Interreg

EUROPEAN UNION

Danube Transnational Programme

DIONYSUS

Integrating Danube Region into Smart & Sustainable Multi-modal & Intermodal Transport Chains

WPT2.4: Danube Port Digitisation – Strategy & Action Plan

Output O.T2.3

Version: 2.0

Date: 17/10/2022]

[Status: final]

Project co-funded by European Union Funds (ERDF, IPA, ENI)

Document History

Version	**Date**	**Authorised**
1.0 (draft)	02.09.2022	EHOO
2.0 (final)	17.10.2022	EHOO

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Table of Contents

Table of Figures

Abbreviations

Abbreviation	Explanation
EHOO	Ennshafen OÖ GmbH
DR	Danube Region
WPT2	Work package T2
DTP	Danube Transnational Program
RIS	River Information Services
PDM	Pro Danube Management
ICT	Information and Communication Technology
MPAC	Maritime Port Administration Constanta
AIS	Advanced Information Services
PMS	Port Management System
PCS	Port Community System
RPA	Robotic Process Automation
HPA	Hamburg Port Authority
PDC	Port Development Company
HMS	Harbour Master System
VPAS	Verejné prístavy, a.s. / Public ports, JSC

Executive Summary

Inland ports play an important role in IWT (Inland Waterway Transportation) sector. As there is a significant impact of ICT technologies on transport-related business, starting from fast and secure information exchange to the full automatisation of certain operations processes, Danube ports have to prepare themselves to integrate digitalisation in their daily business in a step-by-step approach.

This report represents an overview about digitalisation status quo of **Sea ports and Inland ports** as well as the results of a survey and questionnaire also done within the DIONYSUS project. It was dealing with internal needs of port authorities, solutions for the needs of harbour master, as well as fully integrated solutions and solutions supporting port operations and interactions with port actors.

An overview of the current **EU policy and legislative framework** for waterborne transport digital transformation shows up the various regulations as well as developments of RIS COMEX project Idea dealing with the implementation of the directive into the waterway business are highlighted in one chapter. Furthermore, digitalisation Initiatives support the process of integrating digitalisation in Danube Region Ports like the European Green Deal and NAIADES3.

While Seaports in Europe especially such as Rotterdam, Amsterdam, Hamburg, Antwerp, Barcelona, Valencia, etc. are frontrunners in the digitalization transformation/adoption trend, inland ports start with the digitalisation process in a smarter way, that needs a **special tailor-made approach** and must be developed in a bottom-up way.

The **SWOT analysis** illustrates that the strategy for digitalisation in Danube Ports is based on a strong process orientation and process ownership. A **shell-like approach** (**shell-model** under 9.1.1) is very recommended as well as a step-wise implementation with between steps of validation and feedback loops. It starts with the core processes of a port business in the centre and allows – if needed - enlargement and interconnections to other processes which are not in the fare core business or connections to other process owners who are not necessary in the ownership of the port authority itself (but may be in the ownership).

The realisation of the first step, **the PMS** (**Port Management System**), is described under 9.1.2, which must be realized in a very simple way to support daily business of skippers, harbour masters and partners for transhipment process. In further steps this PMS may be developed into the next stages (PCS / Port Community System).

Finally, the **Strategy & Action Plan** for digitalisation approach in the Danube Region Ports is devided into a short-term, mid- and long-term chapter where the stepwise approach of the digitalisation implementation in inland ports especially along the Danube is described in detail.

As the process of digitalisation is not without some downsides such as the exposure if information to hackers also other topics related to port digitalisation especially Cybersecurity & IWT as well as emerging technologies for overcoming operational challenges for ports are described in this report.

In the final conclusions is again highlighted the fact, that the digitalisation of port processes has to focus on the really core processes of the port business like vessel management within the port, transhipment activities of cargo between water and land, as well as all other corresponding items of harbour master activities in order to get a state-of-the-art harbour master book.

1 Introduction

1.1 Scope of the report

Facilitating the full integration of Danube ports into the multimodal transport chains of the DR is the main objective of WPT2 within the DIONYSUS project. The global economy is gradually increasing the demand for efficient cargo transfers. Being a connection point between two or more transport modes, ports are considered as main nodal points of multimodal transport chains. However, to achieve full integration in these transport chains, the connectivity and accessibility of the ports to the local/national, regional, and EU/international transport infrastructure networks are of vital importance.

The Danube and its navigable tributaries offer significant free capacity for freight and passengers flows. A prospering waterborne transport sector contributes to a sustainable transport system and regional growth. Besides better fairway conditions, a more modern, energy-efficient fleet, better management of the transport system through comprehensive infrastructure planning and investment solutions are required. The investment needs refer to port infra and superstructure, multimodal connections to port hinterlands.

New technologies are rapidly changing the transport and logistics landscape, thus requiring all actors involved in the logistics chains, including inland and seaports, to become more innovative and smarter. Therefore, one work package of Dionysus project focused on developing a framework which shall outline the prerequisites, and necessary steps to be taken by Danube Region port authorities towards enabling the highest level of digital innovation of the Danube Sea and inland ports, by means of an Integrated Danube Transport Corridor Digitalisation Strategy and Action Plan (digitisation is a first step and a prerequisite when changing from analogue to digital data), which contains the actual document. Digitalisation trend in the logistics and transport sector and the resulting challenges for the ports will be addressed through Port Digitalisation Strategy & Action Plan which derives from the following:

- To this end, first a stock-taking exercise and subsequent assessment of the current digitalisation capabilities and needs of the DR ports (ICT-Infrastructure and digital services, digital skills etc.) was carried out by means of a survey coordinated and designed by VPAs with the direct support of PDM.
- Furthermore, an overview of the current EU policy and legislative framework for waterborne transport digital transformation was delivered within D.T2.4.1. In this context, to ensure synergies and capitalisation special attention was given to past DTP/Interreg Projects' outputs and lessons learned (DAPhNE, DBS Gateway) and ongoing digital development initiatives and projects (RIS deployments, Rhine Ports Information System (RPIS)) and the EU Digital Inland Navigation Area (DINA), and other digitalisation projects along the TEN-T Rhine-Danube Core Network Corridor etc.
- Identification & Dissemination of digitalisation initiatives along the logistic chains in line with the RIS deployments and the outcome of the inventory on port digitalisation capabilities were done by PDM (D.T2.4.2).
- Additionally, a study on enabling a faster and more sustainable communication between Danube Inland & Sea Ports boosted by Robotic Process Automation have been elaborated by MPAC (D.T2.4.3) applying a multimodal approach.

1.2 Objectives

There is a significant impact of ICT technologies on transport-related business, starting from fast and secure information exchange to the full automatisation of certain operations and processes. For Danube ports, digitalisation is a new topic and they should follow the lead of the digitalisation development level of major European sea and inland ports. The main goal of the

Integrated Danube Transport Corridor Digitalisation Strategy & Action Plan is to outline the main steps and implications for the Danube Region port authorities in their capacity as key enablers of the digitalisation process at port organization and port community level and give attention to the following:

- KISS: keep it short and simple,
- cost-benefit calculation is very important / low-price-segment of port business > no high sophisticated expensive technology solutions,
- tailor-made principle and step-wise approach,
- better coordination of ship, rail and truck modes of transport through digitalisation, to accelerate processes and make them environmentally friendly,
- optimization of slot management in the Danube Region for all transport modes.

2 Status Quo – Digitalisation in general, Sea ports and Inland ports

2.1 Digitisation & Digitalisation

Digitalisation refers to enabling or improving processes by leveraging digital technologies and digitized data. Therefore, digitalisation presumes **digitisation**. Digitalisation increases productivity and efficiency while reducing costs. Digitalisation improves an existing business process or processes but doesn't change or transform them. That is to say, it takes a process from a human-driven event or series of events to a software-driven one.

Digital Transformation is really business transformation enabled by digitalisation. The process of digital transformation implies new qualities. The acceleration of innovation speed enabled by the technological connection of people and objects, the enormous potential of data collection and analytics, sensors and the mobile accessibility are examples of aspects which need to be considered when talking about digital transformation.

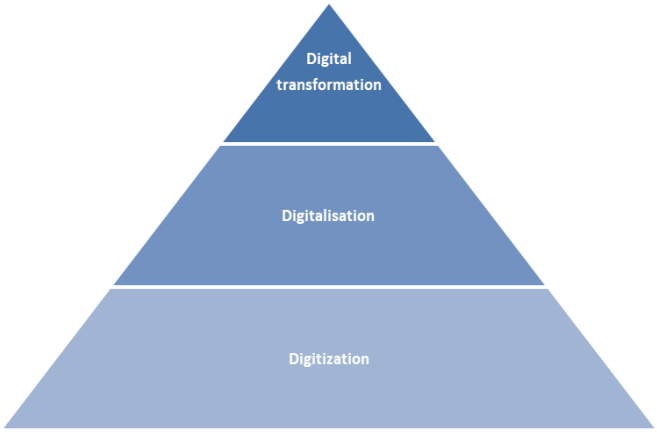

Figure 1: digital transformation pyramid

Digital transformation must remain linked to the objectives and strategies of the Port Authority/Administration, combining practices and techniques to generate new value proposals.

There are three main axes in which the developments carried out by Port Authorities are being framed for the digitalisation of the sector and for the application of new technologies in the logistics-port area:

- **Digitalisation of systems**, implementing new technologies in all port areas, allowing sustainable management of port operations and services, using for this purpose all the capacity and power offered by ICT.
- **Deployment of integral technological platforms** to standardize and integrate the different systems that are part of a port, to turn the port into a more efficient, innovative and oriented to user service using a Smart Port concept.
- **Changes in logistic and transport parameters, including the elimination of intermediation and the improvement of modal exchange, in** order to improve the competitiveness of transport chains based on automation and on robotization.

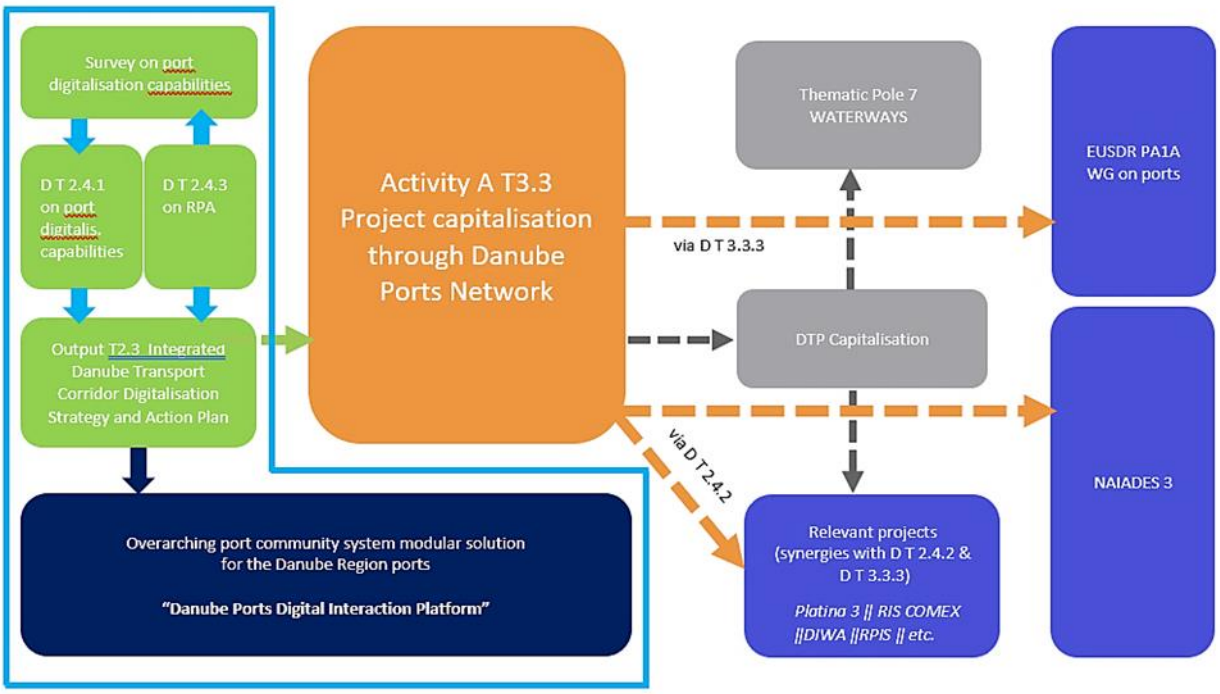

Figure 2: Synergies between digitalisation and capitalisation activities

2.2 Port Community System / PCS

(Source: Platina report D4.3 report on requirements towards digital and automated inland navigation tools from the infrastructure operator and user perspective)

PLATINA is a coordination and support action aimed at the promotion of inland waterway transport (IWT), where we could find in the report D4.3 very good description for Port Community System.

