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PROMOTING MARITIME AND MULTIMODAL FREIGHT TRANSPORT IN THE ADRIATIC SEA (PROMARES)

Activity 3.3 - Cross-border action plan for enhancing maritime and multimodal freight transport

D.3.3.1, best practice analysis

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1 INTRODUCTION

This best practice analysis is compiled according to contract stipulated on 23.04.2019. between University of Rijeka, Faculty of Maritime Studies as a client and Aksentijević Forensics and Consulting, Ltd., as a contractor.

Project PROMARES – *Promoting maritime and multimodal freight transport in the Adriatic Sea* is facing challenges disrupting development of the sea and multimodal cargo transport in the program area. They are mostly caused by imbalance in development of multimodal traffic systems, weak coordination and communication between stakeholders and policy makers and non-alignment of measures and tools on cross-border level, leading to increase of road traffic with negative implications in form of pollution, greenhouse gas (GHG) emissions and noise pollution.

Goal of PROMARES project is to enhance sea and multimodal cargo traffic in all ports of interest that generate intermodal and multimodal transport flows, facing the same type of challenges of accessibility of multimodal transport and efficiency of TEN-T corridor in the region (from the port to inland), and increase level of cooperation and stakeholder cooperation. Focus of cooperation of PP11[1] is research of elements of multimodal transport system with final goal of creating a solid set of KPIs and testing models of their measurement.

Project duration is 30 months from January 2019., and best practice analysis is due to be delivered according to stipulated contract until 15th June 2019.

[1] PP11 is abbreviation for „Project Partner 11“, University Of Rijeka, Faculty Of Maritime Studies Rijeka

Activity 3.3 of Promares project foresees the elaboration of a cross-border action plan for enhancing maritime and multimodal freight transport.

PP11 has therefore conducted an analysis on the best practices on ICT tools and policies for enhancing maritime and multimodal transport.

The intermediate results of the territorial needs assessments and best practice analysis will be discussed at the 2nd PSC[2] meeting, when a training seminar is also held by the WPL on the most recent policies and practices for enhancing maritime and multimodal transport, also outside the Programme Area.

Based on the results of the territorial needs assessments, the best practice analysis and the training session, WPL will draft a cross-border action plan for enhancing maritime and multimodal freight transport, containing guidelines, priority measures and KPIs, to be tested in pilot actions (WP4) and laying the basis for the cross-border strategy

The deliverables of Activity 3.3 are the following:

1. D.3.3.1, best practice analysis: PP11 provides an analysis on the best practices on ICT tools and policies for enhancing maritime and multimodal transport. The scope will cover EU and international experiences.

2. D.3.3.2, cross-border training seminar: PP11 holds a cross-border training seminar, back to back with the 2nd PSC and open to stakeholders and invited institutions on the most recent policies and practices for enhancing maritime and multimodal transport, also outside the Programme Area.

[2] PSC is abbreviation for „Project Steering Committee“

3. D.3.3.3, cross-border action plan for enhancing maritime and multimodal freight transport: based on the results of the cross-border study (D.3.2.11) territorial needs assessment and the best practice analysis on ICT tools and policies (D.3.3.2), PP11 elaborates a cross-border action plan for the enhancement of maritime and multimodal freight transport, including KPIs, to be tested through the pilot actions (WP4) and serving as a basis for the crossborder strategy (WP5)

This best practice analysis covers first deliverable of Activity 3.3, D.3.3.1.

Best practice analysis on ICT tools and policies for enhancing maritime and multimodal transport covering EU and international experiences contains:

1. Analysis of best EU practice and identified and applicable international practice,
2. Explanation of stakeholder swimlanes, processes and systems in sea and multimodal transport, defined by relationship between national – regional – supranational levels,
3. Differentiation between administrative and commercial processes related to cargo,
4. Definition of different stakeholder interests and challenges in integration of their business information systems
5. Description of modalities of building and integrating information systems of stakeholders' participation in sea and multimodal traffic (for example, TOS, b2b, b2c, b2g, g2c, CRM and ERP systems), and best practices in establishing NSW systems,
6. Description of best practice in organization and management of maritime and multimodal transport ICT systems,
7. Description of potential bottlenecks and ways ICT technologies are used to mitigate them, and

8. Clear emphasis of digital transformation paradigm on maritime and multimodal transport, and relevance of timely information exchange and security policy implementation in achieving information security and data privacy goals.

During study phase, by using means of e-mail, a request for suggestions for applicable technologies and concepts to be encompassed by this best practice analysis was addressed towards the following identified stakeholders and participants in the project indicated by PP11:

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Feedback on the request was received and used as a guideline and indicated concepts and technologies have been included in the analysis.

Content of the best practice analyis is the following:

The **first chapter, Introduction**, outlines basic assupmptions behind best practice analysis and its contents.

General considerations on maritime and multimodal IT systems are described in the **second chapter**.

Overview of maritime and multimodal transport stakeholders including business process groups and cargo transport timeline is topic of the **third chapter**.

Best practice examples for various successful projects are selected, researched and described in the **fourth chapter**. These examples include PMIS, NSW, MNSW (CIMIS), and development of the national Croatian PCS starting in the Port of Rijeka Authority, Port of Ploče PCS, Single window of the Republic od Korea, Dutch MNSW, NACCS development in Japan, SafeSeaNet in Norway, and MAINSYS and SeaMean Control System in Israel.

Brief description of selected disruptive technologies impacting the programme area is outlined in the **fifth chapter**.

Basic guidelines for implementation of the maritime and multimodal ICT system are topic of the **sixth chapter.** As a part of this chapter, scope and stakeholders are defined, policy issues are identified along with use of legacy systems and processes, basic information security requirements are set, special care is taken to describe possible monetization models and appropriate modeling methodology possibilities are shown.

Technological side of the architecture is briefly discussed in the **seventh chapter**, along with implementation best practice examples of various technologies.

In the **eighth chapter**, conclusion – summary of the best practice analysis, the most important summary findings of the best practice are described along with the source for the identification of the best practice.

Finally, a **list of consulted resources** is compiled along with **glossary of used terms**.

2 General considerations on maritime and multimodal IT systems

The term "*national single window*" (NSW) is generally used as a trade facilitation idea to describe implemented and pre-agreed functionality for international (*cross-border*) traders to submit regulatory documents at a single location and/or single entity. A consensus exists in international scientific and multimodal transport stakeholder community that there is a need to set up a "*single window*" system to exchange multimodal cargo documents in maritime and land transport, taking into account and building upon existing standards.

