Chieti (IT) - Public / Body governed by public law
- Elevante Trading & Consulting S.R.L. (IT) - Private
- Autorità del porto di Zadar (HR) - Public / Body governed by public law
- Autorità del porto di Ploče (HR) - Public / Body governed by public law

2.1.2 PROMARES

- Port Network Authority of Eastern Adriatic Sea (LP – IT) - Public / Body governed by public law
- North Adriatic Sea Port Authority – Ports of Venice and Chioggia (IT) - Public / Body governed by public law
- Venice International University (IT) - Public / Body governed by public law
- Interporto Trieste-Fernetti (IT) - Public / Body governed by public law
- Port of Ravenna Authority (IT) - Public / Body governed by public law
- Central Adriatic Ports Authority (IT) - Public / Body governed by public law
- Southern Adriatic Sea Port Authority (Ports of Bari, Brindisi, Manfredonia, Barletta and Monopoli) (IT) - Public / Body governed by public law
- Port Authority of Rijeka (HR) - Public / Body governed by public law
- Porth Authority of Ploče (HR) - Public / Body governed by public law
- Faculty of Maritime Studies Rijeka (HR) - Public / Body governed by public law

2.1.3 INTESA

- North Adriatic Sea Port Authority – LP - Public / Body governed by public law
- Italian Ministry of Sustainable Infrastructures and Mobility - Coast Guard Headquarters (IT) - Public / Body governed by public law
- RAM- Logistica Infrastrutture e Trasporti SpA (IT) - Public / Body governed by public law
- Port Network Authority of The Eastern Adriatic Sea (IT) - Public / Body governed by public law Ravenna Port Authority (IT) - Public / Body governed by public law
- Central Adriatic Sea Ports Authority (IT) - Public / Body governed by public law
- Southern Adriatic Port Authority (IT) - Public / Body governed by public law
- Rijeka Port Authority (HR) - Public / Body governed by public law
- Port of Ploče Authority (HR) - Public / Body governed by public law
- Split Port Authority (HR) - Public / Body governed by public law
- Croatian Ministry of the Sea, Transport and Infrastructure (HR) - Public / Body governed by public law
- Meteorological and Hydrological Service of Croatia DHMZ (HR) - Public / Body governed by public law

2.1.4 DIGLOGS

- University of Rijeka, Faculty of Maritime Studies Rijeka (LP – HR) - Public / Body governed by public law
- CFLI (Intermodal Logistics Traning Consortium) (IT) - Public / Body governed by public law
- ELEVANTE srl (IT) - Private
- University of Trieste (IT) - Public / Body governed by public law
- Actual I.T. (IT) - Private
- Cluster for Innovation in Logistics and Transport System (Polo Inoltra) (IT) - Private
- Port of Rijeka Authority (HR) - Public / Body governed by public law
- Port of Sibenik Authority (HR) - Public / Body governed by public law
- Rovinj Port Authority (HR) - Public / Body governed by public law

2.2 Projects main issues and objectives

Within this chapter projects main issues and objectives have been provided and gathered.

2.1.1 TRANSPOGOOD

Project TRASNPOGOOD timeline: 01/01/2018. – 30/06/2019.

The main issued tacked by the project are the following:

- Information gap in logistic chains
- Lack of ICT solutions in the Programme area
- Lack of a platform for information exchange and coordination
- Lack of interoperability and compatibility of systems TRANSPOGOOD solutions
- Information exchange implementations have so far mostly taken place at an individual mode level
- Many SMEs lack the capability and resources to properly interoperate and collaborate with other companies.
- All Adriatic ports have established ferries lines, but there is little to no information exchange between the different actors in the transport logistics chain (shippers, logistic providers, transport operators, and authorities). By increasing information exchange between key logistics stakeholders, we can find the best solution of transport services (e.g., best price of combined transport, lower emissions of entire chain, e-procurement tools for maritime transport services, higher bi-directional load factor)

Objectives:

- capitalizing the main results of the INTERMODADRIA project by developing a set of innovative ICT tools that can assist users in finding the best solution of transport services offer and ensure monitoring transport logistics and environmental performances demonstrating concrete benefits in transport and logistics implementations.
- improving the knowledge in the transport and logistics sector by organizing the training modules and jointly define a set of outputs to improve the market, policy and regulatory conditions for intramodality.

2.2.2 PROMARES

Project PROMARES timeline: 01/01/2019. – 30/06/2022.

The main issued tacked by the project are the following:

The project tackled the challenges hampering the full-fledged development of the potential for maritime and multimodal freight transport in the Programme Area. They are mainly caused by:

- the imbalanced development of multimodal transport options,

- weak coordination and communication of stakeholders and policy makers in the port hinterland interface
- and uncoordinated measures and tools at cross-border level,

The above issue lead to increased road transport with negative consequences on the Programme Area in terms of pollution, greenhouse gases emissions and noise.

Objective:

PROMARES aimed at tackling the challenges hampering the full-fledged development of the potential for maritime and multimodal freight transport in the Programme Area, mainly caused by:

- the imbalanced development of multimodal transport options,
- weak coordination and communication of stakeholders and policy makers in the port hinterland interface and
- uncoordinated measures and tools at cross-border level.

2.2.3 INTESA

Project INTESA timeline: 01/01/2019. – 30/06/2022.

The main issued tacked by the project are the following:

Maritime freight transport is still characterized by lack of coordination among relevant players such as port authorities, custom agencies, freight forwards, inland ports, terminal operators. There are still inefficiencies in the logistic chain. Addressing only the improvement of a single ring of the whole logistics chain would be useless, therefore there is the need to connect and synchronize the chain at multisector and cross border level.

The connectivity of the Adriatic region and between the Region and the rest of EU is still insufficient. It needs to be tackled through a cooperative and coordinated approach.

Road freight transport still plays a major role, maritime transport is not sufficiently exploited, and existing inter-modal terminals are still underutilized. An in-depth needs assessment/SWOT analysis of the whole area is necessary

- There is a need to upgrade PCSs and there is a need to update nautical IT systems/interoperability among systems.

Objective:

The project aimed at establishing a network among the National Maritime Administrations of Italy and Croatia and main port authorities of the Adriatic Sea (Venice, Trieste, Ravenna, Ancona, Bari, Rijeka, Ploce and Split) with the scope of harmonizing and optimizing the procedures of the complete maritime transport process. More specifically, the project aimed at addressing the following specific problems:

- Port-land interface: to optimize the port procedure from unload of the cargo from the ship to the forward by train or truck and vice versa.

- Port-sea interface: to optimize the procedure to enter and exit from the port, avoiding waiting times and limiting the use of technical services as for example tug boats; to increase port performances in bad weather conditions safeguarding safety and security requirements.
- Deep sea: design and implementation of integrated ICT tool for the management and broadcast of the information on Maritime Safety to all ships en-route in the Adriatic Sea to improve safety in maritime transport operations.

The proposed tools to be used were:

- integration of logistics players through data exchange.
- harmonization of port procedures.
- efficient connections among ports and logistics nodes.
- optimization of traffic management.
- upgrade of navigation aids.

The INTESA project aimed also at:

- improving cross-border cooperation in the port-port sector, via joint actions on both sides of the Adriatic Sea,
- standardizing and integrating the monitoring and management procedures.
- improving quality, safety and sustainability of maritime transport services and the port-hinterland connections.

2.2.4 DIGLOGS

Project INTESA timeline: 01/01/2019. – 31/12/2021.

The main issued regarding the territorial challenges tacked by the project are the following:

- The transport processes are characterized by limited sharing of information on freight and passenger's movements, status and authorizations between the various transport actors.
- Inefficient handling of the cargo and accompanying documentation hampers the take up of intermodal and combined transport.

Objectives:

- developing the technological solutions, models and plans to establish the most advanced digitalized logistic processes for multimodal freight transport and passengers' services in the Italy-Croatia area.
- significantly improving logistics quality, port and goods safety and security, and environmental sustainability.