A port community brings together all port actors with a dedicated interest and involvement in a certain port activity. Starting from port authority/administration/PDC to terminal operators, shipping lines, shipping agents, forwarders, inland transport operators (road, rail, barge), stevedores, navigation authorities, customs, other authorities, financial and insurance companies and representatives of the civil society, the port community requires a solid platform built upon existing stakeholders' relationships which shall enable intelligent and secure information exchange.

According to the International Port community Systems Association (IPCSA), a PCS is an electronic platform which connects the multiple systems operated by a variety of organizations that make up a port community. It is a modular system with functionality designed to provide all the various players within a port community environment with the tools specific to them, thus delivering a tightly integrated system. Developed for port users by port users, a PCS in general provides a huge range of services and key features which can be summarized as follows:

- Easy, fast and efficient information exchange, re-use and centralization, availability "34/7/365" is probably typo
- Customs declaration
- Electronic handling of all information regarding import and export of containerized, general and bulk cargo
- Status information and control, tracking and tracing through the whole logistics chain

- Processing of dangerous goods
- Processing of maritime and other statistics

To this end, a PCS optimises, manages and automates smooth port and logistics processes through a single submission of data and by connecting transport and logistics chains, being acknowledged as the most advanced method for the exchange of information, interconnecting multiple information management systems within a single or national port community infrastructure.

2.3 Harbour Master System / HMS

(Source: Platina report D4.3 report on requirements towards digital and automated inland navigation tools from the infrastructure operator and user perspective)

PLATINA is a coordination and support action aimed at the promotion of inland waterway transport (IWT), where we could find in the report D4.3 very good description for Harbour Master System.

Another important system is the Harbour Master System. The safety of navigation for any vessel utilizing the port and its approaches is the Harbour Master's primary concern. Harbour Masters regulate the manner in which vessels conduct their navigation in port (including also recreational boating – visiting yachts, tour boats operators, power boats, etc.).

From port calls to determining the berthing of vessels, provision of pilotage and tugs, confirmation of mooring resources, liaison with stevedores on the ETA/ETD of the vessel to enable them to plan their resources for loading/discharge effectively, key loading/discharge plant and equipment availability and reliability, security requirements and liaison with other authorities (such as port state control, customs, veterinary agencies, health agencies, environmental agencies, local government and utilities) where necessary, all these are functionalities of a harbour master system.

2.4 Digitalisation in Sea Ports

(Source: Platina report D4.3 report on requirements towards digital and automated inland navigation tools from the infrastructure operator and user perspective)

PLATINA is a coordination and support action aimed at the promotion of inland waterway transport (IWT), where we could find in the report D4.3 very good description for Digitalisation in Sea Ports.

Seaports are forerunners in the digitalisation transformation/adoption trend. Several ports around the world have introduced digital programs as part of their strategic agendas. In Europe, several seaports such as Rotterdam, Amsterdam, Hamburg, Antwerp, Barcelona, Valencia, etc. have already built-up impressive experience in dealing with new technologies in most cases for their container terminals.

The **Port of Hamburg** has conducted tests with 5G, the next-gen communication network in diverse applications. Sensors on ships were installed to transmit movement and environmental data in real time across large areas of the port. In another test, the port linked traffic lights to the mobile network in order to control traffic remotely through the port, as well as improving safety and efficiency processes. A third trial allowed the port to access all the data it collects outside of existing networks, transmitting 3D data to an augmented reality application. The success of the trials could lead to more secure links between ports and logistics companies and provide the foundation for a more intelligent- Internet of Things (IoT) -supply chain.

The **Port of Amsterdam** first introduced its Digital Port Programme in 2017. By making data available using digital services, the port became more transparent for users and was able to handle vessels more quickly and intelligently. The port was also the first to create a test zone for

aquatic drones and more recently trialled a new monitoring system to explore drone usage in its airspace.

The **Port of Rotterdam** includes software tools that enables port authorities to manage their port operations more efficiently and safely and reduce costs on the assets. The solution encourages collaboration and coordination between all port users, allowing for faster handling of ships, trains and inland vessels. This leads to a strengthening of the port's competitive position. Port Forward additionally offers digital solutions for shippers, freight forwarders and traders who want to increase their insight and control of their logistic chains. Consider for example a smart route planner that displays all the transport options from the coast through to the hinterland.

The **Port of Antwerp** has centred its operational improvement plan on NxtPort, an "information sharing system." The goal for its use of NxtPort, which allows the port to share information with companies like BASF, MSC, Katoen Natie, DP World and PSA, is to " become a self-sustaining data-commercialization company that will gather, centralize, store, analyse and exchange data from a wide variety of logistic actors." Eventually, customs, governmental agencies, food quality control, and IT app developers will be able to access the information on the platform as well. The port also plans to monetize the data it is receiving from the system, which will help "individual users reduce costs through better planning." Moreover, not only will this generate more income for the port, but it will also improve logistics, lower truck exhaust emissions, and reduce the number of containers in depots. The Port of Antwerp is also exploring the use of blockchain for container collection, which will allow "digital rights" to be transferred from one party to another, which means only one party can pick up the container, rather than anyone with a PIN number. This will reduce fraud by validating the container transfers.

The **Spanish Port of Valencia** has been named the smartest port in the Spanish port system, leading the ranking in categories such as environment**.** The port of Valencia has been trialling since 2018 Internet of Things (IoT) technology aimed at improving its operational efficiency. For example, truck fleets have been equipped with dedicated IoT devices, allowing for near real-time tracking of movement of vehicles in order to help the port authority predict and manage potential congestions, as well as to anticipate truck arrivals at the gates. The Port of Valencia installed black boxes on "200 cranes, straddle carriers, trucks and forklifts" that collect a variety of data "such as their location or energy consumption, which could help terminal staff find ways to reduce idle time. The information from the black boxes is analysed in real time and shared with terminal staff to "identify operating bottlenecks and initiate appropriate action." The anticipated results of the black boxes include lowering operating costs by 10% by "reducing equipment idle time and minimizing energy use." Additionally, this port installed a smart illumination system that only light up when vehicles come in the vicinity of the port, which has cut energy consumption by 80%.

The **Port of Barcelona** uses the PortIC telematic platform, which connects the entire Port Community. This smart platform ensures "coordinated management of all the services provided in the Port's waters (pilots, tugs, mooring, provisioning, etc.); and the storm forecasting system developed jointly with the national authority Puertos del Estado." The port is also in the process of implementing a project to "collect Radar and AIS (Automatic Identification System) signals from vessels passing through the Port in order to anticipate possible incidents." This is expected to increase the port's safety. The Eco calculator, a tool in use at the Port of Barcelona, allows customers to "quantify their cargo's environmental footprint" and meet their environmental goals. Barcelona's Container Tracking Application allows the port and container owners to track "the physical process of a container, from the moment the vessel arrives, when the container touches the ground, is processed by customs, leaves the terminal and other points."

2.5 Digitalisation in Inland Ports

(Source: DIONYSUS deliverable D.T.2.4.1 Inventory on port digitalisation capabilities in the Danube Region)

Within the DIONYSUS project a report was elaborated where results of a survey are summarized that are giving input in the following chapters.

The European research **project PortForward**, which began in July 2018, has set itself a major goal. Under the direction of the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg, 13 partners from **Germany, Spain, Italy, Greece, the United Kingdom and Norway** want to develop new concepts in order to operate small and medium-sized ports with the help of digital solutions in a smarter, more networked and environmentally friendly way. Five European ports are involved in the PortForward project, where the new solutions will be developed and tested. The project, which will run until 2021.

RPIS 4.0 project - smart community system for Upper Rhine Ports aims to improve the performance and competitiveness of multimodal transport through the integration of digital solutions in the global supply chain and thus be able to promote modal reporting on clean transport modes such as inland navigation. Nine Upper Rhine Ports (**Ludwigshafen, Mannheim, Karlsruhe, Kehl, Strasbourg, Colmar/Neuf-Brisach, Mulhouse, Weil am Rhein and the ports of Switzerland**) have joined forces in order to promote the port locations in the trinational Upper-Rhine-region. The project aims to continue the good work of the previous projects and proposes 3 main actions: Modular extension of the RPIS traffic management platform for bulk cargo and river cruise; Development of new digital services; Cross-border community for sustainable logistics in the Upper Rhine region.

DataPorts - A Data Platform for the Connection of Cognitive Ports: DataPorts seeks to provide a secure environment for the **aggregation and integration of data** coming from the several data sources existing in the digital ports and owned by different stakeholders. As such, the whole port community could improve their processes, offer new services and devise new AI based and data-driven business models. To this end, DataPorts will design, implement and operate an Industrial Data Platform (Cognitive Ports Data Platform).

3 Results of Survey & Questionnaire

(Source: DIONYSUS deliverable D.T.2.4.1 Inventory on port digitalisation capabilities in the Danube Region)

Within the DIONYSUS project a report was elaborated where results of a survey are summarized that are giving input in the following chapters.

3.1 Internal needs of port authority / administration / PDC

Not surprisingly all analysed ports have fixed and stable internet connection, which is an inevitable condition for any kind of digitalisation and 5/17 ports include digitalisation and/or digital transformation in their port development strategies.

Annual budget for digital infrastructure varies from several hundred euro (e.g., Murfatlar) to tenths of thousands of euros (Bratislava, Ennshafen). The highest annual amount was indicated by port of Constanta (650,000 EUR) which is relevant to the fact that it is a combined (inland waterway and maritime) port.

In terms of software solutions used in ports and/or by port authorities, these solutions should be divided into subcategories. As expected, almost all respondents indicated standard office applications running under operational system Window such as Microsoft Office. Second category was accounting software, namely commercial software OMEGA (Bratislava), Oracle (Constanta), SAP (Ruse West) and state software for accounting, taxation, for operational, HR and inventory control (Izmail). Port operation itself is administered usually by inhouse solutions (e.g., Linz, Constanta), port of Adony indicated usage of Metrisoft, commercial application for weighing / dosing.

Asset management software is an important topic since it provides overview of the port assets, installations, maintenance, inspections, repairs, etc. 7 respondents indicated having an asset management implemented:

- Freeport of Budapest - defect repair system and software; inventory, fixed asset records
- Port Terminal Ruse West - SAP ERP system; GIS
- Port of Linz - in-house software solution
- Izmail - management of port assets
- Port of Constanta - Neptun (locally developed solution, based on Oracle forms)
- Ennshafen – BMD

Adony and Port Bulmarket - Ruse indicated high interest in the topic.

Another sub-area of focus was the **optimization of processes**. Any kind of process optimization must be based on process mapping. Process optimization is desired by the vast majority of respondent, however only 5 of them indicated the process mapping methodology in use. This is a sign that respondents understand the importance and see the opportunity for optimization. An overview of the best practices in this area could find its purpose and help partners to define the goals and strategy to undertake.