Such documents are typically customs declarations, applications for import/export permits, and other supporting documents such as certificates of origin and trading documentation.

In maritime and multimodal cargo traffic, and considering number of various involved stakeholders, it is a general consensus that implementation of NSW systems on national, regional and supranational levels is of great importance for facilitation and enhancement of cargo flow, increase of security and compliance with legislative requirements.

NSW, depending on the adopted viewpoint, can be treated and implemented in real-life scenarios, using two different architectures:

1. National single window – when NSW is implemented as the only single window solution nationally, meaning that that all operations are performed through one NSW.,
2. As a bus and data conversion portal between supranational and international data exchange systems and national data management systems.

Analysis derived from real life scenarios has shown that NSW systems provide for:

1. Simplified electronic means of covering administrative formalities for ships in maritime transport,

2. Standardization of logistics activities, interface and information in maritime and multimodal transport, and
3. Improved maritime and multimodal logistics efficiency and strengthened maritime and multimodal logistics competitiveness of the states that have implemented NSW.

In most practical application cases, single window concept is mostly concerned with cargo-side issues. However, government stakeholders are very interested also in administrative tasks related to ships' arrival announcement, arrival, and departure, summarily called *„ship clearance* “. Therefore, it is a good practice to include in NSW also procedures and guidance related to clearance of the ship. This approach cancels the need for definition of different different single windows for cargo-side (commercial) operations and ship's clearance, as one single window on a national level – NSW – can attend to both needs.

In the past, a single window did not necessarily mean implementation and usage of ICT, however, nowadays it is difficult to imagine a functional and all-encompassing NSW without identification and adoption of relevant technologies to be integrated within NSW.

Discussion on different types of single windows their relation to trade and transport is lively and ongoing, both on global and regional level, involving different organization of interested stakeholders. These discussions are typically aimed towards creating a best practice compendium, sharing real-life experiences and creating a set of applicable standards.

General best practice guidelines for NSW adoption are developed by the *United Nations Centre for Trade Facilitation and Electronic Business* (UN/CEFACT), the *World Customs Organization* (WCO) and other organizations aiming to provide definitions, models, data harmonization and steps towards implementation of NSW.

However, no guidelines covering the overall development life cycle, business process analysis, requirements collection, system design and development exist, hence national bodies leading the NSW implementation may face many difficulties in their development.

3. Overview of maritime and multimodal transport stakeholders

Major factor affecting successful deployment of a single window system, is how well it satisfies the requirements of the intended users. This means that implementation of the best practice requires designers of the single window to understand who the users are and what are their requirements.

Multimodal cargo transport has different dimensions, each with different parties and different responsibilities. A single window solution must define the dimensions, involved stakeholders and responsibilities it is intended to serve and subsequently implement technical solutions that satisfy these requirements.

3.1 Involved business process groups

Multimodal cargo transport involves a number of different stakeholders and their business processes which interact to achieve the objective of movement of goods. Figure 1. illustrates major main business processes and parties in trade and transport. The top level, driving the whole process, is international trade. It creates the need for transportation, in most cases supplied by transport service providers, for example, the freight forwarders. The transport is performed over several phases, some of which are typically by ship, especially when covering large distances. During the ship transport, operational issues occur that need to be taken care of between the parties involved in the transport operation.

These identified business process groups are shown in Figure 1 on the next page.

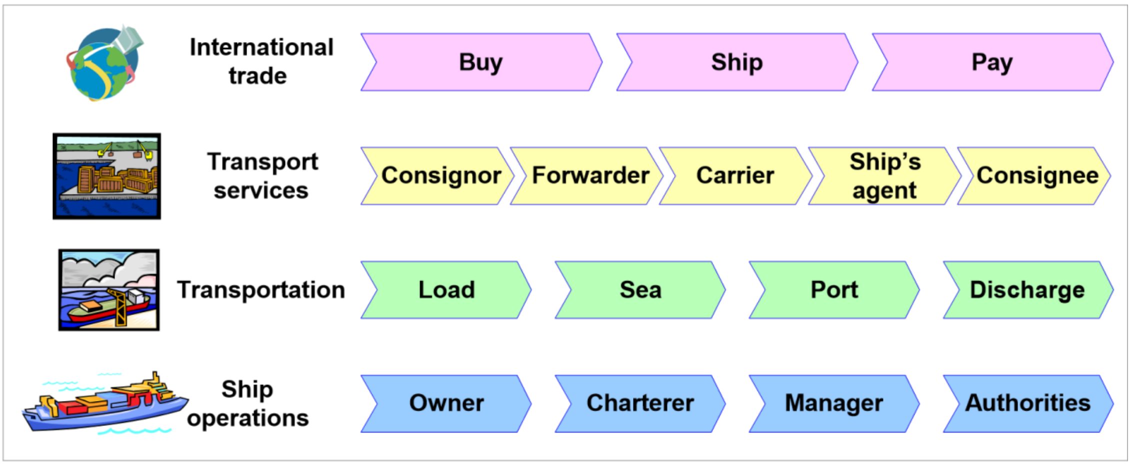

Figure 1 — Main business processes in trade and transport

Outlined figure is only a high-level view of the processes. In reality, the processes are significantly more complex. Also, four described levels are not executed just once, and may be repeated several times over the freight operations and the roles and actions on each level will often be interconnected with other levels' roles and actions.

The users' requirements on each of the identified levels are driven by the business processes and have different locus of interest. On the top level they are driven by the production, sale and purchase of transported goods, while on the lowest level they are driven by the need for utilization, and return on investments in ship and port infrastructure. Therefore, single window solutions may not be able to tend to all requirements and in many cases a combination of different single windows is used along with more conventional single party to single party interaction. Therefore, one of the primary goals of single window national and international projects in multimodal transport is also simplification of architecture of involved systems in a single cargo operation.

3.2 STAKEHOLDERS IN MULTIMODAL CARGO TRANSPORT

Different groups of stakeholders bearing individual responsibilities also have a significant impact on what information needs to be exchanged, in what form and when.

The point in the overall process at which a single window is introduced has a significant impact on the required functionality of the single window.

Generally, each business process line involves different groups of parties that have very different roles. This is shown in Figure 2.