2.2.5 The main issues and project objectives summary

The above-described projects identified and tackled the most important issues hindering the development of modern IT-based logistics and the full use of multimodality in the Programme Area. Each project included an in-depth analysis of the status quo and the specific port characteristic. SWOT analysis made it possible to identified the issues at stake, ranging from infrastructural, technical, organizational, financial, logistical and cultural. The issue of enhancing the education and training of the human resources has been attributed a high relevance.

Establishing and managing an efficient supply chain is a very challenging task, even when the stakeholder relationships are monomodal and take place within a nation. The task becomes enormously more challenging when:

- Multimodal relationships are needed because of unavoidable transshipments across oceans and sees or search for, to reduce environmental impacts and improve sustainability.
- Multinational, so that custom and safety issues are important, thus involving also public authorities collecting custom duties and performing the necessary health and safety related checks
- Port-related, thus taking place in the complex and space- and time-constraint environment of seaside ports and dry-ports.

Digitation and digitalization can arguably facilitate the task, but, at the same time, it opens up a series of technical, financial and human-related challenges that the four projects have explored and search solutions for.

The projects selected a variety of relevant and challenging objectives that could be summarized with the following key-concept: coordination, technological innovation, harmonization, and integration in the programmed area. Together with human resource improvements, these set of objectives have the potential to upgrade the port infrastructures and the transport practices and to enhance the development of multimodality and reduce the transport and port pressure on the natural resources.

The recent geo-political developments, occurred after the start of the analyzed projects have put to fore new challenges that could be added to the objective to be achieved in future projects such as:

- The resilience of the supply chains in face of epidemic and political issues (i.e., Covid19 and the Ukrainian war), which forces countries to revise their industrial specialization with profound consequence on the maritime flows and logistic chains
- The climate change challenge that, in addition to the conventional air pollution problems in the vicinity of sea-ports and dry-ports, forces big changes in vehicle's powertrains (including ships, trucks, and port operation equipment).
- The clean energy challenge demanding a shift from fossil fuel-based to renewable sources of energies.

As commonly the case, a challenge is also an opportunity. The improvements in digitization and digitalization, realized also thanks to the INTERREG projects, increase the flexibility in the supply chain management and

port operations laying out the foundations for the needed adaptation to the new challenges facing the Adriatic ports and the maritime industry.

2.3 Barrier identification

2.2.1 TRANSPOGOOD

The main barriers envisaged within the project were:

- Information communication technology (ICT) barriers (compatibility and interoperability of systems, ICT integration and standardization).
- User-related barriers (enterprise size, economic and financial constraints, operation-related barriers, management-related barriers, confidentiality of information).
- Policy barriers (lack of policy incentives, lack of coordinated and harmonized policies, lack of standardization policies).

2.3.2 PROMARES

The main obstacles to a successful multimodality in the Programme Area are identified as follows:

- Imbalanced level of hard and soft infrastructural development, both in terms of last mile bottlenecks and missing links along the main networks.
- Institutional fragmentation at two levels: within each country, between ports/intermodal logistic nodes and public institutions (e.g. customs); between the two countries, where a coordinated cross border development strategy for enhancing maritime and multimodal transport is missing;
- Insufficient communication and coordination between freight operators and the logistic nodes, especially in the port-inland interface.

2.3.3 INTESA

The main barriers to improving the quality, safety and environmental sustainability of marine and coastal transport services and nodes by promoting multimodality in the Programme area are identified as follows:

- The freight transport is still characterized by lack of coordination among relevant players such as port authorities, custom agencies, freight forwards, inland ports, and terminal operators.
- The connectivity between the two sides of the Adriatic Sea is not sufficient and not only they cannot contribute to stronger cooperation in economic activities, cargo supply and mobility of citizens, but can be considered the main bottleneck to the full deployment of a balanced and sustainable development.
- Significant improvements are still needed on the harmonization of procedures/operations, data exchange and on establishing mechanism to enable maritime traffic information exchange between national IT systems and between national and local IT systems.

2.3.4 DIGLOGS

The main barriers identified by the project are the following:

- Barriers related mainly to big data management for freight and passengers mobility and traffic automation systems in multimodal transport flows.
- The digital gap between different players makes difficult the coordination among private and public players determining the impossibility to take common decisions.
- Barriers hindering the development of multimodality and passengers' services both in Italy and in Croatia, include:
    - infrastructure barriers (e.g. different power supply systems, low speeds, different rail gauges),
    - technical barriers (e.g. friction at transfer points, lack of standardization of equipment and loading units, missing information flows),
    - organizational barriers (e.g. lack of transparency, unclear responsibility in the transport chain),
    - financial and economic barriers (perceived high costs of investment in intermodal infrastructure),
    - logistics barriers (e.g. missing services, missing information about services, missing awareness of intermodal services),
    - cultural and adoption barriers in relation to the utilization of IT tools in logistics.

2.3.5 Barrier Identification summary

The project identified a wide array of barriers hindering the promotion of multimodality and environmental sustainability in the Programme area. The most often quoted ones are lack of coordination, insufficient integration, heterogeneous and not-harmonized procedures, imbalanced level of hard and soft infrastructural development, high degree of institutional segmentation, insufficient financing, heterogeneous ICT development. Human resources are available, although there is still a high margin for improvement.

By reading the description of the existing barriers in the 4 projects, spanning over the timeframe 2019-2022, it is not easy to understand whether there has been progress in overcoming those barriers. To be able to answer, it is suggested:

- To describe in more detail each barrier, identifying the object, the subject or the procedure that hinders a more efficient functioning of the system.
- To develop metrics\indicators that could the measure strength of the barrier. Both objective and subjective indicators might be useful.

It goes without saying, that the stakeholder participation is essential to properly identify, describe, and measure each barrier.

2.4 Pilot actions

2.4.1 TRANSPOGOOD

The project partners have performed two main pilot actions.

Construction of the TRANSPOGOOD platform

- The platform was implemented as a set of collaborative information services. It provided tools to plan and manage transport and supply chain services on a multi-provider and door-to-door context.
- The aim of the platform was to help find the best solutions for transport according to the following metrics: best price of combined transport, lower emissions of entire chain, e- procurement tools for maritime transport services, higher bi-directional load factor.
- The platform provided 4 level of services:
    I. Informative: it provided information about costs and intermodal services based on standard tables provided by shipping lines. It is like the google maps path-finding algorithm but calibrated for truck users and considering intramodality.
    II. Strategic procurement: users were informed that is possible to use specific business platforms to obtain a price quotation of desired transport services. Links to several platforms were provided. As pilot application, for the project's duration, real market data was used as test bed. This allowed to have a benchmark of real market costs related to connections between Italy and Croatia.
    III. Spot market: users were informed that is possible to use a specific platform to make spot transport requests and obtain price quotations.
    IV. Connection with PCS: as pilot application, real time data from Ploce PCS will be displayed. Data are mainly regarding parking availability. Data are sent through xml format.

Training courses were organized to improve human capital.

- The courses were offered at 3 levels: technical and transversal skills, unemployed, managers. The courses capitalized on previous projects. More specifically, with INTERMODADRIA project, financed by the IPA Adriatic, and supporting the promotion of quality jobs in ports, to increase the attractiveness of port professional profiles, avoiding the risk of lack of skilled and qualified workforce. The web-portal, managed by CFLI, was enriched and re-organized within the TRASPOGOODS project.

2.4.2 PROMARES

The project performed actions in three main areas.