The **most important solution** to be made digitally available to DR ports customers was recognized as demand for availability and booking of mooring/berthing places, booking of tugboats or pilot services and sharing information about port dues calculation and water depth. Currently used solutions for booking such as phone calls and emails are outdated. Online application is only used in the port of Izmail.

Another important requirement was online availability and booking of onshore power supply facilities.

Currently the reservation of berths and other services are provided by email or telephone request, online application is used in the port of Izmail. Automatic invoicing is available only at 3 ports (Baja Public Port, Port of Linz and Izmail). Most ports are equipped with CCTV cameras.

3.2 Solutions to the needs of the harbour master

For the monitoring of vessels in restricted areas of the DR ports, the harbour masters are mostly using automatic identification system (AIS) - an automatic tracking system that uses transceivers on ships, supporting vessel traffic services (VTS). The vessels entering or leaving ports are not always digitally registered; if so, DR ports are using own automated digital solutions.

The communication between port and vessel is in most cases provided by phone, radio stations or even paper based. 16 from 17 DR ports deem necessary to have reliable solutions for predicting the arrival of vessels in the ports.

ETAs and ETDs of the vessels entering/departing from the port is digitally recorded in 6 ports (Murfatlar, Ruse-East, Port Terminal Ruse West, Port of Linz, Port of Constanta, Centroport) either via in-house solutions or standard office applications (MS EXCEL).

7/17 ports (Nikopol, Port Lom, Freeport of Budapest, Port Terminal Ruse West, Izmail, Port of Constanta, Centroport) have a communication platform in place to share information about a port call with other authorities involved (e.g., Single window, Bulris, Maritime Single Window, Port Community System, KSH Elektra), other ports use telephone, email and paper.

Port dues are mostly calculated manually or by software and there was identified demand for the solution to accurately calculate port dues with minimal administrative workload that allows an easy integration with the existing billing system. Murfatlar, Freeport of Budapest, Public port of Bratislava, Port Terminal Ruse West, Port of Linz, Port Governance Agency, Izmail, Port of Constanta indicated usage of software, for example ISSP (integrated fee management system), SAP ERP, Neptun ERP or inhouse solution. Other ports did not indicate usage of any dedicated software.

Only 4 ports (Murfatlar, Baja Public Port, Port Terminal Ruse West, Centroport) have digital overview with all information about vessel 's call (e.g., time spent in the port, service usage, etc.)

Data exchange and communication with other participants via a common platform between DR ports appears to be a suitable solution through which the individual requirements of the harbour masters for digitisation could be implemented.

3.3 Solutions supporting port operations and interactions with port actors

The survey showed that communication between vessel, shipper, harbour master and port authority is in most cases not provided digitally. The most common communication canal at ports is email or phone, in few cases it is still the paper-based communication. Similar is the communication between vessel, shipper and Customs.

Information on the status of Customs clearance can by followed in real-time only in 5 DR ports (Port Terminal Ruse West, Port of Linz, Port Bulmarket - Ruse, PGA, Izmail). 3 of requested ports are communicating with the vessels by RIS related to navigation, the remaining ports are using email communication or even do not have digital communication between the vessel, the shipper and the navigation authority.

7 ports (Port Lom, Port of Dunavecse, Baja Public Port, Adony, Port of Linz, Izmail, Centroport) can provide a real-time update on the cargo volumes and information on the loading and unloading status of vessels.

NOR and SOF reports are either paper based or provided by email. Data generated by the Gate in/Gate out procedure are stored digitally only in 3 ports (Port of Linz, Izmail and Ennshafen).

80% of the respondents do consider necessary to upgrade the traditional bill of lading, river waybill to an electronic format.

3.4 Fully integrated solutions

A Port Community System (PCS) handles electronic communication in ports between the private transport operators (shipping lines, agents, freight forwarders, stevedores, terminals, depots), the private hinterland (pre- and on-carriage by road, rail and inland waterways), the importers and exporters, the port authorities, Customs and other authorities. It optimises, manages and automates port and logistics efficient processes through a single submission of data and connects transport and logistics chains. This applies both to business-to-government (B2G) communication and to communication between companies (B2B).

To the question of how many ports use a PCS solution, only 3 ports are working with one (Nikopol, Port of Linz and Izmail), other ports communicate via phone or email. Only Nikopol has a PCS solution and the National Single Window integrated. Port Terminal Ruse West was the only one that reported digitally the exchange of information within the local port community. This exchange works under Bulris software. Storage & management of multimodal traffic data is in all DR ports still paper-based, whereas 13 ports indicated a combination of paper-based and digital solutions.

In 5 DR ports (Nikopol, Port Terminal Ruse West, Port of Linz, Izmail, Ennshafen port) port operators have real-time information about all possible hinterland connections.

5 DR ports (Freeport of Budapest, Baja Public Port, Public port of Bratislava, Port of Linz, Ennshafen port) track & trace container cargo. Cargo management solutions used were not revealed in general, since operators do not share such information. According to the survey, Port of Constanta uses SAP, Microsoft - Warehouse management system, Adony keeps track of stocks via weighing system.

Port clients in Nikopol, Port of Dunavecse, Port of Linz, Port Bulmarket - Ruse and Ennshafen port have the possibility of matchmaking the hinterland transport (based on the real time information on the availability of transport operators and their capacity).

Since there is only one combined (seaport / inland port) port in the group, there is no comparison possible in terms of data exchange between a Danube port and a seaport. According to information provide by Port of Constanta, the data exchange is provided via email.

DR ports are dealing with a lack in the field of automation, only half of the ports are using some type of an automated system. Invoicing and statistics purposes are identified as the most suitable and the most desirable applications for automation in the nearest future.

There was identified a significant demand for single PCS solutions for the DR ports, that will deal with exchanging information digitally in the port community.

Interesting information is that only 20% of ports offer the possibility of sharing information from RIS further into the port community, even though the majority of DR ports indicated regular usage of national RIS, mostly for tracking the position of vessels.

3.5 Smart solutions to enhance safety and sustainability

Sensors are the drivers of Industry 4.0 and the Internet of Things (IoT) in factories and workplaces. Once implemented at scale, the combination of sophisticated sensors and increased computational power will enable new ways to analyse data and gain actionable insights to improve many areas of operations (UNIDO, what can policymakers learn from Germany ‘s Industry 4.0 development strategy?2018).

Current status of monitoring among respondent partners is the following:

- Only four ports indicated active monitoring present at their facilities, Murfatlar, Bratislava and Freeport of Budapest (water depth) and Baja Public Port (water depth and purity).
- Port Terminal Ruse West, Centroport and Bratislava are planning to implement the monitoring of water depth and water quality (emission control).
- Monitoring in place in Baja Public Port and Murfatlar transmits measurements and information independently.
- In addition, 6 partners expressed their interest in installing smart buoys in the port.

Monitoring is very often in relation to waste management. Only 2 ports (Linz and Ennshafen port) have a digital overview of the waste in the port. Despite not having digital monitoring in place, 10 other partners see digital waste monitoring as useful.

Separate subcategory where monitoring is extremely important is handling of hazardous cargo. Here the rate of active monitoring among partners looks differently comparing to other types of monitoring. The common trend visible here is that handling of hazardous cargo is not the direct responsibility of the port / port authority. For example, Izmail and Ruse-East do not use digital solutions. In Freeport of Budapest, Port Terminal Ruse West, Port Bulmarket - Ruse and Port of Constanta monitoring is on the agenda of the respective operator (MOL - HU, Dalby – SK).

For handling of hazardous cargo there are procedures in place in all relevant ports, either in the form of emergency plans (e.g., Port Lom, Freeport of Budapest, Baja), official requirements / state emergency response plan (Port of Linz, Izmail), contingency plans for operators and Port administration (Constanta). In case of emergency in Bratislava, standard intervention units (police, firefighters, ambulance) would be alarmed. If emergency situation is in relation to water, the Transport authority would intervene.

To general question “whether it would it be useful to have a digital solution for administrating and monitoring dangerous goods in the port,” all relevant partners replied positively. 8 partners would even be interested in aerial (drones) support in hazard management.

3.6 Data management and cybersecurity

Data management solution (data integration, preparation, visualization, governance) for analysis, reporting or loading into other application purposes is currently being used in only 5 ports and in other 4 implementation is planned. Port Terminal Ruse West uses SAP and Archimed, Linz and Izmail are using inhouse IT solution and Port of Constanta uses Confluence, Neptun ERP and SIIP.

What can be evaluated very positively is the fact that all partners are familiar with the terminology of cybersecurity and its implications in the field of transport. On the other hand, IT strategy to cover the topic of cyber risk management & cyber threats mitigation was labelled as not applicable for 7 partners. Same number of ports answered positively (Port of Dunavecse, Bratislava, Ruse West, Port of Linz, PGA, Izmail and Port of Constanța).

Last sub-area assessed was cybersecurity. Among the partners we can observe significant reserves, since less than half of them see currently used solutions as reliable. The rest of the group is either not content or sees potential for the increase of reliability. Majority of partners (12/17), therefore see potential in establishing a cybersecurity governance framework within Port Community System.

Cybersecurity awareness may be supported by dissemination of activities of the European Cyber Security Agency (ENISA), since only 4 partners are familiar with it (Freeport of Budapest, Ruse West, Port of Constanta, Ennshafen port).

Thankfully only two ports from the group (Public port of Bratislava and Port Terminal Ruse West) indicated cyber-attacks happening. Public ports of Bratislava increased the protection on software level (antispam / antimalware software).

Terminal Ruse West hired a consulting company, formed a crisis team, and implemented the consultant's recommendations for solving the issues causing vulnerabilities.

3.7 Conclusion

According to the data collected with the support of the survey, which has been summarized and evaluated, the following conclusion have been formulated:

- Many of the tasks related to port operations is not digitalized and provided in an outdated way (emails, spreadsheets, phone calls)
- Communication platform among port stakeholders and private / public entities involved in port operation is missing in most of DR ports
- Instant digitalized monitoring of ports is mostly reduced only to CCTV, with no other information (water pollution, ongoing loading/unloading etc.)
- Reported cyber-attach rate is quite low. Fact, that less than half of DR ports see currently used solutions as reliable combined with low rate of IT trainings, there is a significant area for improvement in awareness.
- Survey showed not only room for improvement, but what is even more important is the will of DR ports to implement digital solutions for port operations, communication and monitoring of port assets.
- Invoicing and port statistics are identified as the most suitable and the most desirable for automation in the nearest future.
- Significant demand for a single PCS solution for the DR ports was identified.

4 Current regulatory and policy framework at national and EU level

An overview of the current EU policy and legislative framework for waterborne transport digital transformation was delivered within D.T2.4.1.

RIS Directive

Directive 2005/44/EC of the European Parliament and of the Council of 7 September 2005 on harmonised river information services (RIS) on inland waterways in the Community establishes a framework for the deployment and use of harmonised, interoperable, and open RIS. Member States must provide RIS users with the data necessary for voyage planning and electronic navigational charts for waterways and notices to skippers are provided as standardised, coded, and downloadable messages.

RIS Technical guideline

Commission Regulation (EC) No 414/2007 concerning the technical guidelines for the planning, implementation, and operational use of RIS lays down technical guidelines and specifications for RIS through five implementing acts:

- Commission Regulation (EC) No 414/2007 concerning the technical guidelines for the planning, implementation and operational use of RIS;
- Commission Implementing Regulation (EU) No 909/2013 on the technical specifications for the electronic chart display and information system for inland navigation (Inland ECDIS);
- Commission Regulation (EU) No 415/2007 concerning the technical specifications for vessel tracking and tracing systems (as amended by Commission Implementing Regulation (EU) No 689/2012);
- Commission Regulation (EU) No 164/2010 on the technical specifications for electronic ship reporting in inland navigation.
- Commission Regulation (EC) No 416/2007 concerning the technical specifications for Notices to Skippers.