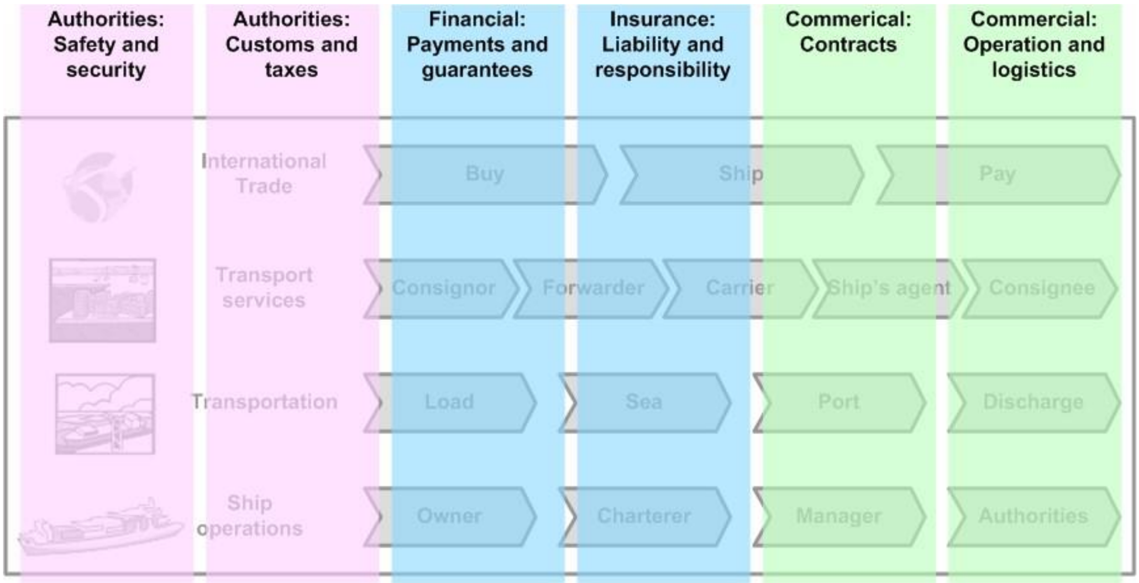

Figure 2 — Different roles in each process

The vertical columns indicate the different stakeholder groups and their roles. These are:

- *Authorities – Safety and security*: Authorities in charge of safety and security in the different operations. Their regular duties include control of prohibited goods and transport of legal, but dangerous materials.

- *Authorities – Customs and taxes*: Authorities in charged with levying taxes on import and export as well as some forms of general transport. The most common ones are export and import customs duties.
- *Financial – Payments and guarantees*: These roles cover interaction with financial institutions and general payment for commercial services including those provided by authorities.
- *Insurance – Liability and responsibility*: They cover all aspects of responsibilities for safe delivery of cargo at predefined times under contractual obligations. It also covers liability insurance for traffic and maritime accidents or spills.
- *Commercial – Contracts*: This covers interaction related to contracts, e.g. exchange of proofs of ownership and status messages
- *Commercial – Operation and logistics*: They cover operations and exchanges related to planning and execution of the operations, resources ordering, and sending and receiving arrival and departure notifications.

3.3 MARITIME CARGO TRANSPORT TIMELINE

The use of the single window, best practices in integration of IT systems and technologies and reporting requirements depend on the stage where a ship or the cargo is on its voyage. Figure 3 shows some of the phases that are typically used as reference points for establishing them.

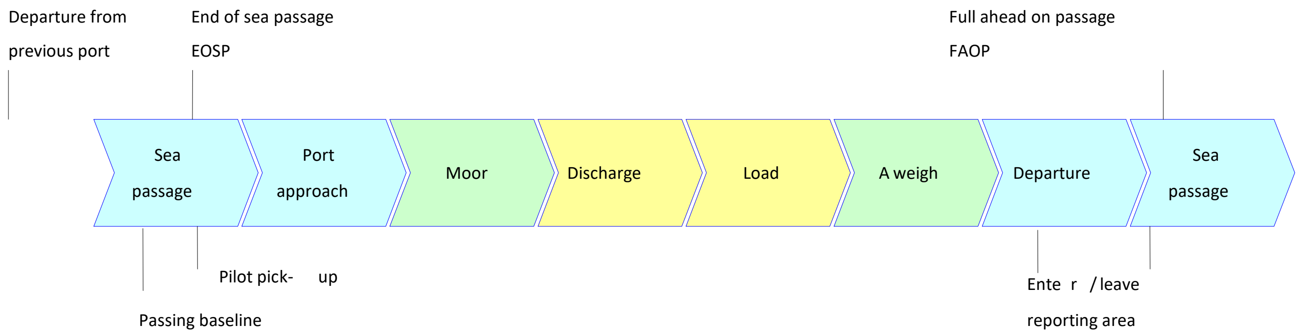

Figure 3 — Timeline in a transport process

Depending on applicable rules and underlying cargo procedures, several other subdivisions can be used. Some of them are already included in Figure 3:

- *Passing point:* When the cargo ship enters national waters, usually with some reporting requirements to the coastguard, navy or police,
- *End of sea passage* (EOSP): Used in transport contracts, when the ship decelerates from transit speed,
- *Pilot pick-up*: Often at EOSP.
- *Enter/leave ship reporting area (*VTS (VTMIS) area)
- *Full ahead on passage* (FAOP): Where transit to the next port begins.

Sea passage section may contain channel or strait passages and subsequently the port approach may be subdivided into more stages.

While harmonization of reporting is in general desirable, it should be verified that the integration of reporting into a single window does actually have benefits. If a specific report does not overlap with other reporting requirements in terms of data and/or parties involved, then integration of that report into the single window system might complicate the overall processes rather than simplify them.

4 Implementation of maritime and multimodal IT systems - best practice case studies

4.1 Case study 1: PMIS (Italy)

Italian Coast Guard was tasked a few years ago with strategic acitivities and challenges of Implementation of the Reporting Formalities Directive (RFD) in Italy and implementation of pre-clearing for customs simplification. These activities have been performed by transposition of RFD in the National legal framework (Law n.179 of 18 October 2012 (Art.8 Par.10 to 17) Conversion Law n.221 of 17 December 2012 laying *"Further urgent measures for the country's growth*".