Developing an in-depth cross-border study

- Development of the study was done by analyzing each territory in detail, a dedicated training seminar and the elaboration of a cross-border action plan, to be tested through pilot actions

Testing ICT solutions

- For streamlining freight transport in the ports and the most relevant intermodal logistic node of the Programme Area, from the port to the hinterland and at cross-border level, setting standards that may be replicated to other logistic nodes, also beyond the project's geographical scope. In particular, ports focused on their Port Community Systems, as scalable and powerful tools to increase communication and coordination among terminal and logistic operators and public institutions. This is the list of the pilot actions by project partner:
    - **LP – Port of Trieste Pilot action 1:** Creation of a new module of the PCS Sinfomar dedicated to the management of the movement of goods between external Free Zone areas outside the Port of Trieste, using data from existing cameras both for rail and road transportation to ensure the traceability of goods.
    - **LP – Port of Trieste Pilot action 2:** Extension of the PCS Sinfomar to manage the external buffer areas belonging to the zone under the control of the Port Network Authority of the Easter Adriatic Sea.
    - **PP01 AdSMAS Port of Venice:** Enhancement of the railway telematics system for shunting operations (SIMA) and its integration with PCS and information system of other subjects involved in the developing rail services.
    - **PP03 RRT-TS Interporto di Trieste:** Improvement of the Sinfosec system to provide dry port services for the Port of Trieste.
    - **PP05-AdSPMACS Port of Ravenna:** Develop a new "Rail Module" for the PCS of the port of Ravenna
    - **PP06 AdSPMAC, Central Adriatic Port Authority:** Definition of the technical, operational and ICT requirements for the tracking and monitoring of the container traffic at the commercial dock of the Port of Ancona.
    - **PP07 AdSPMAM – Southern Adriatic Sea Ports Authority:** Development of a software solution able to monitor the embarkation and disembarkation from ferry boat of people and private/commercial vehicles (trailer/container). The solution will be able to provide structured data regarding the transit flows.
    - **PP09 PRA – Port of Rijeka:** The existing passage control system on different entrances needs to be updated.
    - **PP10 PPA – Port of Ploce Authority:** Upgrade of existing ICT solution, that can be used as prerequisites in the requirements engineering process for the purchase of AIS Base Stations and a Traffic Image Application (application for VTS and SAR operations). The aim is upgrade and develop system for better control and management in all areas, focusing on ship arrival/departure procedures and gate in/out procedure covered within Entrance Terminal.

Setting up a long-term cross-border cooperation network

- using a simultaneously and innovatively a bottom-up (from stakeholders to policy makers) and top-down (from policy makers to concrete action) approach.

2.4.3 INTESA

The INTESA projects set up 10 pilot action, summarized below:

- **PILOT LP - THE NORTHERN ADRIATIC SEA PORT AUTHORITY (NASPA):** Pilot study to improve nautical accessibility and nautical safety through the implementation of navigation aids based on geo-localization, high precision cartography and real time AIS data sharing; precision antennas and tablets that combine the most advanced Portable Pilot Units available on the market (PPU), with dedicated training for pilots. Ultra-detailed cartography was created, both in "static" and "dynamic" versions with aerial photographs and aerial photogrammetry of the port areas, together with the creation of a topographic database based on aerial photographs and digital models in relief at a scale of 1: 2,000, in close collaboration with Water Management Authority of the Venice Lagoon and Veneto Region.
- **PILOT PP03 - PORT NETWORK AUTHORITY OF THE EASTERN ADRIATIC SEA:** integration of port's PCS with.
  - electronic and smart monitoring of the natural harbour: exact positioning of the ships waiting to moor at the port and management of particular weather conditions.
  - Management of anchor duties: status of payment, automatic management of income request and calculation of the amount.
  - Electronic management of customs late corrections: standardization of customs declarations concerning goods data and motivations of the corrections.
  - Integration with the Vessel Traffic Service (VTS): call sign or MMSI, date and time of communication, docking point and ship position.
- **PILOT PP04 - CENTRAL NORTHERN ADRIATIC SEA PORT AUTHORITY:** The pilot action aims at improving the nautical accessibility and nautical safety through:
  - Test of new PPUs for efficient and safe pilotage;
  - Collection of real time meteorological and hydrological data from 9 stations installed along the canal;
  - Improvement of Port Monitoring System;
  - Test of aquatic drones for the measurement of bathymetry;
  - Improvement of a software for the calculation of the carbon footprint of vessels calling the port.
- **PILOT PP05 - CENTRAL ADRIATIC PORT AUTHORITY:** installation and testing of innovative equipment to improve navigation aids and rescue operations at Sea. More specifically:
  - the upgrade of the technical equipment of the Pilots of the Port of Ancona to improve the navigation in restricted waters and heavy fog conditions, through the purchase of 3 portable pilot units and the updating of software and electronic nautical charts;

  - the naval simulator upgrade for the training of students and professionals: navigation in bad weather conditions, piloting of last generation of ships, updated cartography of the ports of Ancona, Ortona and Pesaro;
  - the upgrading of IT equipment of the Port of Ancona Harbour Master for search and rescue activities.
- **PILOT PP06 - SOUTHERN ADRIATIC PORT SYSTEM:** purchase and installation of five tide gauges equipped with software in the multiport system of Bari, Brindisi, Manfredonia, Barletta and Monopoli, and the subsequent connection and integration with the current GAIA Port Community System or Vega system (one of the most advanced in Italy).
- **PILOT PP07 - Rijeka Port Authority:** The Pilot action aimed at improving, extending and upgrading the VHF (Very High Frequency), AIS (Automatic Identification System) and VTS (Vessel Traffic Services) systems for the acquisition and exchange of data to better manage the port operations. Through: a) the installation of additional base stations with the required capabilities in order to allow the coverage of VHF, AIS and VTS systems in the areas currently 'uncovered'; b) the coverage of the Rijeka basin with a thermal imaging system for monitoring small boats that are not required to have AIS.
- **PILOT PP08 - Port of Ploče Authority:** Upgrading of existing ICT systems with upgrade of PCS message broker and incident management system related harmonization and orchestration of data exchange between NSW and local systems. The Port Community System exchanges data relating to the integration with the AIS Base Stations and the Traffic Images Application for the Vessel Traffic Services Center and Search and Rescue operations (SAR) and Port Maritime Rescue Sub Center (MRSC).
- **PILOT PP09 - Split Port Authority:** selection and purchase of technical equipment for measuring weather conditions: buoys with sensors in order to measure changes in the air and sea and the different meteorological conditions to enable the ship safe navigation, mooring and anchoring, with the final aim of protecting the environment of the port basin. Educational workshops for port users: new legal guidelines (rule-book) that take into account various weather and air-pollution conditions.
- **PILOT PP10 - Croatian Ministry of the Sea, Transport and Infrastructure:** upgrading the Maritime National Single Window (HR MNSW) in order to guarantee and provide administrative data exchange - available in electronic format - with local port IT systems via web services. The interconnection of systems (i.e. Port Community Systems) facilitate the information exchange on cargo, ship waste and ship berthing, thus reducing ship waiting times in ports thanks to faster administrative clearances. It facilitates the workflow of the Ports. It involves the cargo and waste terminal concessionaries in the reporting process and realize electronic exchange of special request forms in port, as well as all other reporting formalities.

2.4.4 DIGLOGS

The project carried out 7 action pilots that are classified as follows:

- Process informatization trends in the programme area:
  - Pilot 1: WMS 4.0 – Dry Port Case Study (PP2 - Elevante)
  - Pilot 3: Mobile Safety/Security (PP4 - UNITS)
  - Pilot 5: Innovative solution for Access Control (PP8 – Port of Šibenik Authority)
  - Pilot 6: M2M Dialogue (PP9 – Port of Rovinj Authority)
- Big data for freight and passengers' mobility:
  - Pilot 4: Application for Data Flows Management (PP7 – Port of Rijeka Authority)
  - Pilot 7: Spatial Data Management System (PP1 - CFLI)
- Traffic automation systems in multimodal transport:
  - Pilot 2: PCS automation – Deliveries Planning (PP5 - Actual, PP6 – Polo Inoltra)

More in detail:

- The Pilot WMS 4.0 – Dry Port Case Study (PP2 - Elevante) took place in the intermodal rail-road terminal of Gorizia (SDAG), Friuli Venezia Giulia Region, Italy, mandatory transit point of the freight traffic flows between Western and Eastern EU (and also of most Italy/Croatia freight flows). The pilot related to the test of a web application that is going be used by carriers, Multimodal Transport Operators (MTO), dry ports and public authorities in the Programme area. It implemented an information system delivering data about intermodal appointments in the nodes.
- The Pilot Mobile Safety/Security (PP4 - UNITS) investigated the technical feasibility of a system for aiding ship evacuation based on Bluetooth beacons have been investigated. The pilot system is composed of a mobile application to be installed on mobile wearable devices (smart bands) and a backend application to configure and monitor the system from the ship bridge. The APP exploits a Bluetooth beacon net to enable mobile devices unauthorized.
- The Pilot Innovative solution for Access Control (PP8 – Port of Šibenik Authority) - is new digital access control system, that encompasses stakeholders whose activities are aimed towards processes underlying passengers disembarking and boarding cruisers and passenger ships, port concessionaires, business personnel, vehicles, drivers, containers and other stakeholders within identified target groups.
- The Pilot M2M Dialogue (PP9 – Port of Rovinj Authority) consisted of upgrading the existing maritime traffic control system. The new system is interconnected with all of the port's stakeholders and serve as an intermediator with the National Single Window's – CIMIS.
- The Pilot Application for Data Flows Management (PP7 – Port of Rijeka Authority) acquired new VTS equipment to improve boat resolution and visibility, and by showing port basin situation to end stakeholders and passengers and enhancing safety in the area.
- The Pilot Spatial Data Management System (PP1 - CFLI) improved the Spatial Data Management System for the North Adriatic Sea Port System Authority with represents a centralized and

interoperable spatial data repository used for the internal processes and shared with external operators and institutions.

- The Pilot PCS automation – Deliveries Planning (PP5 - Actual, PP6 – Polo Inoltra is an IT solution, based on Big Data and PCS automation, aimed at better planning multimodal deliveries, based on real-time and predicted traffic conditions, service prices, transit times, schedules & ITU requirements comparisons, automatically suggesting or enabling selection of best travel routes before or during the trip. The tool is a specialized Decision Support System that calculates and suggests routes by processing normalized real-time data coming from external sources and systems used by the port community. Deliveries planning solution can be connected to the existing Port and Maritime information systems both as sources and as targets of the Delivery Planning Solution.

2.4.5 Review and summary of the projects pilot actions

The 27 pilots identified in the 4 Italia-Croatia INTERREG projects are classified. **Errore. L'origine riferimento non è stata trovata.**, **Errore. L'origine riferimento non è stata trovata.**, **Errore. L'origine riferimento non è stata trovata.**, and **Errore. L'origine riferimento non è stata trovata.** classify them by area of intervention. The items of classification are not mutually exclusive. For instance, a pilot might deal both with technology and education, or deal with both land-side and sea-side port issues.

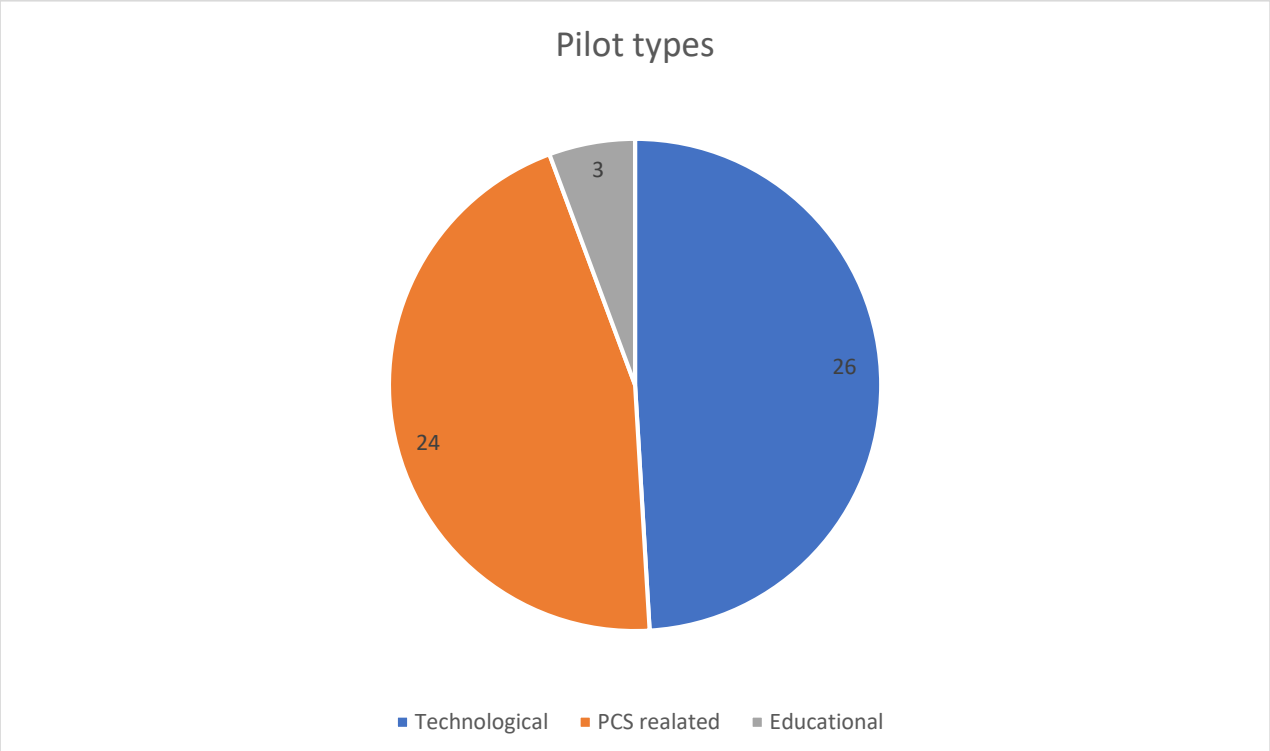

Figure 1 Pilot types

It can be seen from **Errore. L'origine riferimento non è stata trovata.** that almost all of them are technological (26 out of 27) rather than educational (3). Of the technological ones, 24 out ot 26 are PCS-related. The parallel development of technical and human capital is certainly needed for a successful implementation of the pilot actions.

Simlarly, with regards to the ports' PCS. They are the core of port digitalization which makes a lot of sense that most of the pilot actions focus on PCS development, improvement, and extension. The development of multimodal transport needs an enhanced interaction between the ICT systems operated by the public and the private companies. It is suggested that the interplay between the two system be considered for futher development of the pilots.