Recent developments of RIS COMEX Project Idea

The RIS COMEX project deals with the implementation of the directive into the waterway business with special focus on:

- continuing harmonized RIS implementation in Europe,
- providing seamless services on Corridor / European level following the CoRISMa concept,
- establishing necessary framework for sustainable operation and
- ongoing stakeholder management and user integration.

These information services among fairway authorities, waterway users and logistic partners shall optimize the use of inland navigation corridors to

- enable reliable route planning by supplying dynamic and static fairway- and infrastructure information (level 1),
- enable reliable voyage planning and traffic management by providing traffic information (level 2) and
- support transport management of the logistic partners (level 3).

By these means the expected impacts are

- better plannability and reliability of inland waterway transports,

- reduction of administrative barriers and reporting burdens,
- reduction of waiting and travel times

and so leading to an overall increased efficiency of inland navigation transports.

The ambitious goals of the project will be realized by means of two common systems:

(1) EURIS System: gathers data from national data sources, provides fairway-, infrastructure- and traffic-related data, single point of access for the users and supports traffic and transport management on European level.
(2) CEERIS System: Central & Eastern European electronic Reporting Information System to reduce the reporting burdens and to enable "reporting only once" with "single entering of data".

Directive on technical requirements for inland waterway vessels

Directive (EU) 2016/1629 of the European Parliament and of the Council of 14 September 2016 laying down technical requirements for inland waterway vessels, amending Directive 2009/100/EC and repealing Directive 2006/87/EC maintains the European Hull Database (EHDB). This database contains selected information regarding inland waterway craft, including each vessel's unique European vessel identification number, its name, its dimensions, and an electronic copy of the vessel certificate.

Directive on the recognition of professional qualifications in inland navigation

Directive (EU) 2017/2397 of the European Parliament and of the Council of 12 December 2017 on the recognition of professional qualifications in inland navigation and repealing Council Directives 91/672/EEC and 96/50/EC facilitates the electronic exchange of information about crew members by setting up a system of national registers and a database to be kept by the Commission. Document contains data on crew members' Union certificates of qualification, service record books11 and vessel logbooks.

TEN-T Regulation

Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network establishes guidelines for the development of the trans-European transport network, which also consists of the infrastructure for inland waterway transport. Some of the Regulation's priorities deal with information and communication technology, such as implementing telematics applications (including RIS).

GDPR Regulation

Regulation (EU) 2016/679 and Regulation (EC) No 45/2001 replaces the Data Protection Directive (Directive 95/46/EC). As of 25 May 2018, it sets forth a single set of rules across the EU to protect and empower all EU individuals with regard to the processing of their personal data and to hold organisations processing personal data of individuals in the EU accountable for their processing activities. It gives powers to the competent supervisory authorities to impose corrective measures, fines and penalties on companies that do not comply with these rules.

Network Information Security (NIS) Directive

Directive (EU) 2016/1148 on security of network and information systems (NIS Directive) promotes collaboration between Member States and aims to develop their capacity to investigate incidents rapidly and raise awareness of vulnerabilities at national level. In addition, in September 2017, the Commission published a review of the 2013 cybersecurity strategy in

which it proposed that the EU Network Information Security Agency (ENISA) be granted a permanent mandate and that a voluntary scheme for cybersecurity certification and labelling be set up to create a cyber-resilient ecosystem.

eIDAS Regulation

Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market provides a clear regulatory environment to enable secure and seamless electronic interactions between businesses, citizens and public authorities. Electronic identification and trust services are key enablers for building a Digital Single Market Regulation ensures that people and businesses can use their own national electronic identification schemes (eIDs) to access public services in other EU countries where eIDs are available.

5 Digitalisation Initiatives

Digitalisation is indispensable for the future of IWT, for its efficient and enduring integration in the transnational transport and logistics system as well as for its degree of competitiveness. It represents a viable solution to considerably reduce administrative costs and to make a more systematic use of the existing resources of IWT infrastructure. Furthermore, digitalisation facilitates the expansion of new businesses, making IWT a more attractive mode of transport. With digitalisation undisputedly having an essential role in adequately adapting IWT to the most recent EU legislative framework in terms of climate neutrality, the goal of this chapter is to provide an overview on the existing policies linked to digitalisation. These policies and initiatives thoroughly analyzed here are reflected in the **Digital Initiatives Observatory,** an interactive e-tool accessible on the DPN website which became fully operational in Period 2 of DIONYSUS.

5.1 The European Green Deal

Introduced in December 2019, the European Green Deal is at the heart of the European Union's ambitious goal to become the first climate-neutral continent by 2050. It is a roadmap meant to foster the transition of the European Union towards a climate-neutral economy by reducing climate emissions towards 55% by 2030 and achieving carbon neutrality by 2050. The core objective of the Green Deal is to serve as "(...) a new growth strategy that aims to **transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy** where there are **no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use**" (European Commission 2019: 2, bold in the original).1 The main objectives of this policy framework can be summarized as follows:

1) Increasing the EU's climate ambition for 2030 and 2050;
2) Supplying clean, affordable, secure energy;
3) Mobilizing industry for a clean and circular economy;
4) Building and renovating in an energy and resource efficient way;
5) A zero-pollution ambition for a toxic-free environment;
6) Preserving and restoring ecosystems and biodiversity;
7) Farm to Fork: a fair, healthy and environmentally friendly food system;
8) Accelerating the shift to sustainable and smart mobility.

The highlighted objective is of particular importance for the digitalisation process of the Danube IWT sector. A shift towards smart and sustainable mobility can only be achieved by dedicated actions and measures to adequately support the efficient integration of IWT in the new digital era.

The figure below illustrates the central elements of the European Green Deal:

Figure 3: The European Green Deal. © European Commission

5.2 Sustainable and Smart Mobility Strategy

The Sustainable and Smart Mobility Strategy presented by the European Commission on 9 December 2020 lays the foundation for how the European transport system can achieve its green and digital transformation as outlined in the European Green Deal. The document outlines the development direction of the European transport policy in order to reduce greenhouse gas emissions and transport's reliance on fossil fuels. The successful implementation of the goals set by the European Green Deal depends on the sustainability of the transport system. Digitalisation is in this regard an indispensable driver for climate neutrality.

Important to highlight is the fact the European Commission recognizes the challenges faced by waterborne transport in terms of decarbonization due to the limited uptake of innovative technologies, an issue affecting both ports and vessels. Moreover, the document stresses the importance of ports as key facilitators of international connectivity and their capacity to become multimodal mobility and transport hubs.
The strategy is structured around three key objectives:

- Sustainable mobility: shift to zero emission mobility by making all transport modes more sustainable.
- **Smart mobility**: supporting sustainable choices by taking **advantage of digitalisation and automation** to achieve seamless, safe and efficient connectivity. Another ambitious plan is to **boost innovation and the use of data and artificial intelligence** for smarter mobility.
- Resilient mobility: reinforce the Single Market, make mobility fair and just for all, increase transport safety and security across all modes.

Of particular interest for the process of digitalisation of the Danube IWT sector is the objective Smart Mobility. To make "smart mobility" a reality, the strategy proposes the following flagships (key areas for action):

- Making Connected and Automated Multimodal Mobility a Reality
    - Take full advantage of smart digital solutions and intelligent transport systems (ITS).
    - Support the development of connected, cooperative and automated mobility.
    - Paperless options in all modes of transport.
    - Efficient capacity allocation and traffic management: further development of Vessel Traffic Monitoring and Information Systems (VTMIS).
- Innovation, Data and Artificial Intelligence for Smarter Mobility
    - Favorable conditions for the development of new technologies and services.
    - Research and deployment of innovative and sustainable technologies in transport.
    - Highest level and performance of digital infrastructure.
    - Data availability, access, and exchange.
    - European Common Mobility Data Space.

5.3 NAIADES 3

The NAIADES3 action plan seeks to "(...) shift more freight transport on inland waterways, and set the sector on an irreversible path to zero-emissions, underpinned by a **paradigm shift towards further digitalisation**, as well as accompanying measures to support the current and future workforce. Meeting these core objectives will require an integrated approach and a basket of measures incorporating transport, environmental, digital, energy and fiscal policies, backed up with financial incentives (...)".2 It was tailored to accomplish the ambitious climate goals of the European Commission, acting as the pillar of the pathway towards a climate-resilient, digital, and reliable inland waterborne transport system. Digitalisation plays in the frame of NAIADES3 a central role with a dedicated action plan to support the development of a smart inland waterway transport.

It foresees the following objectives:

- Revision of the RIS Directive (in 2022);
- Technical assistance for a permanent operational structure for a single point of access for the provision of RIS-based Corridor Information Services (in 2024);
- An integrated and operationalized vision for the digital transformation of the current traffic and transport related business models and processes in the sector (in 2023);
- CEF technical assistance project to strengthen public-private cooperation in inland waterway transport and facilitate implementation of the digital vision (in 2023);
- Facilitate the development, demonstration and the deployment of holistic Smart Shipping Concepts for the digital integration of inland waterway transport in the synchro modal supply chain, including RIS, through Horizon Europe and CEF (from 2022).

5.4 Report "Towards Future-Proof Inland Waterway Transport in Europe"

The report initiated by MEP Caroline Nagtegaal and adopted by the European Parliament recognizes IWT's crucial role in achieving the ambitious objectives of the European Green Deal. In achieving IWT's ultimate goal in becoming climate neutral, the report stresses that adequate "investments in expanding, updating and upgrading the physical and digital infrastructure of inland waterways" are essential prerequisites. Likewise important is the development of inland and seaports as multimodal nodes in the transnational logistics system as well as the human-resources aspects in providing appropriate working conditions, modernizing the inland navigation education and training system, and last but not least, to encourage the development of research and innovation within the sector.

The report dedicated a section to digitalisation and automation, highlighting that "(...) digitalisation and data collection can contribute to a cleaner environment and improved safety on board". Equally important, digitalisation is seen as a contributor to emission reduction stressing the need to provide adequate funding opportunities.

5.5 Digital Initiatives Observatory

Status: June 2022

Digitalisation is indispensable for the future of IWT, for its efficient and enduring integration in the transnational transport and logistics system as well as for its degree of competitiveness. It represents a viable solution to considerably reduce administrative costs and to make a more systematic use of the existing resources of IWT infrastructure. Furthermore, digitalisation facilitates the expansion of new businesses, making IWT a more attractive mode of transport. With digitalisation undisputedly having an essential role in adequately adapting IWT to the most recent EU legislative framework in terms of climate neutrality, the goal of this chapter is to provide an overview on the existing policies linked to digitalisation. These policies and initiatives thoroughly analysed here are reflected in the Digital Initiatives Observatory, an interactive e-tool accessible on the DPN website which became fully operational in Period 2 of DIONYSUS.

The Digital Initiatives Observatory collects information about digitalisation initiatives along the logistics chains in line with RIS deployments, EU digitalisation policy goals, legislation, and measures in relation to IWT. Hosted by the DPN website, the Observatory enables the visitor a fast and easy access to the most relevant information.

By means of digital filters, the visitor can select the information which interest him/her the most, choosing between the following pre-defined categories: country, transnational projects, policy initiatives, dedicated working groups and funding opportunities. The Digital Initiatives Observatory is fully operational on the DPN website since Period 2 of DIONYSUS and is continuously being updated by the team of PDM based on own research activities as well as on the input provided by project partners.