These actions encompass the following:

1. Port Management Information System (PMIS) fully takes on role of the National Single Window (NSW),
2. Envisaged submission of FAL1, FAL2, FAL3, FAL4, FAL5, FAL6, FAL7 and Maritime Declaration of Health;
3. Implemented submission of any additional information required according to current EU legislation and any other information to be rendered in response to other national laws or regulations;
4. Achieved interoperability of PMIS with:
   - SafeSeaNet,
   - Customs Information System,
   - Port Community Systems, and
   - Other national competent authorities (Ministry of Health, Border Control, etc).

PMIS is the Italian National Single Window designed in 2005 well before RFD in order to manage typical administrative reporting formalities related to arrival to national ports and departure from national ports. It is using and updating national reference databases of the Italian VTMIS platform (e.g. vessel, dangerous and polluting goods, ports, etc.. Also, it manages monitoring of vessel mooring and movement within port waters. Originally it was designed to manage 29 Italian national ports.

However, PMIS at the beginning of the enhancement project PMIS, today, did not fully serve the function of a National Single Window as intended by RFD because it managed only a portion of the required reporting formalities, there was no interconnectivity with other systems and data entry relied on Web interface, most importantly, there was no interoperability with other systems (Customs, PCS, Health and other national competent Authorities) and there more than 100 other ports to be considered except the initial 29 ports.

In order to ensure PMIS compliance with RFD, the Italian Coast Guard HQs, with respect to the directions of the eMS WGs, was involved in the following activities:

1. *Process analysis* at the ship-port interface for the harmonization of relevant administrative procedures in order to ensure PMIS compliance with RFD,
2. *Technical Working group with Customs*, aimed to ensure interoperability between the PMIS and the Customs information system – AIDA,
3. *Technical Working group with Port Authorities*, aimed to ensure interoperability between the PMIS and the PCS (Venezia, Genova, Bari, etc.),
4. *IMP project* aimed to design a first european prototipe of a National Single Window (request for technical assistance to EMSA in order to reuse some modules within the national implementation),

5. *ARGES project* aimed to design the first prototype of the Italian National Single Window, and
6. *Participation in AnNa project*.

„*As is*“ layout at the beginning of the implementation is shown in the Figure 4. below.

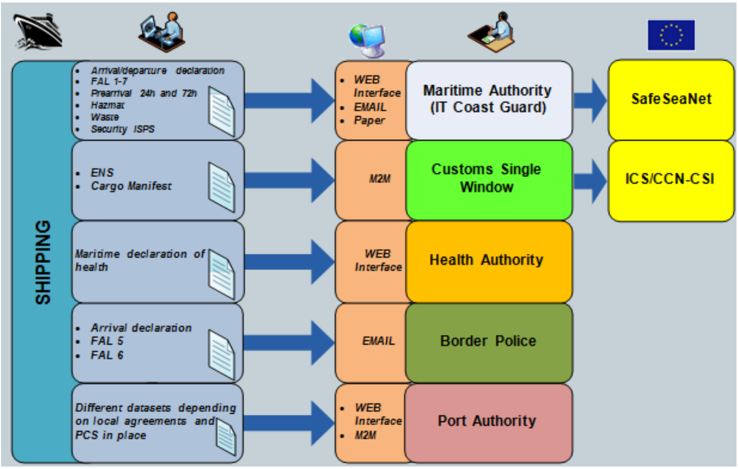

Figure 4: “As is” layout at the beginning of the PMIS project

“To be” achieved situation after successful execution of the project is shown in the Figure 5.

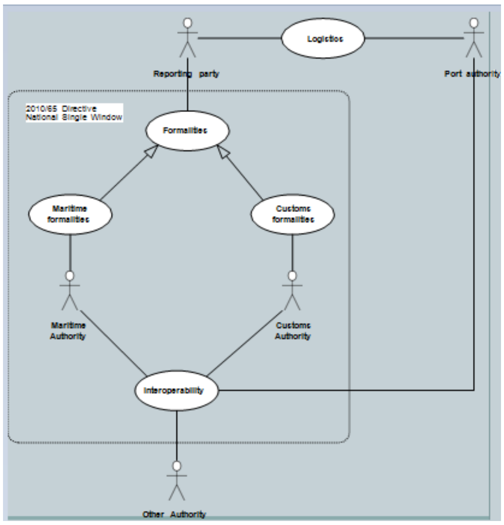

Figure 5: “To be layout at the end of the PMIS project

Italian Single Window implementation according to 2010/65/EU framework greatly relied on interoperability among Public Administrations to achieve the goals set by RFD (i.e. submit once). As prescribed by the national Law, interoperability has to be ensured towards Port Authorities, even if they do not participate in formalities processing, to improve their logistics platform.

Use case of data integration and exchange was the Pre-Clearing procedure. The Pre-Clearing experimental procedure allows for an early submission of customs declarations up to 36 hours before ship arrives in the port of destination. It is based on two essential elements: seiplifications introduced by the One-Stop Customs and ship monitoring carried out by the PELAGUS monitoring system managed by the Italian Coast Guard. The Italian NSW became a pillar toward the simplification of the administrative procedures applied to the maritime transport, with important pending issues still to be agreed at EU level in order to meet the goal (e.g. eManifest, NSW guidelines under the AnNa approach, harmonized Message Implementation Guide).

4.2 Case study 2: NSW and MNSW (CIMIS) development in Croatia

NSW study created by the consultant IN2 for the Ministry of Maritime Affairs, Transport and Infrastructure from 2011. describes the contents and methods of integration of the national single window system. Chapter 3 describes in detail the integration of NSW and PSC systems. The basic assumption is that the same data is delivered to the system only once. Figure 8. shows in general the NSW orchestration and message exchange.