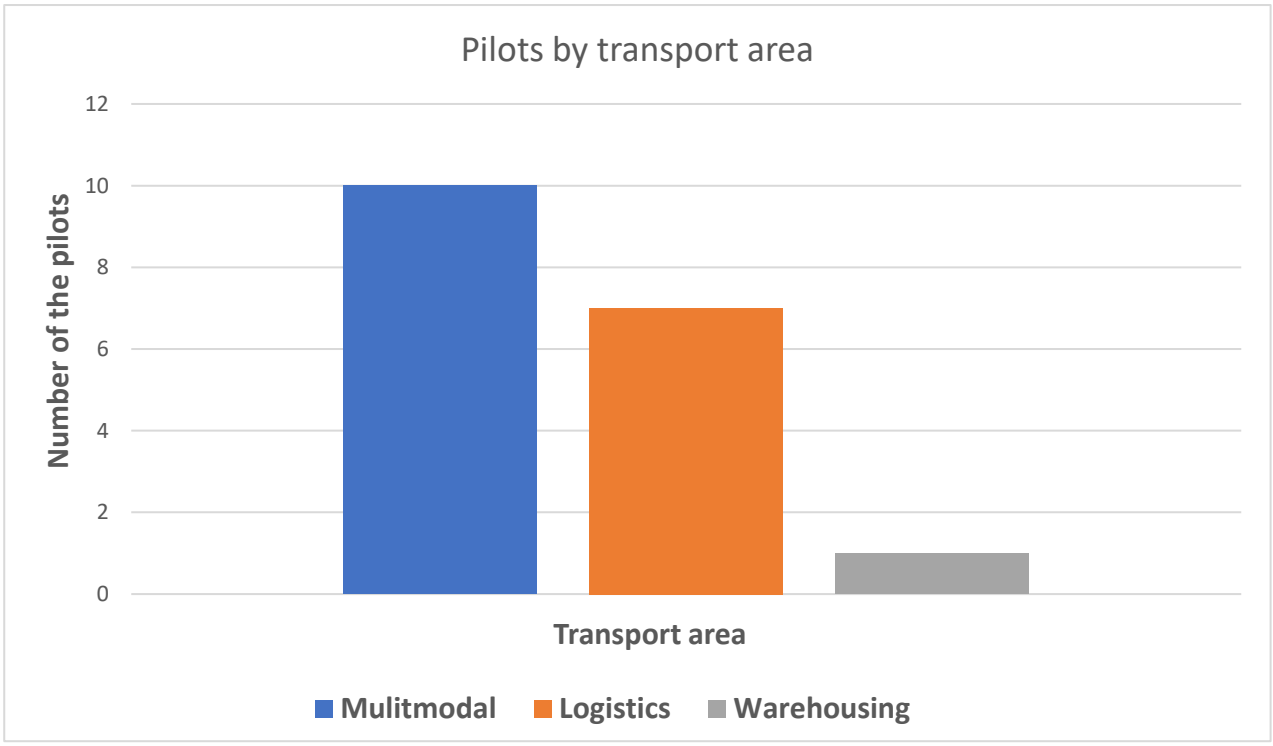

Figure 2 Pilots by transport area

Errore. L'origine riferimento non è stata trovata. reports which part of the supply chain are investigated. It r esults that 10 pilots deal with multimodal transport, 7 focus also on logistics aspects and only 1 incorporates aspects relate to warehousing. Such a distribution depends on the general aims of the INTERREG programmes. The low number of pilots dealing with warehousing should be considered and interpreted with attention. Warehousing is not as relevant in the modern supply chains as in the ones of some centuries ago.

It would be interesting to better understand the ratio between moving and standing time in moder supply chains. The use of modern technologies such as IoT should greatly facilitate the task.

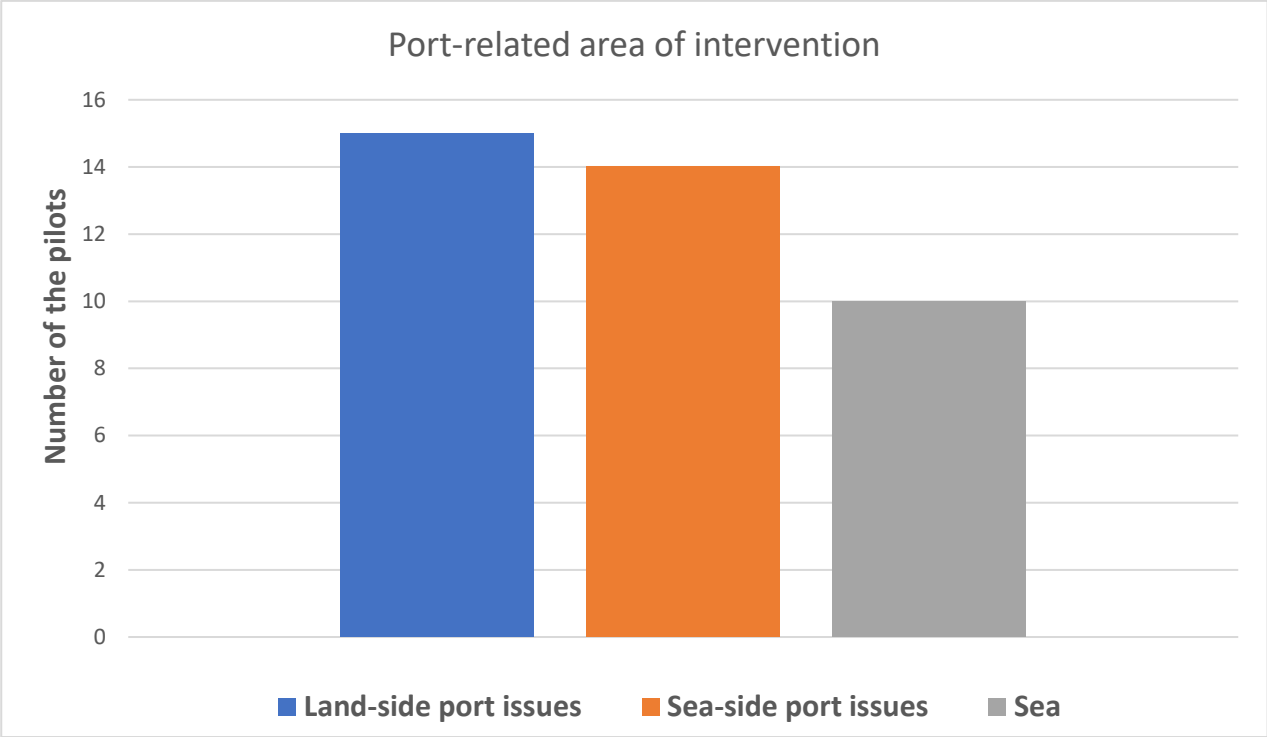

Figure 3 Pilots by port-related area of intervention

Errore. L'origine riferimento non è stata trovata. classifies pilots according to the port related area of i ntervention. Land-side connections of the ports are investigated by 15 pilots, and sea-side connections by 14. 10 pilots deal also or only with sea-realated issues such as safety and accessibility. In the case, the distribution among the three identified areas is well-balance and properly represents the importance of each supply chain leg.

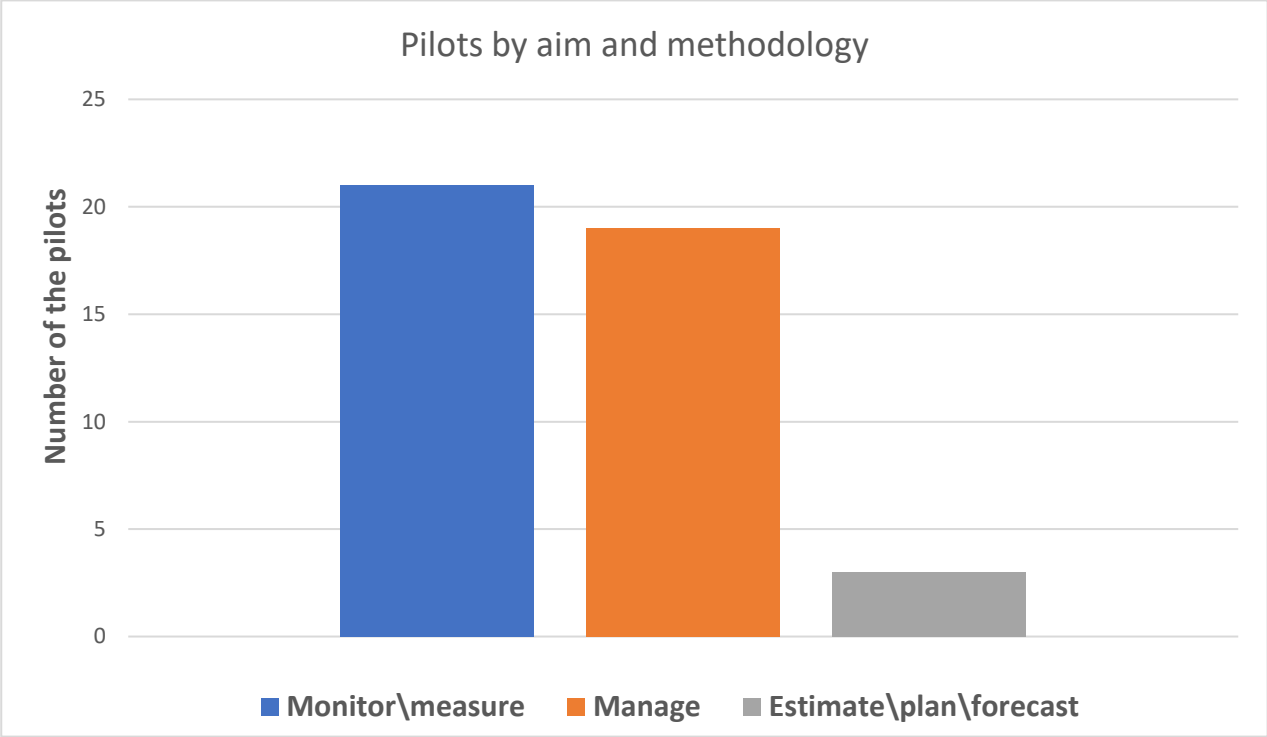

Figure 4 Pilots by aim and methodology

Errore. L'origine riferimento non è stata trovata. classify the aims and methodologies used in the pilots. The l arge majority aimed at improving monitoring\measuring and managing port-related events, while only 3 deal with estimating, planning and forecasting.