The figure below illustrates the Digital Initiatives Observatory which is available on the DPN website (www.danubeports.eu):

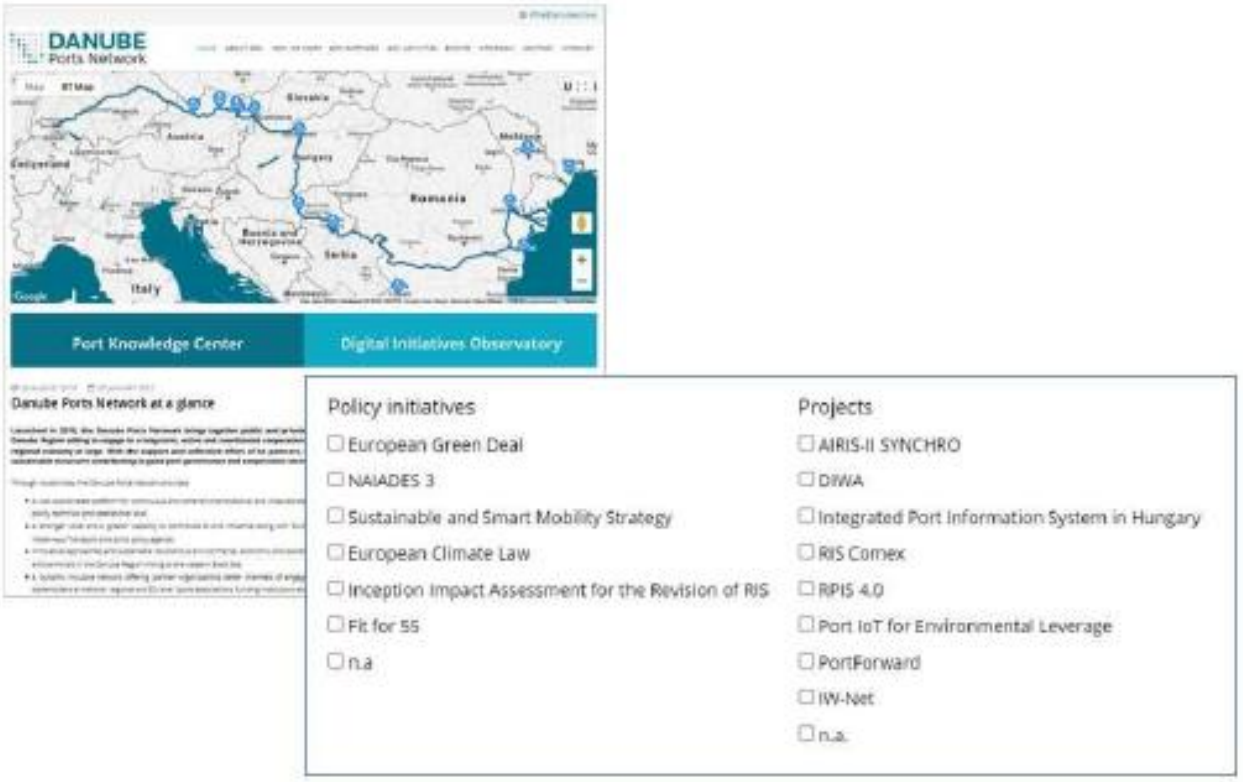

Figure 4: Digital Initiatives Observatory

6 Robotic Process Automation / Seaport Constanta RO

(Source: DIONYSUS D.T.2.4.3 Inter-Connecting Danube & Sea Ports digital infrastructure through Robotic Process Automation. A multimodal approach.)

Within the DIONYSUS project deliverable D.T.2.4.3 was elaborated from the project partners of Constanta, where Robotic Process Automation will be implemented in future.

Robotic Process Automation (RPA) uses the software technologies to automatically handle computer tasks that are repetitive, rules driven, tedious for employees. Usually, back-office employees, spend up to 80 % of work hours filling in forms, making repetitive calculations, processing orders or such routine activities.

RPA is a very good solution for optimizing processes, and reducing durations, but cannot be implemented in all cases. There are clear criteria that are to be followed. In addition, in order to benefit from a rapid ROI, the best fit for RPA implementation are processes that passed through a transformation initiative using the Lean Six Sigma methodology.

RPA is the use of software to handle high-volume, repeatable tasks that previously required humans to perform. Various port operators continue to use their existing applications without having a satisfactory level of alignment to the new EC requirements in regard to data exchange, such as Directive 2010/65/EU with its recent revisions or the European Maritime Single Window Environment (EMS We) initiative.
The study aims at leveraging port administration/authority attributes in order to trigger participative actions from the other Danube ports partners to summarize such existing applications and study the opportunity to make them "talk to each other"/exchange data through RPA. The study will go as far as gathering a list of used (digital) applications vs what processes could be digitalized and therefore generating more attraction/awareness to the project objectives.

The Robotic Process Automation for ports is a strategic approach/functionality, this ascending automation trend being introduced and developed during the recent years in order to improve port efficiency. As in the current programming period, important resources were allocated by EU to research innovation in the transport field, RPA being one of the studied technologies, it is proper to study how practically this could be introduced in the Dionysus Project area.

Conclusion

The study run has reached its objective in understanding how a more sustainable communication between and inside the Danube Inland & Sea Ports workflows could be improved by Robotic Process Automation (RPA).

Collecting data through different channels (questionnaire, interviews, process visits, desk research, etc.) the study has identified more than 2 solutions (as required) for an RPA solution implementation.

20 distinct processes were nominated, having a potential for RPA implementation. These processes were analyzed in depth and 5 have been proposed for being optimized with a RPA solution: Invoicing Process, Berth allocation process, Merchandise tracking (Loading/ Unloading/ Transhipment), Notice to enter/exit a port and Issuing port access documents / permits to access premises, the last one being specific to Port of Constanta and APDM Galati.

There are also other processes that, from the input type, the existing rules and the steps that are being made, would make sense to have an RPA implemented, but at this moment, due to the reduced volumes involved, they do not become economical candidates for such an implementation (e.g., Licensing process, Order handling, Process of making offers).

All processes identified have impact in the overall Dionysus objectives: Improve multimodalism, Enhance Supply Chain, Follow the requirements of EMSWe. From the data gather, the highest impact is on the Supply Chain objective. Multimodalism, still being applicable only in very few situations, as ports do not have the proper infrastructure yet.

For processes between port the survey shows that there is little of no communication between ports run at the port authority level.

We do recommend here the implementation of an RPA solution that could link systems like: River Information System, local standardized software or portals. RPA could be used for electronic data exchange to different authorities (port authority, Police, Customs etc.). This would be done in order to facilitate preparation of incoming ships from the destination port, with a direct impact in the supply chain objective and also to reduce processing information several times from the ship owners and other entities involved.

The RPA impact is essential in taking a decision of whether to implement it, or not. The RPA will not redesign processes by itself, but it will increase productivity, accuracy, consistency, reliability, it will ensure compliance, and increase customer satisfaction.

As identified in the study, the major pitfall for implementing an RPA for processes inside the port is the type of input that processes have. In case the document is not standardized, there is an obvious requirement to have a structured content in a standard document. If the input is not digital, a scanning and character recognition software could be implemented, at extra costs and still the risk of having items which are not recognized is high. The recommendation is to eliminate any handwritten document, and if paper is still required, at least to be a print-out of a document filled in digitally.

Considering the possible change that an RPA solution will bring people are to be considered in the implementation plan. Although IT literacy has improved over time, this representing a good platform of knowledge to move towards digitalisation, some of them will be afraid of implementing a robot on their desktop. The same happed also, when we introduced physical robots in the industrial area.

7 Related Topics

7.1 Cybersecurity & IWT

Given the ambitious climate goals of the European Union and the ongoing trend of globalization, the process of digitalisation within the IWT sector will be further accelerated.

The advantages of digitalisation are obvious: it streamlines processes, increases productivity and efficiency, reduces operational and administrative costs, and improves the competitive advantage – just to name a few. However, the process of digitalisation is not without some downsides such as the exposure of information to hackers.

New technologies will fundamentally change inland shipping. Therefore, crew members must develop special digital skills in order to operate and/or oversee semi-, or even fully automated operations in their daily activities. With COMPETING having the core objective to set the scene for the modernization and harmonization of professional qualifications in inland navigation as stipulated in the **Directive on the Recognition of Professional Qualifications in Inland Navigation**, the present document argues that cybersecurity must be fully integrated in the teaching materials of the European IWT education system.

General aspects of cybersecurity

- **Confidentiality** – this aspect refers to the fact that the ownership of information, services or system resources is not made available to unauthorized persons or processes
- **Integrity** – the property of maintaining the accuracy of information, services or network technologies.
- **Availability** – this means that the ownership of information, services, or system resources is accessible only to authorized persons or processes.

Confidentiality, integrity, and availability refer to the **content**. Nevertheless, besides the content, we may also be concerned with the **identity of other actors**, such as

- Authenticity – the capacity of ensuring the proper identification and authentication of persons, information and communication system devices and services. It "prevents actors from impersonating someone else, usually by providing others with a means to verify a claimed identity" (Herrmann/Pridöhl 2020: 13).

An even stronger protection goal is

- **Non-repudiation** – which prevents actors to deny that they have carried out a particular act such as sending a message or performing a bank transaction (Herrmann/Pridöhl 2020: 13)

A fundamental aspect of cybersecurity refers to the risk management of IT systems. The risks associated to any kind of cyber-attack mainly depend on 3 factors:

1. **Threats** – who is attacking? Who is responsible for the cyber-attack? Therefore, in case of an observed security breach within the IT system, identifying the "attacker" is essential in finding proper solutions to overcome and resecure the IT infrastructure.
2. **Vulnerabilities** – identifying the weakness of IT systems is another important aspect: if they exist, they are likely to be exploited. Protection against vulnerabilities considerably limits the potential attack surface.
3. **Impact** – what are the concrete consequences of the cyberattack on the system?

In a global and digitalised world, cybersecurity has become in many ways a race between defenders and attackers. Attackers constantly analyse the weaknesses of IT systems forcing defenders to have a watchful eye on any potential threats. A successful cyberattack might compromise the privacy, integrity and even availability of an ICT (**I**nformation and **C**ommunication **T**echnology) system.

Inadequate cybersecurity measures can lead to numerous harmful consequences such as obtaining financial, personal, or professional information without the knowledge of the victim. So-called Denial-of-Service (DoS) attacks can slow down or even prevent access of the legitimate users to computer systems. Attacks on industrial control systems can lead to the destruction or disruption of the equipment which controls them (Mihai/Ciuchi/Petrica 2018: 25).

ENISA – Institutionalising cybersecurity at EU level

Established in 2004 and strengthened by the EU Cybersecurity Act, the European Union Agency for Cybersecurity contributes to EU cyber policy, enhances the trustworthiness of ICT products, services and processes with cybersecurity certification schemes, cooperates with Member States and EU bodies, and helps Europe prepare for the cyber challenge of tomorrow. Through knowledge sharing, capacity building and awareness raising, the Agency works together with its key stakeholders to strengthen trust in the connected economy, to boost resilience of the Union's infrastructure, and, ultimately, to keep Europe's society and citizens digitally secure.

European Digital Identity – a new milestone in the EU digital world

The premise of internet is free exchange of information and partially this is also something that has been exploited by cyber criminals because at the very moment we do not have an opportunity to identify very clearly who we communicate with. There is currently no single trusted European digital identity that can be attached to individuals, to businesses or to machines. Therefore, in the attempt of creating a more secure cyberspace the premise of the trustworthy **European Digital Identity** offers the opportunity to create a safe internet environment where different partners can communicate with each other.

With the **eIDAS 2 Regulation**, cross-border e-ID identity will become reality. With IWT being a transnational transport mode par excellence, the possibility of implementing a truly European digital identity system might have a positive impact on transnational voyages within the EU by considerably facilitating swift border crossing keeping a European digital database of e-logbooks & e-service record books.

According to the European Commission, the European Digital Identity was elaborated in a way to be available to all EU citizens, residents, and businesses in the EU. The proposed regulation is fully compliant with the existing EU legal framework such as the GDPR, the NIS Directive and the Cybersecurity Act. It therefore aims to offer the **highest level of assurance,** preventing and managing potential security breaches, supporting a vast range of functions.