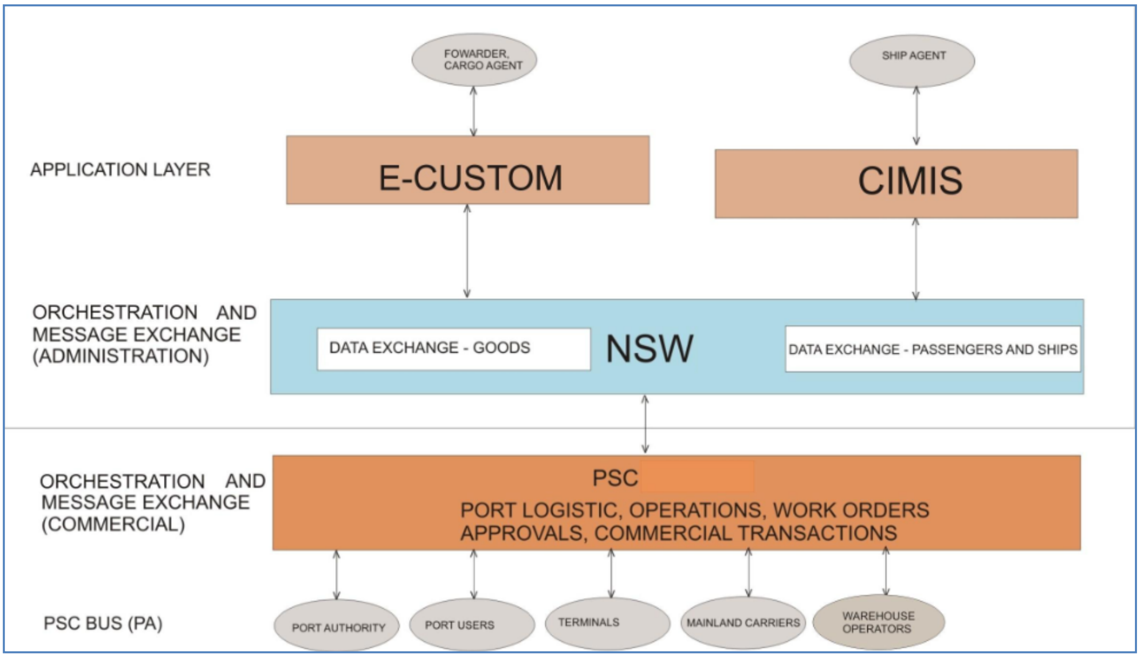

Figure 8: Envisaged high level NSW orchestration and message exchange

In the rest of the chapter highlights of the NSW definitions and roles are drawn from the mentioned document.

CIMIS is the unique MSW (Maritime Single Window) system that implements all na-tional level processes related to the administrative aspect and aspect of navigation safety. The role of the

CIMIS system is to manage, store, and provide master data (MDMs) such as ship code (NIB and IMO numbers), ports, berths, anchors, agents, shipping, and so on.

Croatian Ministry of the Sea, Transport and Infrastructure (MMPI) has developed advanced IT platform CIMIS (Croatian Integrated Maritime Information System) in order to enhance electronic delivery and exchange of data about ships, cargo and passengers in official administrative procedures related to ship's announcement, arrival and departure.

In order for CIMIS to be able to exchange dant with external systems (PCS, police information systems, customs and others), and exchange data and information, CIMISNet XML data exchange system has been established. CIMISNet is comprised of the following Web interfaces:

1. *CIMISNet web service* is an interface allowing end users to reach all dana and documents related to visit of a maritime object to a Croatian port that are received and stored inside CIMIS database. Except reaching the data, it also enables basic user actions over those documents,
2. *CIMISNet-eSeaFarer* web service interface that enables end user to browse and enter dana related to seafarer movements,
3. *CIMISNet-eNatNav* web service interface that enables end users to announce arrivals and departures of maritime objects to Croatian seaports
4. *CIMISNet-eShipLine* web service interface that makes it possible for the end user to declare cargo and passengers for each maritime activity and sailing schedule for each ship line under concession. Interaction between CIMIS Web intefrace and CimisNet WS is shown in Figure 9. on the next page.

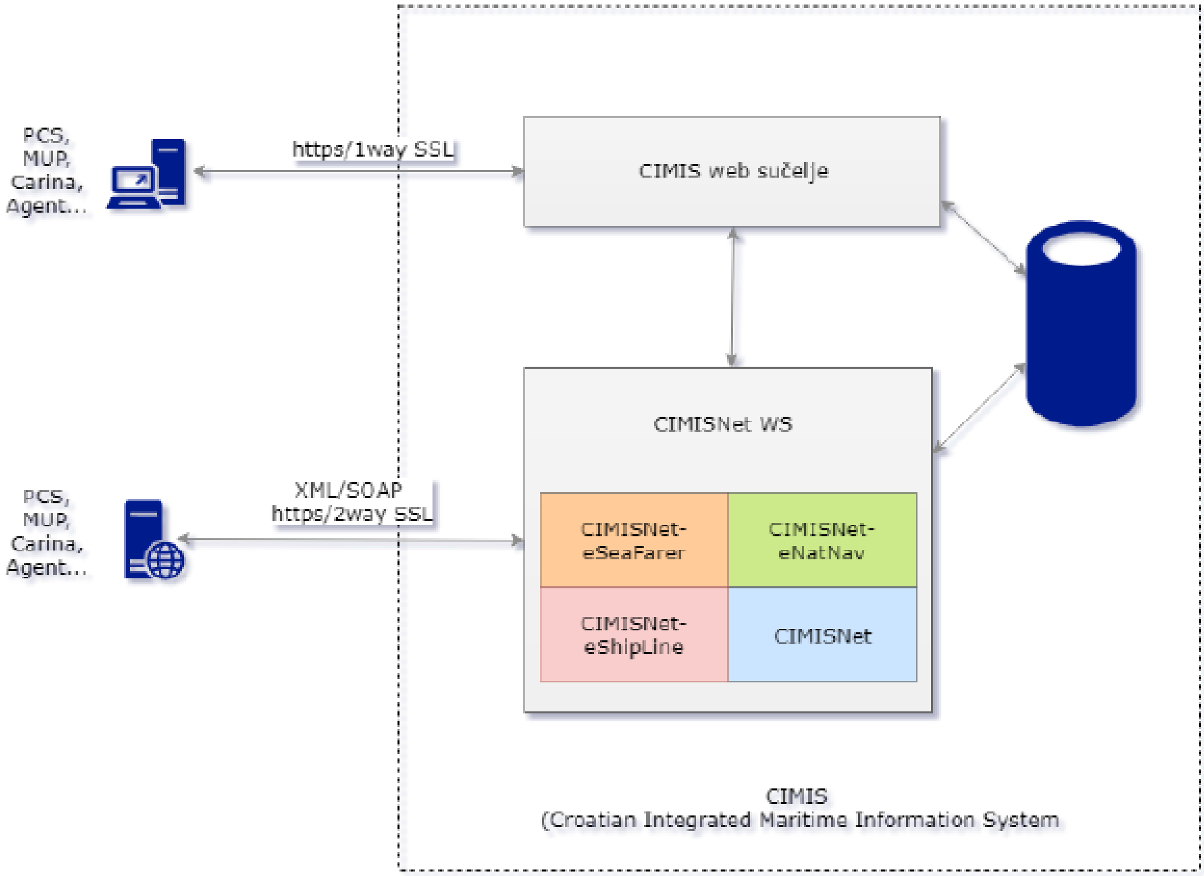

Figure 9: Orchestration of messages within CIMIS

Goals of the CIMIS system are:

1. More efficient dana collection
2. Availability of detailed statistic dana on maritime traffic
3. Reliable and secure way of exchanging XML messages and underlying documents
4. Removal of administrative load in maritime traffic
5. Simplification of dana flow between all participants in maritime traffic and state bodies

6. Increase of efficiency in maritime traffic and port service delivery
7. Contribution to integration of Croatian maritime traffic routes into European traffic routes

In order to achieve exchange of XML messages and documents in a safe and reliable manner to all involved stakeholders, CIMISNet's architecture follows web service paradigm (SOAP/HTTPS) that will use Internet and HTTPS as communication channel and both-sides authentication on a communication lavel (2-way SSL). Envisaged data exchange methodology is technologically independent and it will make possible for uniform communication between end

PCS is the local single window for managing all port operations (land-based processes), from when the vessel was moored until his departure.

NSW Platform mediates data exchange between CIMIS (and other national systems: Customs, Ministry of the Interior, Ministry of Health,..) and PCS systems.

NSW Platform is also an administrative-service bus that will be responsible for implementing business processes, orchestrating data exchange, ensuring compliance with business rules, format conversions, and other functions required for integration into a unique sys-tem.

The platform will also include:

1. A digital archive (storing all messages in a specified time period), the valuator to check the formal correctness of the message, a message generator and interface for secure delivery of messages.
2. The repository of business processes and associated XML schemas. They will be in-tegrated with the central authentication and authorization system that will enable the central administration of the identity and rights (roles) of all system users. Authenti-

cation mechanisms will primarily use digital certificates, but the system will also support modular add-on authentication mechanisms as well as authentication with username and password (reserve option).

3. Integration with all other components of the NSW system and connection with other national systems (Ministry of the Interior, Customs, Ministry of Health and other government bodies).

The diagram in Figure 10. shows targeted integrative (functional) system architecture of the NSW system.

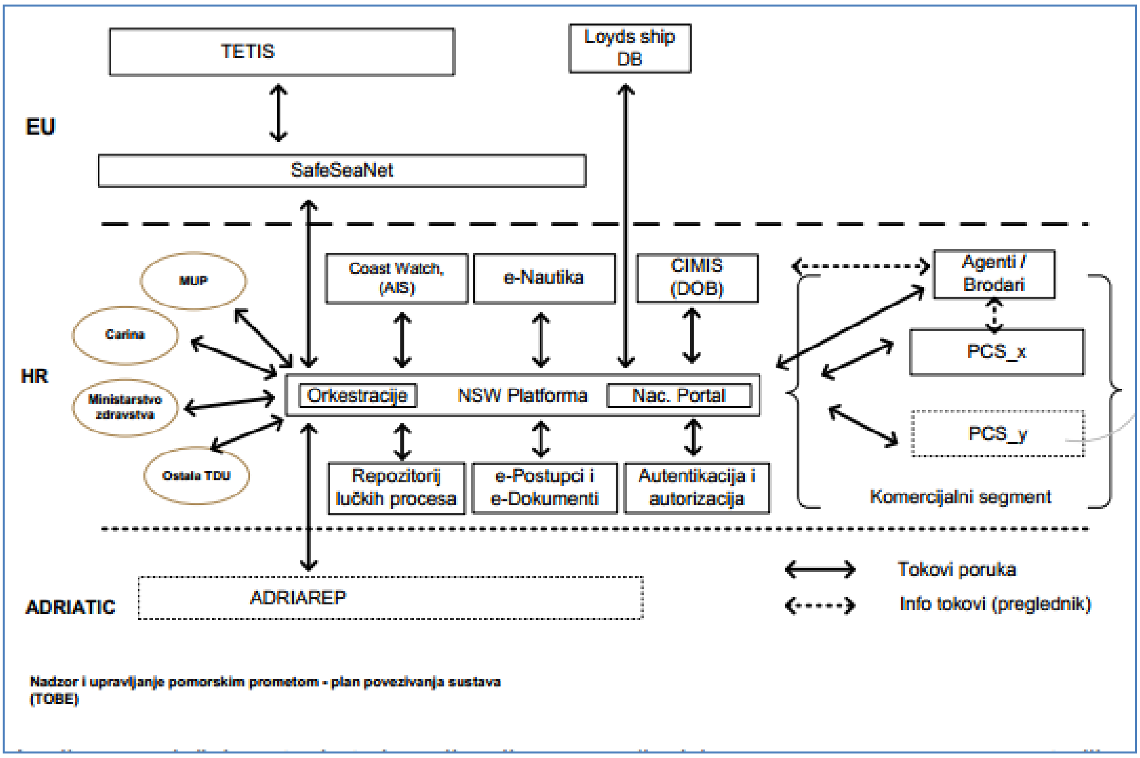

Figure 10: Croatian NSW development - Complete functional integration architecture

As it can be seen from the previous figure, PCS – or a series of PCSes developed on the basis of the “national” PCS first to be implemented in the Port of Rijeka – are an important segment of overall national orchestration within NSW area of remit.

The National Single Window (NSW) can be defined as the standalone information system operating at national level, providing connectivity and data (document) exchange with other systems by using standard and well established ways of communication, accepting information in strictly defined structure and making information available to various different stakeholders within the country in a harmonized manner. Single Windows may also be supranational or regional. According to the Directive 2010/65/EU of the European Parliament and of the Council (Directive 2010/65EU, 2010) each Member State should implement the Maritime National Single Window (MNSW) in order to optimize and facilitate the process of announcement and registration of ships which arrive to ports and/or depart from ports of the Member States.

4.3 Case study 3 - National PCS Initiative (Croatia)

PCS is an electronic platform which interconnects multiple information management systems operated by a variety of organizations and stakeholders that make up a port community cluster.

The term PCS is widely spread and in use in different port environments in the whole world.

PCS traits generally include:

- neutrality and electronic platform openness enabling intelligent and secure exchange of information between public and private stakeholders in order to improve the competitive position of the sea ports communities;
- optimization, managemene and automatization of port and logistics processes through a single submission of data, connecting transport and logistics chains;
- an electronic platform that connects the multiple systems operated by many different organizations that make up a seaport community. PCS is used to standardize message exchange among port community members and centralize all port community information as much as possible.