The overwhelming larger number of pilots devoted to monitoring\measuring or managing movements flows and accesses\exits is justified by the need to improve the knowledge and the efficiency of the supply chains and intermodal transport. Estimating, planning and forecasting is performed in some major pilots such as the TRANSPOGOOD platform, the PCS automation – Deliveries Planning (PP5 - Actual, PP6 – Polo Inoltra) and the pilot of the Central Northern Adriatic Sea Port Authority: improving nautical accessibility. Understandably, estimating, planning and forecasting are difficult task. They require developing a model, estimating or calibrating its parameters, perform within-the-sample tests and out-of-the sample forecasts. Furthermore, the models need to be updated and\or modified in light of the rapid and drastic changes affecting supply chains. It is a daunting task, whose scope go beyond the time-frame and the capability of a usually three year project. Yet, estimating, planning and forecasting is crucial for strategic planning and for medium-to-long term investments.

2.5 Projects results

Achieved results from the projects have been provided within this section.

2.5.1 TRANSPOGOOD

The project achieved two main results.

The TRANSPOGOOD platform

The platform is implemented as a set of collaborative information services. The platform provided tools to plan and manage transport and supply chain services on a multi-provider and door-to-door context. The platform represented an innovative ICT tool to find the best solutions for transport according to the following metrics: best price of combined transport, lower emissions of entire chain, e-procurement tools for maritime transport services, higher bi-directional load factor. The platform provided 4 level of services:

- Informative: it provides information about costs and intermodal services based on standard tables provided by shipping lines. It is similar to the google maps path-finding algorithm but calibrated for truck users and considering intramodality.
- strategic procurement: user is informed that is possible to use specific business platforms to obtain a price quotation of desired transport services. Links to several platforms are provided. As pilot application, for the project's duration, real market data is used as test bed. This also allows to get a benchmark of real market costs related to connections between Italy and Croatia;
- spot market: users are informed that is possible to use a specific platform to make spot transport requests and obtain price quotations. Links to the platforms are displayed;
- connection with PCS: as pilot application, real time data from Ploce PCS will be displayed. Data are mainly regarding parking availability. Data are sent through xml format.

Training course to improve the human capital, also taking advantage of the fact that the young generation has embraced digital lifestyle. The courses were offered at 3 levels: technical and transversal skills, unemployed, managers. The courses capitalized on previous projects such as INTERMODADRIA, a project within the IPA Adriatic. The INTERMODADRIA portal, created and managed by CFLI has been, implemented, reorganized, and enriched.

2.5.2 PROMARES

The main result achieved by PROMARES will be the enhancement of maritime and multimodal freight transport in the Programme Area. PROMARES will result in:

- increased technical knowledge and transport planning competences of all the ports generating intermodal and multimodal freight transport as well as the most relevant intermodal logistic node of the Programme Area for enhancing maritime and multimodal freight transport

- Improved capacity of all the ports generating intermodal and multimodal freight transport as well as the most relevant intermodal logistic node of the Programme Area to streamline freight flows through the use of low-cost and highly efficient ICT tools, also by upgrading the Port Community Systems and ICT systems aiming at a better communication and coordination with port stakeholders (private and public) at node and at cross-border level.
- Establishment of a multilevel and multidisciplinary cooperation network among transport stakeholders and policy makers, through a convergent bottom-up (from the needs of the territories to the policy actions) and top-down (from the policy actions to the implementation of measurable and concrete low, medium and long-term transport facilitation measures) approach. Ultimately, by increasing the competitiveness and productivity of maritime and multimodal freight transport, PROMARES will result in an increase of goods transported by sea and rail in the Programme Area.

2.5.3 INTESA

INTESA aimed at improving the quality, safety and environmental sustainability of marine and coastal transport services and nodes, by promoting multimodality between Italy and Croatia at large, creating a technological integration of the two National safe navigation systems.

The project optimized port operations/procedures, short-sea shipping capacity and improved links to the mainland network. It improved coordination and harmonization of data sharing via AIS ASMs messages. For first-time, Italian and Croatian Authorities jointly defined common guidelines for real-time AIS National Systems and the sharing of Application Specific Messages.

2.5.4 DIGLOGS

The project achieved various results listed below.

Result 1 - WMS 4.0 – Dry Port Case Study (PP2 - Elevante)

The Pilot Action WMS (Warehouse Management System) 4.0 implemented a Decision Support System (DSS) in the form of an open-source platform providing optimized transport arrangements for last-mile transport segments, by making use of specific algorithms and coordinated data from multiple stakeholders. By allocating specific time slots to trucks via a booking system, it proved that the terminal operator is able to optimize:

- the flows of incoming vehicles (specifying the gate, vehicle inspection, potential parking slot where to wait, etc.);
- resources utilization and operations management to the expected volume;
- traffic conditions to the terminal premises and surrounding areas;
- communication between the terminal and the drivers informing on delays, etc.

The next step is the implementation of Truck Appointment System (TAS), which will enable a communication exchange between the inland terminal and truck operators, and to support the terminal manager in the optimum scheduling of operations.

Result 2 - Mobile Safety/Security (PP4 - UNITS)

The Pilot Mobile Safety/Security (PP4 - UNITS) proved the feasibility of accelerating ship evacuation through the adoption of mobile technology is feasible. The tests carried out with a sample population showed a mean reduction of evacuation time equal to 16.9% when some of the escape routes are not available.

Result 3 - Innovative solution for Access Control (PP8 – Port of Šibenik Authority)

The Pilot Innovative solution for Access Control allowed for increased speed of permit processing, the development of an application suite for suitable and individual needs (police, Web, mobile application), increase cost efficiency in comparison to "off the shelf" products, modernized permits issuing and checking process and the introduction of structured reporting module and capability.

Result 4 - Application for Data Flows Management (PP7 – Port of Rijeka Authority)

The Pilot Application for Data Flows Management: a) improved the monitoring system allowing to exactly pinpoint every small vessel or other vehicle present or approaching the passenger terminal; b) provided a dedicated, custom made Web client application displaying in real time the inflow of small and large vessels approaching the passenger terminal.

Result 5 - M2M Dialogue (PP9 – Port of Rovinj Authority)

With respect to currently used solutions, the new system realized with the Pilot M2M Dialogue enabled faster and more efficient business processes, eliminated the need for using several non-interlinked services in order to keep track of all business-related activities, enabled greater level of autonomy while reducing the possibility of error occurrence due to human factors.

Result 6 - Spatial Data Management System (PP1 - CFLI)

The new centralized data infrastructure, realized with the Pilot Spatial Data Management System, eased collaboration between employees and stakeholders and the sharing of data processing results. The new Spatial Data Infrastructure is more reliable and effective, and improved the speed and quality of the decision-making processes. It enabled spatial based web services and system integration both of internal tools and with external actors' web platforms.

Result 7 – PCS automation – Deliveries Planning (PP5 - Actual, PP6 – Polo Inoltra)

The DDS developed within the Pilot allowed for: integrated information on routes (rail-sea-road) & ITU's compatibility; automatic cost, transit times and emission calculations, taking into consideration the different emission classes for rail, sea and road options; improved re-routing options, based on the current traffic and weather situation; automatized emission calculator, and full cost-transit time-emission comparison for different service ITU, for an improved selection.