Citizens will be able to prove their identity and share electronic documents from their European Digital Identity wallets with the click of a button on their phone. They will be able to access online services with their national digital identification, which will be recognized throughout Europe. Very large platforms will be required to accept the use of European Digital Identity wallets upon request of the user, for example to prove their age. Use of the European digital Identity wallet will always be at the choice of the user.

The European Digital Identity will be:

- **Available to anyone who wants to use it**: Any EU citizen, resident, and business in the Union who would like to make use of the European Digital Identity will be able to do so.
- **Widely useable**: The European Digital Identity wallets will be useable widely as a way either to identify users or to prove certain personal attributes, for the purpose of access to public and private digital services across the Union.

- **Users in control of their data**: The European Digital Identity wallets will enable people to choose which aspects of their identity, data and certificates they share with third parties, and to keep track of such sharing. User control ensures that only information that needs to be shared will be shared.

The Regulation is currently undergoing the ordinary legislative procedure.

Conclusions

Cybersecurity is still a rather neglected field in the IWT education system.

To keep pace with other modes of transport and given that due to the ambitious climate targets enshrined within the European Green Deal, the process of digitalisation will be accelerated in all fields of activities. Therefore, the need to develop **strong digital skills** must be coupled with basic **knowledge in the field of cybersecurity**. The maritime sector has reacted in this sense and as such made cybersecurity awareness training mandatory by 1 January 2021. Our recommendation is that the IWT education system follows this example of good practice.

This deliverable provides, in a first step, a basic understanding of cybersecurity, proposing, based on extensive desk research activities, a definition of this concept. It furthermore provides a comprehensive analysis of the **status and role of cybersecurity in IWT**, highlighting that more work must be done in this field. The next chapter dealt with the European legislative framework on cybersecurity. Both the **NIS Directive** as well as the **EU Cybersecurity Act** are relatively new pieces of legislation and are considered the key pillars that shape cybersecurity within the European regulatory landscape. This exploratory study continued with the analysis of the role of **ENISA** – the European Union Agency for Cybersecurity. The website of ENISA hosts different studies dealing with cybersecurity which may be used to develop adequate teaching materials. Finally, still undergoing the ordinary legislative procedure, this study provided a brief description of the **European Digital Identity**, as part of the revised eIDAS Regulation. This is also an important aspect in the ongoing digitalisation process of IWT being strongly interconnected with different aspects of cybersecurity.

7.2 Emerging technologies for overcoming operational challenges of ports

Within the wider transport and logistics sector, more and more companies are experimenting with a range of connectivity and data-enabled technologies. In a post-pandemic scenario, ports worldwide are facing several challenges like the peaks in freight traffic, rising pressure to comply with stricter environmental targets and complex supply chain operations. Emerging technologies are necessary instruments for ports to overcome these challenges and gain a competitive advantage over their peers.

Internet of Things (IoT)

In aggregate, an example of such technologies forms the **Internet of Things** (IoT), which represent a convergence between the physical and digital worlds, ultimately using data as a source of value. It is expected that in the near future, all objects in the port – such as vessels, cranes, trains, trucks, containers, weather stations, pilot vessels, etc. – will become increasingly smarter and will be able to communicate with each other in real time through the Internet of Things platforms. With its ability to digitize the delivery process with the aid of smart sensors, IoT can monitor the condition of port equipment, keep track of temperature, gas and humidity levels and enable radiofrequency identification of containers, monitor the use of physical assets.

Blockchain

Blockchain is the next big technology for the ports of the future. Being the preferred technology for data security, it can establish the provenance or origin of cargo, enabling port authorities to maintain traceability, transparency and accountability of their transactions.

Big Data:

Unlocking **big data** from port operations makes it easier to optimise usage of resources and infrastructure. For example, a typical crane operator works only one quarter of the time, remaining le for the other three, waiting to get a container ready to load or unload. Increasing the number of trucks may not be a viable solution given the congestion it would cause. As such, big data analysis could synchronise movements, so that the crane operator works more time. For instance, signals related to crane position, status, and GPS position signals could sync movement of trucks and containers to reduce idling time. Also, cranes show different performance levels according to various factors such as skill of driver, workload, weather, container type and yard density. Understanding such patterns makes it possible to either find solutions to overcome the roadblocks, or sync operations to factor such limitations, ultimately enhancing productivity.

(S: Platina report D4.3 report on requirements towards digital and automated inland navigation tools from the infrastructure operator and user perspective)

Significant amounts of data are generated during digitisation, the value of which must first be recognized and leveraged - Systemic linking and processing with artificial intelligence; image evaluations, arrival times, waiting times (depots of empty container, packing stations...)

5G Technology – Processes must be digitally controllable in real time

Interconnectivity: priority platforms (provider-bound, commercially operated platforms / Access often complex and limited / user-rights...) to open networks, non-discriminatory networks

Internet of Things: Combination of different identification-, communication- and sensor-technologies that enable the real-time localization, status detection and communication of objects in logistic systems such as vehicles, devices and loading units with each other and via the Internet with various actors. Load-, vehicle- and device- movements as well as the status of goods, objects and technical systems can be determined in real time, communicated and made available for decisions and evaluations. Optimization of logistical flows and operational processes / also environmental optimization (e.g., predictive controls for reduction of power and energy consumption)

Artificial intelligence: Analyzes and forecasts for better decisions (e.g., camera system with KI / Tracking & Tracing

Use of drones for ports: e.g., Tests at the Port of Hamburg in the course of the PORTwings project

(Source:https://smartports.tv/a/project-spotlight-unmanned-vehicles-in-the-port-of-hamburg-portwings)

Each of the following vehicles has its own reason for existing and, based on their advantages, can be leveraged for a specific application. Within the PORTwings drone programme, the HPA is dealing with the implementation and introduction of tele-operated drones (UAV´s) in the port of Hamburg. Currently, the HPA is testing the system in the operational environments "disaster control" and "intelligent port infrastructure management". RoboVaaS (Robotic Vessels as a Service) intends to revolutionise shipping and near-shore operations by offering on-demand robotic aided services via small unmanned vessels (UVs) such as unmanned underwater vessels (UUVs) and unmanned surface vessels (USVs) to support coastal maritime operations. HPA's hydrographic department operates four survey vessels to map the continuously changing seabed within the challenging port area. As a force multiplier and high-end add-on, the autonomous surface vehicle “echo.1” is the unmanned twin of these multi-sensor vessels.

8 Realisation of digitalisation in Danube Region Ports

While digitalisation refers to enabling or improving processes by leveraging digital technologies and digitized data without changing or transforming them, as well as taking a process from a human-driven event or series of events to a software-driven one, digital transformation is business transformation enabled by digitalisation. The process of digital transformation implies new qualities. The acceleration of innovation speed enabled by the technological connection of people and objects, the enormous potential of data collection and analytics, sensors and the mobile accessibility are examples of aspects which need to be considered when talking about digital transformation. Digital transformation must remain linked to the objectives and strategies of the Port Authority/Administration, combining practices and techniques to generate new value proposals.

There are three main axes in which the developments carried out by Port Authorities are being framed for the digitalisation of the sector and for the application of new technologies in the logistics-port area:

- Digitalisation of systems, implementing new technologies in all port areas, allowing sustainable management of port operations and services, using for this purpose all the capacity and power offered by ICT.
- Deployment of integral technological platforms to standardize and integrate the different systems that are part of a port into a more efficient, innovative and oriented to user service using a Smart Port concept.
- Changes in logistic and transport parameters, including the elimination of intermediation and the improvement of modal exchange, in order to improve the competitiveness of transport chains based on automation and on robotization.

All related digitalisation concepts are shaped in relation to the real digitalisation needs of the ports, which are to a great extent influenced by the port's roles & functions, which are:

- Gateway (Port serves as logistics node for volumes generated in the hinterland including transit volumes to/from third countries transiting the country by land)
- Industrial (Port serves as an industrial raw material processing) zone with required infrastructure where feedstock comes in and (semi) finished products go out
- Transhipment (A port where cargo is transferred from one carrier to another or from one vessel of a carrier to another vessel of the same carrier without the cargo leaving the port.)

Another factor worth considering when talking about port digitalisation and digital transformation is making clear what the port's governance / management model is and which are the derived roles & responsibilities, especially of the port authority/administration. From landlord, tool port to public port and full-private service ports, all have a wide variety of workflows that need to be planned, managed and invoiced. However, when it comes to investments in digital infrastructure, tools and applications as well as management during and post implementation, the governance model plays a decisive role.

9 SWOT Analysis for Port Digitalisation Business

In the previous chapters an overview of the current status quo of digitalisation and future developments in ports has been summarized. This status may be structured in the following SWOT-table, which reflects both on the "internal structures and situation" of the ports (strengths and weaknesses) and the "external relationships and market environment" in which port´s businesses and processes are embedded (options and treats) - considering only the most obvious items.

SWOT Analysis for Port Digitalisation Business	
STRENGTHS	• Only (relative) few players in the port sector; this leads to an approach of tailor-made solutions (which will really work) and not to usage of anonymous products from the market (which have even parts which are not useful/senseless) • Ports are not spread over great distances, multi-sites, ..> they are in a clear and closed area (narrow) • Tasks to be depictured for inland ports are in lower range of about 1000 p.a. and not 10000/100000 p.a. • Clear legal frameworks do exist, which give alignment for the users of the software • People involved in software usage are relatively few ("100 and not 10000") > trainings are much easier
WEAKNESSES	• We are working in the fields of (analogous) old technologies with a high percentage of heavy-duty techniques (robust systems, not-sophisticated business) • A lot of the staff comes from the "practical side" (blue color, robust, manual business) • The educational level of staff is not very high • We have to manage several different languages; English is not the common basis for everybody • There is no clear process roadmap for port business with clear structure and defined interfaces, ... – different interpretations of "real port process" • The process at all is under strong economic pressure and cost-squeezing is central; it is not possible to raise fees, ... due to the installation of new techniques in the infrastructure • Business is quite narrow and economy of scale is no chance to reach payback in short years

OPTIONS	• We are not the frontrunner in digitalisation market, so we can use not digitalisation technologies, which are far developed and state of the art • Clients are familiar with digitalisation products in other parts of their life, so there should be no great (mental barriers to switch to new technologies (advantage of the follower) • Software-developments on the market are really mature and support step-by-step-approach and "puzzle-systems" • In/out interfaces are fare developed and part of everyday life (mobile phone, apps, tablets,...) • Process orientation (system specification,...) is state of the art today and allows quick progress for tailor-made solutions right for port businesses if one get really into the detail of port business • Other solutions do exist (other branches) which serve as good benchmarks, sources of knowledge for our approach • Technology in surveillance, data transfer, interfaces, LAN, wireless, ... is now very high developed and gives now a productive environment for establishment of port solutions (e.g., new generation of camera systems, AI-solutions, ...) as we cannot use the old standards of gates (truck or rail business)
THREATS	• Strong orientation on the digital solutions of seaports – there is a completely different business (and processes) in inland ports – the instruments of seaports are not the right ones for inland ports • Most of market solutions are focusing on container business, but we need the software solutions for other processes (container software still exists and is highly developed – but this is not the port business, even if the terminals are situated within the port area) • IT provider (of standard software products) may force us into the existing framework of their products, which are too huge/too comprehensive / too fixed on other processes / ... and do not focus on our core processes • Port business is very narrow, so in the market of external experts it is the same (or even worse); so, we don't get support from experts which really understand the processes and the business (like it is in other sectors with a broad field of knowledge outside the companies – e.g., rail, ...) or they come with solutions which are not customer oriented (e.g., solutions for storage, billing, ... - but these are not port-specific, we have to solve first our specific processes) • Bureaucracy of partner systems (e.g., RIS-development over the last decade) hinders us to find quick solutions for connections (ERI/AIS) • IWW-business is no growing business on the Danube, this does not allow the investment in comprehensive and expensive systems

9.1 Strategy for Digitisation in Danube Ports

The strategy for Digitalisation in Danube Ports is based on a strong process orientation and process ownership.