Although several specific definitions exist, a PCS can be considered to serve as a means to exchange data between different stakeholders in a port, as well as gathering data and making it visible to interested and entitled stakeholders, providing operational data for planning purposes.

The Port Community System (PCS) is intended to integrate the electronic flow of information across the trading partners involved in the maritime transport chain through a common interface.

PCS in different ports are not the same, as the PCS's functionality depends on the local characteristics of the port. The PCS is determined by the operation of a port and this is determined by the location of the port and its surrounding. Furthermore, the functionality of a PCS depends on the initiators of the system as they have a large influence on the development of the system. In short, a PCS can be described as a central point for an organization to deliver or receive information. In smaller port communities, PCS tend to serve as extensions to the in-house systems of major players, offering company-specific applications. In large ports, however, they have a more neutral role as a true information broker.

Regardless of the size of the port, it is very important that members of the port community agree on the system's requirements. A true sense of community and a general feeling of involvement need to be established. Different prerequisites and interests of e.g. major multi-national companies and one-person service providers need to be overcome. The success of a PCS can only be maximized if all member groups of the port community realize benefits and thus share information. A PCS also should not duplicate functions that are already existent in other systems, but rather focus on general operational processes. It is also very important that sensitive information in the PCS be safeguarded.

Seaports with tradition in the use of PCS systems include the following functionality scope:

- Fast, easy and efficient EDI information exchange allowing for the centralisation and one-time lodging of documents and information which allows for the re-use of information which is available 24 hours a day, 7 days a week and 365 days a year,
- The PCS interaction with Customs systems and submission of the necessary declarations,

• All information regarding import, export, transhipment and transit cargo is handled electronically, substantially reducing the need for phone, fax, email, paper messages and personal visit transactions for the stakeholders,

• Provides full transparency on the movement of dangerous goods and other notifiable cargoes,

• Status information and control, tracking and tracing through the whole logistics chain,

• Provides a full range of cargo and data for the maritime statistics,

The top five benefits of a PCS that are identified by the port communities are:

• Message standardisation,

• Reduction of paper,

• Reduction of time required for execution of each process,

• Real time information,

• Transparency of information and a subsequent decrease in fraud.

Other benefits from the realization of PCS are:

• Provides real time information to allow the next step of the process to proceed immediately - the information is available instantly, without additional loss of time;

• Elimination of paper transactions;

• Elimination of personal visits to multiple agencies;

• More efficient and faster cargo movement processes;

• Significantly improves efficiency at all stages of the cargo movement process through accurate transaction information;

• Improves security and Customs offices efficiency through track and trace system;

• Provides full transparency, prevents fraudulent activity and can drive the Authorised Economic Operator (AEO) programme;

• Higher efficiency and speed regarding port processes for all parties involved;

• Possibility to implement collaborative planning;

• Possibility to launch alert messages/status reports.

PCS can improve many parts of the processes in the port:

• Reporting to authorities is simplified. Information is distributed to the respective authorities in compliance with effective directives and local legislation (very important because supply chain performance is increasingly driven by state institutions in the process and the existing legislation in the country);

• Coordination of operations is enhanced at the physical, information, and financial layer. This means that cooperating and competing participants in the process are bound together. PCSs enhance the efficiency and effectiveness of interactions between port community members and thus help to reduce cargo processing costs by providing a central information network which increases visibility and data quality;

• Better data quality:

o The intrinsic category of data quality is related to data accuracy, objectivity, and reputation. PCSs enhance the accuracy of information by checking for input mistakes.

o Data accessibility is enhanced by centralizing community information as much as possible. The structured approach of information exchange via PCSs is better than information exchange through informal information channels. Information is detached from personal communication and thus made available on a 24/7 basis. PCSs also ensure data security by managing access rights and tracing unauthorized access attempts. Information is only made available to authorized members of the port community.

o The contextual category of data quality comprises the dimensions of data relevancy, timeliness, completeness, and data complexity. Besides assuring accuracy, input validations performed by PCSs also enhance data relevancy and completeness. PCSs also help to reduce data complexity by capturing information once and reusing it for different applications, so the need to re-type data can be avoided (“single submission”). Information also becomes more transparent because changes can be traced back to stakeholders and individual organizations or users. Regarding data processing, PCSs can enhance the automation of core workflows and processes based on captured information.

o Representational data quality. Its main dimensions are data interpretability, ease of understanding, concise presentation, and consistent representation. PCSs standardize the message exchange among port community members. All the participants in the processes involved use the same language in terms of data formats and transmitting services.

By having the ability to conduct the business of moving cargo through a PCS, this eliminates the need for multiple personal visits by different institutions involved in the process. Without a PCS, there is a need to visit multiple competent institutions (Customs Officies, Port Authorities, etc.) and for certain cargoes such as hazardous, agriculture and/or animal origin, and others of a specific nature, for which additional competent institutions need to be visited. All of this is time consuming and as not all competent authorities and institutions are located in one area, nor are they located in the port area, this requires the need to travel between the competent authorities, which means an increase in motorised traffic in and around the port and also potentially into the cities, which in turn creates pollution and traffic congestion.

From an environmental and safety point of view, speeding up the cargo movements and eliminated unnecessary journeys there is considerable benefits such as:

1. More accurate scheduling of vessels results in spending less time in port resulting in lower ships emissions (e.g., waiting for pilot aboard the ship, Customs clearance process, yard planning, etc.);

2. Container yard movements can be managed more efficiently through, for example, more efficient movements of containers for Customs inspections resulting in less movements of the container within the CY particularly when there are inspections required by multiple agencies (i.e. Customs Agancy, Port Health, Environment, etc.) which can be coordinated between the agencies;

3. More efficient gate processes results in less waiting and idling time for trucks at the in and out gate resulting in less truck emissions;

4. Managing the receiving and delivery of containers to the port through a truck booking

system can regulate the flow of traffic to and from the port minimising traffic in peak traffic periods. This reduces the road congestion and the truck emissions in and around the port;

5. Eliminates the need for journeys by personnel between various state institutions and other stakeholders in order to process documents reducing congestion and emissions;

6. There are considerable safety gains to be made by improving the flow of traffic and eliminating unnecessary journeys;

7. Reduction of paper documentation. In this way, PCS contributes to sustainable transport logistics and support the ambitions to meet global carbon reduction requirements.