2.5.5 Summary of the project results

The projects reviewed achieved an impressive number of results which definitely increased nautical and port safety and efficiency in port operations, thus reducing congestion, containing environmental risk and unfavorable impacts on the environment and the surrounding urban settlements.

Most results have been achieved via the adoption of technological innovations, both hardware and software. Very often, the goal was to improve and extend the PCS, as a monitoring, informing and coordinating tools for all stakeholders active in the port community.

Some forecasting tooled were also developed. For instance, within the TRANSPOGOOD project, a platform was developed to help find best solutions for transport shipments according to metrics such as the best price of combined transport, lower emissions of entire chain, e- procurement tools for maritime transport services, higher bi-directional load factor. Within the DIGLOGS project, the Pilot PCS automation – Deliveries Planning developed an IT solution, based on Big Data and PCS automation, aimed at better planning multimodal deliveries, based on real-time and predicted traffic conditions, service prices, transit times, schedules & ITU requirements comparisons, automatically suggesting or enabling selection of best travel routes before or during the trip.

Further efforts, as suggested in the INTESA project, could be made by extending the use of Internet of Things (IoT) technologies, the use of drones, and Truck Appointment System.

Organizational innovations were introduced through standardization and integration procedures aiming at a better connectivity within ports and between ports, both at the national (e.g., the National Window System) and international. It is an on-going and probably never-ending process and effort to overcome the specificities of each port and its specialization. A useful organizational innovation, as suggested in the INTESA project, is the experimentation of Fast corridors as organizational innovation aiming at streamline customs procedures.

Some of the projects and pilots stressed the importance of improving human resources via training and education, as required by the increasing digitization and digitalization. The use of modern interactive teaching techniques, both on and off the job might provide continuous improvements and re-training of the labor skills.

3. WHAT WE HAVE LEARNED

The Adriatic ports are highly heterogeneous in terms of specialization, areas served and the level of development. Policies and measures need to take such a heterogeneity into account and be more port specific. As learned from past projects, there is no solution that fits to all stakeholders and ports.

Within the development of the simulation platforms, example from the TRANSPOGOOD platform, they are feasible and can provide useful results. Update and maintenance of these kind platforms require a high level of collaboration and proper funding.

Updating and extending the existing communication and internet-connected devices is not particularly challenging and expensive. The economic sustainability issue might be more challenging than the technological one. To fully take advantage of all its potential, technological improves should be spread among all stakeholders.

IoT technology and cloud computed are a natural way forward which needs to be pursued and there is a large potential for improving human resources.

The collected data need to be organized in proper repositories. Human capital issues might arise, but they can be overcome, provided that the importance of data collecting, and sharing is properly understood and agreed upon.

Data sharing within and between port is still a challenge that requires further experience

Further in text we will try to provide the scope of conclusions from the projects that could be a good lesson point for future projects

3.1 TRANSPOGOOD

- Ports are highly heterogeneous in terms of specialization, areas served, level of development.
- ICT improvements are needed and quite easily implementable at port level. On the other hand, it is still challenging to implement coordination and integration at national and international level.
- The TRANSPOGOOD platform can be realized and maintained, provided a given level of collaboration and the necessary funding.
- There is a large potential for improving human resources, given the good propensity to learn digital skills and the e-learning opportunities (see the website lavorareinporto.it)

3.2 PROMARES

Four key messages have been highlighted by the PROMARES Project:

- the need to sustain an integrated governance, that enables a factual sharing of best practices, transport planning competences, data and ICT solutions to overcome the weak coordination and communication of all stakeholders, both between each port and its hinterland and between ports at cross-border level.

- The uppermost importance of the Port Community Systems in the capacity to manage effectively and coordinately both people and freight transport flows that are going in and out from the nodes of the logistic multimodal chain.
- The powerful effect of ICT lever, compared in terms of investment cost with the physical infrastructures. Lower costs can produce bigger results especially in the first phases of a process re-engineering.
- The great attention that, nowadays, has to be paid for ensuring a solid Cyber Security of PCSs and related suites, especially in the direction of a higher opening-up with stakeholders and new players

3.3 INTESA

The cooperation among governing bodies and the harmonization of the procedures showed that it is possible to effectively increase safety and maritime/nautical accessibility, regardless of the size and level of traffic of the port in question. These goals have been achieved also thanks to the addition of highly technological equipment and\or high level training involving stakeholders in sea-side operations.

In addition to these technologies, other helpful technologies suggested within the project to increase overall efficiency in light of the increased traffic volumes are:

- Internet of Things (IoT), that is a network of items that includes sensors and embedded systems which are connected to the Internet and enable physical objects to gather and exchange data.
- Drones, that is robots that collect data, either aircrafts or aquatic, remotely controlled or fully autonomous.
- Truck Appointment System (TAS) to decrease port operation's time and bottlenecks.

Organizational improvements such as fast corridors, e.g. immaterial infrastructures (by road or rail) that allow to simplify and streamline customs procedures to carried out in inland logistic nodes instead that in the ports are envisioned a way forward to achieve higher levels of efficiency.

3.4 DIGLOGS

Within the project, the different pilots experimented on different digital applications, reached different results and draw different conclusions. The remaining sections reports the main 5 constraints, bottlenecks, weaknesses and threats identified within each pilot and the suggestions on how to overcome or avoid them.

Within this chapter summarized suggestion are:

Lessons from the Pilot 1 - WMS 4.0 – Dry Port Case Study (PP2 - Elevante)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Initial assessment for personal training by using digital information;	By using user-friendly interfaces and clear and detailed user guides;
2.	Providing staff with computers, tablets, smartphones or other devices connected to the Internet;	Nowadays obtaining communication and internet-connected devices is very easy and not expensive;
3.	Digitization should be fully completed to have a full working WMS4.0 service;	Gradually making its use mandatory by all the actors involved;
4.	"Acts of God" - also known as force majeure events – are natural disasters (or other destructive events) which are utterly outside of human control;	Making periodic backups of the data to avoid their loss at any time. Backups must be periodically performed every few days so as not to block the operation of the system;
5.	Initial data digitization cost (digitization is the conversion process applied to the current system into a digital information);	Providing sufficient funding for the future development services.

Lessons from the Pilot 1 2 - Mobile Safety/Security (PP4 - UNITS)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Smartbands battery capacity is insufficient	Redesign smartbands to improve battery capacity
2.	Beacon battery capacity is insufficient	Connect the beacons to emergency grid and use battery as backup source of power
3.	Steel-made structure causes reflection problems	Uses limited signal power of sending beacons to avoid reflection issues
4.	Steel-made structure causes reflection problems	Limit as far as possible the number of active sending beacons per area
5.	A WiFi failure before activating the system can compromise its functionality	Include the WiFi network among the essential systems connected to the emergency grid or establish wired connection between beacons and backend

Lessons from the Pilot 1 3 - Innovative solution for Access Control (PP8 – Port of Šibenik Authority)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Custom solution built by a smaller vendor and as a consequence, highly dependent on the vendor availability	Liaise with the vendor, follow up its situation, timely plan for migration in case that the situation calls for it, ensure proper documenting of the pilot project and its future upgrades
2.	The solution requires maintenance and upgrades to continue functioning	Ensure adequate funding for the maintenance of the permit issuance system mid-term
3.	Budgetary project limitations have enabled on premise solution while hybrid or public cloud would be more flexible albeit much more costly	Timely study technical possibilities and identify possibilities for migration to the cloud as a part of overall IT strategy
4.	New technologies might render developed solution as obsolete	Follow technological trends for similar technologies as the ones used in the pilot project development
5.	Tentative adoption of a new maritime management solution might already include similar permit issuance module, that might displace developed solution within pilot project	Research possibilities to integrate existing solution with the future PCS system displacing need for generic PCS access control module to be implemented