9.1.1 Shell-Model

A shell-like approach is very recommended as well as a step-wise implementation with between steps of validation and feedback loops.

The shell-like approach starts with the core processes of a port business in the centre and allows enlargement and interconnections to other processes which are not in the fare core business or connections to other process owners who are not necessary in the ownership of the port authority itself (but may be in the ownership).

Shell 1:

The core port process is everything which deals with vessel controlling in the port, allowance of in- and outgoing of waterway traffic, berth management and the narrow business of transhipment from water to land and vice-versa. All these activities are related to the harbour master duties and in the end of this processes a state-of-the-art harbour master book shall be delivered.

Shell 1 may be called “Port Management System (PMS)”.

Shell 2:

Shell 2 contains other processes which are in direct connection with shell 1 but are not necessarily be done by the port authority direct –may be done partly or completely inhouse the port (authority) and as such be the same process owner as shell 1.

These processes comprise billing process and further controlling activities (financial income check, …), special statistic evaluation out of the basic database of the harbour master book (e.g. transfer of condensed statistic figures to national authorities or institutions; , business data dealing with technical or commercial management / owners / boards; …), connections and interfaces to related cargo processes (e.g. storage or other processing of goods after the core transhipment process; transfer to other modes of transport without further processing – e.g. to trucks or railway; ….), customs processes or other special ones (e.g. safety items of dangerous goods transport).

Shell 3:

The third shell may contain other processes which are in direct connection with the first two shells due to the special kind of organisation of a port but can have completely different situations in other ports.

This shell may contain process connections with other operative handling activities, if they are done be the same staff of the port (authority) company and need special adjustments (crane business, trucking, storage equipment operation, ….). A container business may be summarized under this 3rd shell, but not due to the fact of the container processing (as this is no (core) port business along the Danube) but e.g. of using the same stuff, …

Process owner: *A process owner is responsible for managing a process from end-to-end. Their responsibility includes implementation, maintenance and improvement of this process. Process owners are most effective when they understand how their process interacts with upstream and downstream processes. Solutions only for one process (box principle), but not as closed shop, must be part of a greater idea and open for quick interfaces / integration with other processes (downstream/upstream integration)*

(S: https://www.panorama-consulting.com/business-process-owner/)

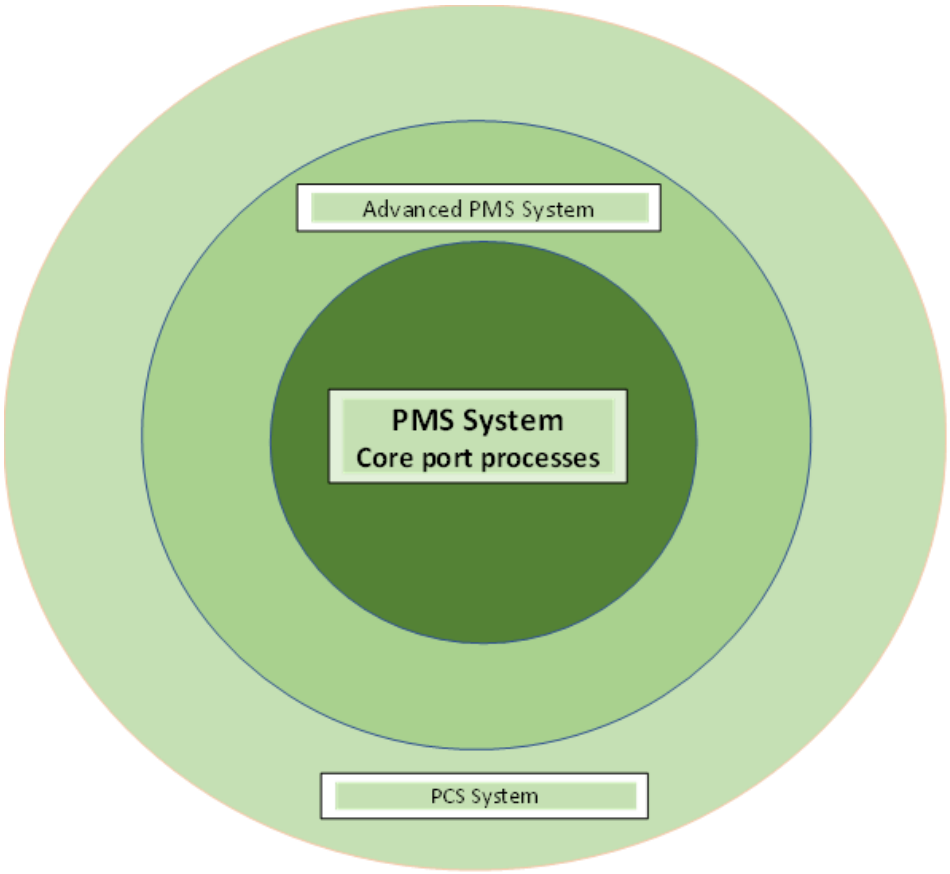

Figure 5: Port Management System

PMS – Port Management System

Core port processes:

- (drinking) water, electricity supply
- camera system or other tracking systems of the port ("digital twin")
- fueling
- customs of shiploads
- temperature of water, noise measurements, other (water) parameters which have to be monitored (e.g., due to authority permission papers).

Advanced PMS System

Other port processes:

- billing
- statistics
- financial income / check

PCS - Port Community System

Integration of Core port processes and other port processes

- cranes, trucks
- storage
- etc.....

The strategy for digitalisation in Danube Inland Ports is based on a shell-oriented process owner principle, this means that a stepwise and modular approach is based on a bottom-up system which may grow and be enlarged in every direction. But the basic data of the core shell (shell 1) must be solved first to create digitized data from the very beginning at a low level, otherwise one will only talk about software application on the level of further (manually) collected or prepared data and no integrated digitalisation approach can be reached.

The overall focus of this strategy has three basic lines in order to follow the line of "KISS" – keep it short and simple – by a stepwise and modular approach (from inner shell to outer shells).

9.1.2 Realize first the PMS / Port Management System (Core processes)

The data of core port processes of a port (waterside transhipment and berth management are the very core processes) must be available in digital form – as soon as possible created digital during the process flow. An exchange with other platforms, interfaces and enlargement in superior systems only make sense, if these data are available in a digital format on the "first point of registration". Concentrate first on the very simple steps which can be overview and not create a huge and comprehensive system which is expensive and hard to realise.

The first process must be realized in a very simple way to support daily business of skippers, harbour masters and partners for transhipment process. This digitalised solution must be a tailor-made solution for each port, even if a basic software product may be developed which can be tailor-made adjusted for each port. It does not make sense to buy a standard product from a far-away software market and adjust your process to this software – the other way round solution has to be followed, the software engineering work has to be adjusted to the port process (but this does not mean, that a port will look first to possible improvements of his own processes in the sense of continuous improvement before implementing his own PMS-solution).

This shell will most probably be linked with some (digitally available) input data coming from the national waterway agency under the international RIS-umbrella (EURIS, CEERIS – see RISCOMEX-project), all other input procedures shall be organized in a most comfortable way (via APPs on mobile phones, tablets, back-office support, ...). The relevant processes are vessel in/out, berth management, transhipment, vessel berthing including basic services (electricity, water...).

Even the transfer of the PMS-data to the financial department of the port (or maybe an external financial service / billing unit, ...) is part of the second step and comprises another set of processes. Therefor the strong process leads to the fact that e.g., billing is an element of PCS and not PMS.

The strategy must include an approach to an open system architecture and database that every item can be easily transmitted or imported to/from other platforms.

Part 1: Core Processes of a Danube Inland Port (reflecting on the basic data for a harbour master book - without container handling, this is not a core process of a Danube Port, because Inland Waterway Transport is not focused on container transportation).

- Incoming/outgoing vessels
- Quays / berths for vessels (anchorage)
- Time of entering/leaving the port – duration of stay in the port
- Freight data
- Cargo handling company
- Meteorological data
- …

Those data are ready to forward them into the billing process (but this is another process which is not specific to the port processes and therefore is no priority with regard to "Port Digitalisation" in the narrow sense of the definition, because it may be solved by a conventional controlling software not specified only for port business). This process is already existing in other fields of business, so it is not necessary to create something new but only to connect to those existing systems e.g., SAP, BMD, …

Part 2: Port infrastructure data (depends on the organisation of a port)

- (drinking) water, electricity supply
- camera system or other tracking systems of the port ("digital twin")
- fueling
- customs of shiploads
- temperature of water, noise measurements, other (water) parameters which have to be monitored (e.g., due to authority permission papers)
- ….

9.1.3 Upgrade of digitalisation solutions into other shells

Look for upgrading of digitalisation solutions and further data transfers via interfaces between the PMS (the port part) and other/superior platforms (extern)- PCS / Port Community System.

The upgrade of digitalisation from Shell 1 (core port processes) into Shell 2 (port infrastructure data) will be a follow-up step when Shell 1 is running. After Shell 2 (advanced PMS) is developed it will lead into Shell 3 (PCS – Port Community System).

The 2nd and 3rd shell of the strategic approach deals with connection and transfer of established digital data in the PMS with software products, applications, users, … (e.g., storage, trucks, railways, customs, …. billing), statistic authorities or other real necessary connections. Don´t make the failure to push everything to a combined software platform, when it is not necessary! (e.g., it does not make sense to combine container operation business in the same software block of waterside business – DIVIDE et IMPERA should be the strategic frame.

In this shell all basic items of a harbour book (finalized and approved by the relevant process owner – e.g., the harbour master) may be interfered with other input data of other processes (e.g., storage date of transhipped goods).

Storage of transshipped goods (connection with existing software): Software solutions for this process are not port specific and normally available as standard products for logistics. Those systems could also be combined with other software products e.g., ERPs of business units or companies. In- and out-figures with railway and truck business can also be combined with

specific (normally existing) systems for these processes, as well a container terminal software application (which are highly developed for these closed shop processes).

When implanting this shell of extending the PMS to an PCS one should have a close look on the market, what software products still exist (and are perfectioned for these processes, which are not port specific), so an intensive market research would be highly recommended as well on the possible interfaces to connect the data sources.

One of the most important things during the strategy of creating software solutions for port business is, to have close interaction with the national agencies dealing with national implementation of RIS (EuRIS and CEERIS) to get close connection to these software environments starting with national implementations in 2022 in the Danube region.

Overall, a stepwise modular approach shall be followed to divide the whole work into smaller packages and make validation steps between realisation of smaller work packages.

9.2 Action Plan for digitalisation approach in Danube Ports

9.2.1 Short-term

Each port in the Danube region shall look for the best way – under the national framework – to realize the first two shells of the strategic approach in a tailor-made form due to national specifics. After this process every port shall have a planning concept / a stepwise realized solution for his own PMS (this has to be a tailor-mode solution but shall deliver a “digitalized harbour book” of common standard.

It is highly recommended that in parallel an international project will accompany this short-term step, in which the ports can exchange information and ideas or software solutions (in the sense of benchmarking or best practice), learn from each other and look for national software specialists which can be integrated into this approach. A common discussion about the “minimum international standard” of a state-of-the-art harbour book may support a quick realisation.

9.2.2 Mid-term and long-term

Within the next steps of action, the way from PMS to PCS shall be done by items like the following (not only / must be checked in a tailor-made process by each port due to its special organization and environment)

- digital transformation analysis
  - analysis of Danube ports digital capabilities
  - Collection of best practices
  - analysis of other applicable ICT solutions and new technologies
  - Danube port’s needs & technical requirements
  - port process management analysis
- cost benefit analysis
- technical specifications
- legal aspects – Governance, data processing & sharing, ownership, hosting, cybersecurity
- national RIS-implementation progress

By these steps the PMS will get more and more connections with other platforms and systems (if there is really demand for it and will bring added value).

Furthermore – in the more long-term dimension - the development will go into other shells of processes which may comprise (depending on the detailed situation of a port)

- Connection with other modes of transport (railway, road,...)
- Connection with storage data or just-in-time cargo-flow data
- Connection with drones (under water drones ...)
- Connection with predictive maintenance, energy systems, ...
- ....

Overall, the action plan shall be based on a bottom-up approach under the alignment of international information exchange and learn from each other. Therefor it is recommended to act local but to think global during the next years and install a strong information exchange platform between ports regarding digitalisation development (either by means of a special project or by means of information days, organised best practice workshops or something else. The local approach by be organized on a national level or a group of ports within a country or stand-alone for each port – this depends on regional specific in each country like ownership of ports, organisational forms or similar factors.

10 Conclusions

There is a significant impact of ICT technologies on transport-related business, starting from fast and secure information exchange to the full automatisation of certain operations and processes. For Danube ports, digitalisation is a new topic and they should follow the lead of the digitalisation development level of major European sea and inland ports.

Seaports are forerunners in the digitalisation transformation/adoption trend. In Europe, several seaports such as Rotterdam, Amsterdam, Hamburg, Antwerp, Barcelona, Valencia, etc. have already built-up impressive experience in dealing with new technologies in most cases for their container terminals.

There is an existing regulatory and policy framework on national and EU level, as well as several projects and initiatives are ongoing to support the digitalisation process also on inland waterway transportation. One important part of this process are inland ports, but the high sophisticated systems e.g., RPA for seaports are too huge for the start-up in inland ports on the Danube.

Digitalisation of port business in the Danube region needs a special tailor-made approach and must be developed in a bottom-up way. It is not only a “copy & paste” process transferring solutions from other rivers (e.g., the river Rhine) to the ports of the Danube or of huge seagoing ports to the much smaller business of the IWW-ports. Especially a benchmark with the river Rhine shows that digitalisation projects on the Rhine are very strong focused on the container business because the Rhine acts as a strong container feeder line for the corresponding seaports downstream, calling for intensive data integration with all other partners in this business.

Container business per se has a strong affinity to digitalisation solutions as cargo flow is segmented in smaller units which can processed easily in a digital twin in parallel to the real handling.

Ports along the Danube have a lot of different organisational structure and operational principles. Container terminals are often situated in or near the port, but they are not necessary situated there due to now container flow on the Danube (except small amounts of empty units on the waterway transport). So, container business is no core process of a port in the narrow sense as in the Danube region much more container terminals are situated outside of ports far away of water connection and digital solutions for these units / for this business are high developed and ready to bay on the market but are no core element of port business itself.

When talking about digitalisation of port processes one has to focus on the really core processes of the port business: vessel management within the port and transhipment activities of cargo between water and land and all other corresponding items of harbour master activities in order to get a state-of-the-art harbour master book.

The implementation steps shall be done in a 3-shell approach to create first a PMS (Port Management System) and afterwards enlarge interfaces and connections to other platforms to go the way to an PCS (Port Community System), if it is necessary and will create added value. The details of implementing these 3 shells are strongly based on the specific circumstances of a port and its national environment and need a tailor-made approach for each port.

11 References

Inputs from other projects and deliverables/report

- Platina report D4.3 report on requirements towards digital and automated inland navigation tools from the infrastructure operator and user perspective
- DIONYSUS deliverable D.T.2.4.1 Inventory on port digitalisation capabilities in the Danube Region
- DIONYSUS D.T.2.4.3 Inter-Connecting Danube & Sea Ports digital infrastructure through Robotic Process Automation. A multimodal approach.

Internet research

https://smartports.tv/a/project-spotlight-unmanned-vehicles-in-the-port-of-hamburg-portwings

Annex-list of projects

12 Annexes

Status: June 2022

This chapter provides a list of identified projects dealing with digitalisation in IWT and was developed to complete the list elaborated in the framework of the **First Yearly Activity Report 2020**. The list of projects is considered a "living document" and is continuously being updated.

Project name: **Innovation-Driven Collaborative European Inland Waterways Transport Network**

Abbreviation: **IW-Net**

Funding programme: **Horizon 2020**

Timeframe: **2020-2023**

Coordinator: **Institut für Seeverkehrswirtschaft und Logistik (Germany)**

Website: https://www.iw-net.eu/

IW-Net will deliver a multimodal optimization process across the EU transport system, increasing the modal share of IWT and supporting the EC's ambitions to reduce transport GHG emissions by two thirds by 2050. Enablers for sustainable infrastructure management and innovative vessels will support an efficient and competitive IWT sector by addressing infrastructure bottlenecks, insufficient IT integration along the chain, and slow adoption of technologies, such as new vessel types, alternative fuels, automation, IoT, machine learning. The Living Lab will apply user-centered application scenarios in important TEN-T corridors, demonstrating and evaluating the impacts in simulations and tests covering technological, organizational, legal, economical, ecological, and safety/security issues:

1) **Digitalisation**: optimized planning of barge operations serving dense urban areas with predictive demand routing (Brussels-Antwerp-Courtrai-Lille-Valenciennes); data-driven optimization on navigability in uncertain water conditions (Danube).

2) **Sustainable Infrastructure and Intelligent Traffic Management**: lock forecasting reducing uncertainty in voyage planning; lock planning; management of fairway sections where encounters are prohibited; berth planning with mandatory shore power supply and other services (hinterland of Bremerhaven via Weser/Mittelland Canal).

3) **Innovative vessels**: new barge designs fitting corridor conditions and target markets: barges with a high degree of automation for urban distribution (East Flanders-Ghent); new barge for push boats capable with low/high water levels optimizing capacities (Danube from Austria to Romania); use of GALILEO services for advanced driver assistance like guidance, bridge height warning and automatic lock entering (Spree-Oder waterway close to Berlin).

Accompanying activities are stakeholder engagement, capacity building, and the delivery of a European IWT development roadmap with policy recommendations for increasing the IWT share.

Project name: **NOVel Iwt and MARitime transport concepts**

Abbreviation: **NOVIMAR**

Funding programme: **Horizon 2020**

Timeframe: **2017-2021**

Coordinator: **Netherlands Maritime Technology Foundation**

Website: https://novimar.eu/

The NOVIMAR project aimed at adjusting the waterborne transportation such that it could make optimal use of the existing short-sea, sea-river and inland waterways, thus expanding the entire waterborne transport chain up and into the urban environment. The vessel train was foreseen as enabler for this transport system, providing opportunities for increased flexibility in cargo destinations, use of waterways and crew deployment. NOVIMAR had a variety of research topics in scope ensuring a balanced evaluation of the foreseen transport system. In addition, NOVIMAR has identified needed boundary conditions for the transport system and ongoing supporting developments in industry and other projects.

Project name: **Novel Inland Waterway Transport Concepts for Moving Freight Effectively**

Abbreviation: **NOVIMOVE**

Funding programme: **Horizon 2020**

Timeframe: **2020-2024**

Coordinator: **TU Delft**

Website: https://novimove.eu/

Inland waterborne transport (IWT) is a major key-holder for unlocking the congestion in seaports, terminals, road networks and access to urban areas, besides being a main factor in reducing CO2 emissions in transport. These advantages however are not fully exploited due to inefficiencies in the seaport-inland logistics chain. Think of containers and vessels which are not loaded to their full capacities resulting in a suboptimal use of the IWT-capacity. Intercontinental and intra-continental cargo (containers) designated for IWT is not yet delivered in large packages causing inland ships calling at many (6-8) terminals to collect a few containers with waiting time at and sailing time between terminals adding up to 60% of the total time spent in port. And of course, there are varying water levels limiting ship payloads due to insufficient air draught under bridges, possibly forbidden navigation in extreme high-water periods and raised transport costs at low water. Another example can be found at volatile water levels and ever-changing riverbed conditions impeding optimal river navigation and cause time losses. Not to forget waiting time at bridges/locks causing additional inefficiencies in IWT-operations.

Thus, the core NOVIMOVE-challenge is: **where, how and with whom to intervene in the logistics system to obtain the largest possible impact at the lowest possible cost?**

Project name: **Inland Waterway Transport Solutions 2.0**

Abbreviation: **#IWTS 2.0**

Funding programme: **Interreg North Sea Region**

Timeframe: **2014-2020**

Coordinator: **Maritieme Academie Harlingen - Stichting Dunamare Onderwijsgroep**

Website: https://project-iwts20.eu/

Inland Waterway Transport (IWT) offers relatively slow, cheap, climate friendly hinterland transport alternatives for commodities transported in large quantities or bulk. The energy input per t/km is superior to rail, road transport. Many waterways in Europe remain widely un-/underused in the past decades.

Addressed challenges:

- Low awareness about small waterway transport opportunities,
- Low innovation in small barge development, transhipment of goods,
- Lack of expertise in using small waterway opportunities,

- Lack of training content and dedicated crews for small waterway sailing.

Partners join forces; mobilize potentials and capacity to move freight to yet under-used waterways by:

- Realizing a quick modal shift by introducing new and proven logistic technologies and
- support logistic managers that decide about modal shifts.
- Make better use of existing waterways by adapting them towards a sufficient standard size vessel.
- Make better use of existing waterways by developing innovative sustainable small barge concepts.
- Modernizing IWT education, training with a focus on navigation on smaller waterways.
- IWTS 2.0. facilitates use of IWT on smaller waterways (comprehensive network) in the NSR region linking them to main TEN-T corridors.

By piloting 8 small waterway modal shifts including; innovative barge-, waterway-, transhipment-, (un)loading-, freight flow mapping-, modal shift decision making solutions, we showcase proven concepts that will be adopted by the market.

Project name: **EMMA Extension Project**

Abbreviation: **EMMA Extension**

Funding programme: **Interreg Baltic Sea Region**

Timeframe: **2019-2021**

Coordinator: **Port of Hamburg Marketing**

Website: https://www.project-emma.eu/

The EMMA Extension Project (08/2019-07/2021) aimed to enhance inland navigation in the Baltic Sea Region by supporting digitalisation in inland waterway transport (IWT) and by implementing new logistic concepts in the Baltic Sea Region. The extension project was based on the results and recommendations of project EMMA (2016-2019), which brought inland navigation to a wider national and European agenda, strengthened its voice and successfully demonstrated feasibility of potential inland waterway transport services in the Baltic Sea Region. The EMMA Extension focuses on next steps towards further market deployment of IWT by capitalizing on the results and partnership of project EMMA and implementing practical IWT solutions. At the end of August, all seven project partners from Germany, Finland, Lithuania, Poland and Sweden gathered to the old pilot station Rosenvik on the waterfront of Stockholm to plan the cooperation in enhancing inland navigation together.

Based on the recommendation given in the EMMA policy paper, EMMA Extension supports the further harmonization of River Information and Vessel Traffic Services (RIS/VTS) in the BSR. The EMMA Extension project links digitalized data services and functionalities such as real-time data regarding bridge clearance to ELIAS system, which was developed during the EMMA project.

The EMMA Extension also implements new logistic concepts in the Baltic Sea Region. The implementation of commercial pilot services under real business conditions in three Baltic Sea Region countries will showcase the feasibility of IWT services in supply chains and promote IWT to cargo owners and forwarders in emerging IWT markets. The pilot sailings will take place on River Neman in Lithuania, on Vistula River in Poland and on the Lake Mälaren in Sweden, showing the benefits of the IWT: high capacity, reliable transportation, lack of congestion and smaller environmental impacts.