Lessons from the Pilot 1 4 - Application for Data Flows Management (PP7 – Port of Rijeka Authority)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Custom solution built by a smaller vendor and as a consequence, somewhat dependent on the vendor availability	During preparatory phases, identify a reputable vendor even if smaller enterprise, that will be able to complete development and provide maintenance services
2.	Maintenance and upgrades are required for the pilot outcomes to continue functioning	For the anticipated duration of the project outcomes, reserve annual financial means and other resources for the maintenance and upgrades

3.	Parts of the equipment are installed in open space towards the sea and, as such, could be jeopardized by weather elements as the time passes, despite being IP-certified, increasing possibility for equipment failure and maintenance costs	Use adequate sheltering and purchase only adequate IP-certified equipment. Use shielded cabling and shelter/isolate the cabling and equipment appropriately
4.	Passengers need to be informed how to access information on the situation in the passenger port	Furnish Web pages and passenger spaces/areas with information, URL link and QR codes to be used to access the information. Use other means of promotion
5.	Application needs to be adjusted for usage in other ports	During subsequent development, try to standardize the mapping portion and create a standardized application to be used with other ports

Lessons from the Pilot 1 5 - M2M Dialogue (PP9 – Port of Rovinj Authority)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Marina Master is a turn-key solution with features that must blend with the existing ones or completely replace them	Timely and often costly endeavor requiring certain level of patience until the data is extracted from existing solutions and adapted to the new ones.
2.	Complexity of not having an integrated accounting service within the existing PCS	The situation presents as fairly unique as the implementation was successful until a certain point. External accounting services are mostly maintained the same until the development of the accounting service within the pilot's solution is fully capable of providing the service itself.
3.	Absence of general ledger	Ensuring that the general ledger has the capability of accepting the exports of journal entries from the system
4.	Requirements for invoice issuance	The current process requires a multitude of information in order to issue an invoice which is not always an easy task as the employees are often required to work in difficult weather situations. Facilitation will come through simplification or reduction of required data entries

5.	Difficulties regarding the connection to the national e-invoice system	Difficulties occur when the aggregate orders for payment of invoices are set to be exported through a bank. Avoidance is unacceptable but tweaks and further development from the developers is a key to overcoming the issue.

Lessons from the Pilot 1 6 - Spatial Data Management System (PP1 - CFLI)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Difficulty to collect data (get the up-to-date and most accurate data)	Create a workgroup to create a list of data, repositories, and responsible persons and draft a plan for the collection activities. Involve department directors.
2.	Resistance of employees to attend training activities	Carry on internal promotion events. Involve department directors, draft a training program in collaboration with the human resources responsible.
3.	Hard to obtain the right IT equipment dimensioning	Use a scalable platform. Oversize the hardware as much as possible. Execute stress tests, if possible, also during training activities.
4.	Resistance of employees to share data with others	Carry on internal promotion events in order to clear the advantages in data sharing. Use data shared from several departments in training activities. Involve department directors. Show some advanced results (data or applications) obtained integrating different data sources.
5.	Some advanced data management requiring external expertise	Consider different type of data management operations in master and detailed plans. Allocate special funds for possible external expertise needs.

Lessons from the Pilot 1 7 – PCS automation – Deliveries Planning (PP5 - Actual, PP6 – Polo Inoltra)

No.	Constraint / bottleneck/weakness/threat	How to overcome it or avoid it
1.	Weak system routing selection	Increase the number of services available in order for the system to find the best solution

2.	International services crossing Italy and Croatia are not considered by the system	Expand the geographical coverage
3.	The traffic and weather calculator may be ineffective	Link the system algorithm to reliable real-time traffic and weather portals
4.	Train and Ro-Ro delays are not reliable	Link the delay-calculation to actual tracking system mounted on intermodal open-access trains and Ro-Ro services
5.	Emissions-saving calculations may be subjective	Link the emissions saving calculation to a certified portal in order to formalize the procedure

4. CONCLUSIONS AND CAPITALIZATION IDEAS BASED ON THE REVIEWED PROJECTS

The INTERREG project reviewed have dealt with important issues hindering the development of modern IT-based logistics and the full use of multimodality in the Programme Area. Such issues include information gaps, insufficient or unequal application of ICT solutions, under-developed platform for information exchange and coordination, lack of standardization of documents and procedure, interoperability issues, and insufficient exploitation of the advantages of multimodality. The complexity of port relationships and the multinational dimension of the tasks make port digitalization and supply chain efficiency an even harder challenge.

The reviewed project clearly identified their goals. The two main general goals are:

a) developing the technological solutions, models and plans to establish the most advanced digitalized logistic processes for multimodal freight transport and passengers' services,
b) improving logistics quality, port and goods safety and security, and environmental sustainability. Such goals have them been specified at a more detailed and practical level such as: developing innovative ICT tools; updating the technological equipment; integrating and enhancing the PCS functionality; and exploring solutions for the port-land and port-sea interfaces and nautical safety and accessibility. In addition to the technical dimension, the goal of improving human capital has been properly conceived as of the utmost importance.

Capitalizing on the work done, the recent geo-political developments suggest integrating the above goals with three new challenges:

a) improve the resilience of the supply chains in face of epidemic and political issues.
b) develop strategies to counteract the climate change challenge.
c) straighten the ability of a port to act as clean energy hub.

The reviewed projects have clearly identified the main barriers. They have several dimensions ranging from infrastructural, technical, organizational, financial, logistics and cultural. Strategies and techniques to overcome them have been developed and implemented. Exploiting the work performed so far, it is suggested to develop metrics\indicators that could the measure strength of the barrier in order to monitor the effectiveness of the implemented actions.

The projects' partnership was mainly composed of public companies and agencies. All Port Authorities participated to the projects together with other relevant governing agencies, depending on the specific topic of the project. Some private partners were also involved. A greater involvement of private partner, for instance those involved in the supply chain (e.g., maritime and custom agents, terminal operators, warehouse operators, truck companies, railway companies, and shippers), either financed or without direct financing, could be considered in order to strengthen the port-land and port-sea interfaces.

The reviewed projects performed many interesting and effective pilot actions. The majority of the pilots were devoted to monitoring\measuring or managing movements flows and accesses\exits in the ports, with the

important aim of improving the knowledge and the efficiency of the supply chains and intermodal transport. The projects achieve important results and allowed projects' partners to learn from the project development and implementation. Crucially, they allowed to experiment and improve the PCSs and their ability to encompass the various aspects of port management, including port calls, custom duties, cargo and vehicle management, permits, security, and so on. Capitalizing on these experiences, a potential extension is to encompass data analytics and forecasting tools in order to strenghten the link between data collection and data use. More on this topic in the next sections.

The projects achieved an impressive number of results which increased nautical and port safety and efficiency in port operations, thus reducing congestion, containing environmental risk and unfavorable impacts on the environment and the surrounding urban settlements. The adoption of technological innovations, both hardware and software, improved and extended the PCS, as a monitoring, informing and coordinating tool for all stakeholders active in the port community. Organizational innovations were introduced through standardization and integration procedures aiming at a better connectivity within ports and between ports, both at the national (e.g., the National Window System) and international level. Some forecasting tooled were also developed. For instance, within the TRANSPOGOOD project, a platform was developed to help find best solutions for transport shipments, and within the DIGLOGS project, the Pilot PCS automation – Deliveries Planning, aimed at better planning multimodal deliveries. Taking stock of these experiences, it is suggested to:

a) extend the use of IoT technologies or drones to collect data in real time.
b) develop analytical and forecasting tools to support strategic planning decisions.

The projects taught very many important lessons. Some concern specific details of the project development implementation, other are more general and have been recalled in the previous sections. Capitalizing and exploiting the experiences gained in the projects reviewed could take place along two non-exclusive paths:

- Retesting and consolidating the previous experiences, avoiding past mistakes while introducing gradual improvements. Such improvements could attempt to: a) adapt the innovation to the port specificities; b) include in the innovation process new port stakeholders along the supply chain (ships, truck, trains, etc.) ; or c) strengthen the inter-collaboration.
- Introduce and test innovations dealing with the new challenges facing modern ports such as resilience, climate change and rising energy costs. These topics are further discussed in the next sections.