Using electronic data exchange, the PCS is an effective real-time information system; fast, focused, flexible and multi-faceted, it aims to improve efficiency at all stages of the process of manifesting, through vessel discharge and loading, Customs clearance, health and phytosanitary control. PCS offers also improved security, cost reduction and potentially more competitiveness for each user.

Therefore, PCS is a platform that allows smart exchange between public and private operators in a port, by creating efficient processes, reducing procedure time and minimizing the use of paper documents. PCS is also a digital solution for the optimization of port's commercial activities, and in Croatian context, it should represent an intermediary between all the users, CIMIS (Croatian Integrated Maritime Information System) and the Customs system of the Republic of Croatia, if it is given the role of local Single Window under prescribed conditions and with appropriate authorization and certificates for such purpose. The definition of PCS determines the role of the system in port activities as support to all the commercial processes and activities within given process regulations. Its utilization generally increases the use of electronic communication in port cluster's business. The PCS's role is not management or administration by nature, in fact, it provides support to the commercial aspect of all stakeholders involved in seaport business. The final goal of the PCS implementation is enhanced exchange of information, maintaining set standards of quality, reliability and timeliness. Implementation of PCS results in significant improvements to the time consumption of ship's arrival to port that can be expected after process reengineering and especially after introduction of Port Community Systems that would result in increased efficiency and variable labour cost reduction. For example, scientific research in Croatia, using real administrative processes in the port of Rijeka, has shown that only administrative labour savings related to ship processing can amount to 48,5 % if proper reengineering is used and PCS is implemented.

Complete overview of PCS in Croatian ports within NSW, including interaction with other national and supranational IT systems of involved stakeholders is shown in Figure 11. on the next page.

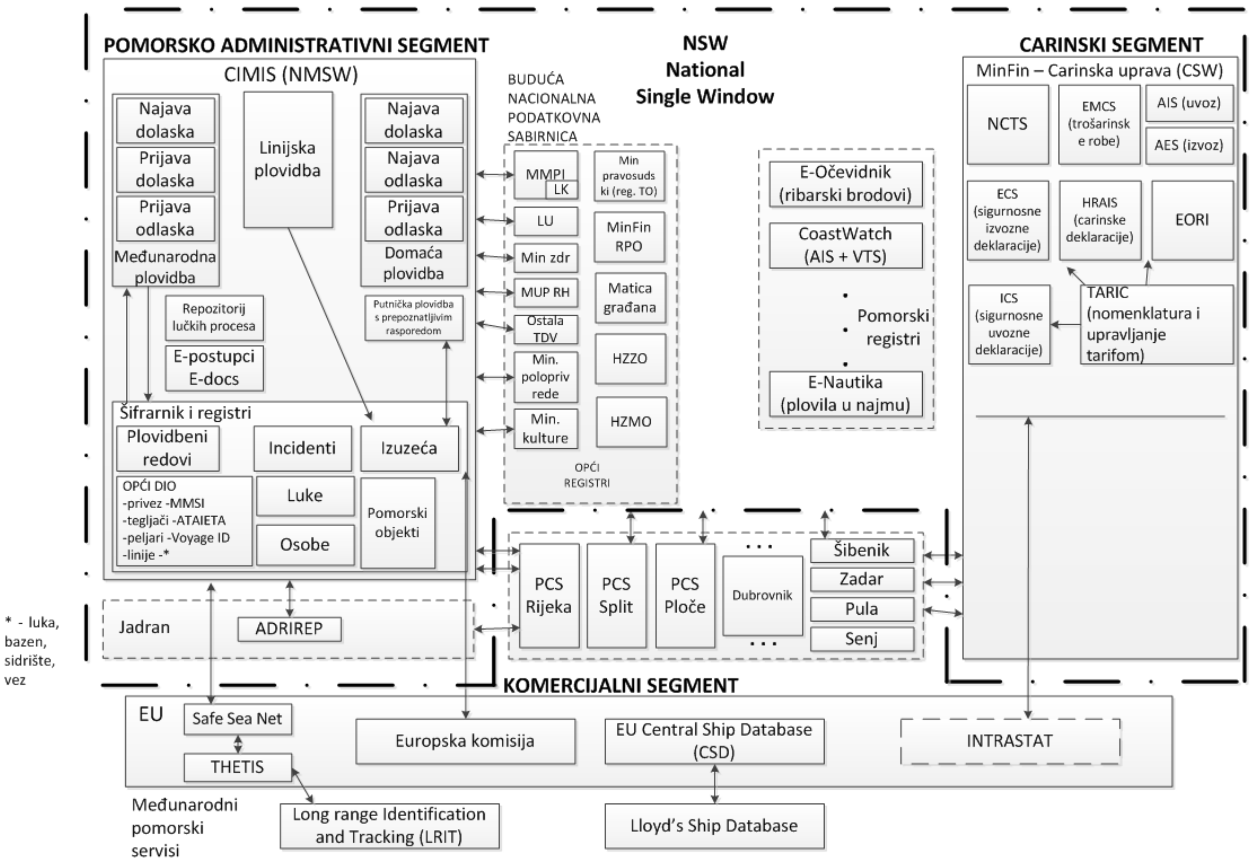

Figure 11: Interaction of NSW, PCS and other national and supranational stakeholders in Croatian ports

PCS needs to be connected to the surrounding systems (such as CIMIS) with underlying goal being avoidance of multiple data entry and facilitation of data exchange between stakeholders. Along with all the other systems enabling electronic communication in maritime traffic, PCS forms an important constituting and participating element of the NSW platform. The "Project of setting up a single national Port Community System" is currently underway, with the Ministry of the Sea, Transport and Infrastructure being the bearer of the project. Cooperating parties in this project are, among others, Port of Rijeka Authority and Port of Ploče Authority. Once the mentioned project is completed in early 2021., all the Croatian port authorities will have a fully functional PCS system at their disposal that will be adaptable to all Croatian cargo ports with minor changes and adaptation dependant on local characteristics of each individual participating port. Port of Split Authority, managing the second largest port in the Republic of Croatia (traffic of over 3,1 million tons of cargo), is currently not actively involved in the development of this project.

Stakeholders and users of PCS system can be divided into two groups:

1. Stakeholders controlling the entered data, and
2. Commercial data users and providers.

Supervisory part of the application, i.e. agencies controlling the data entered are:

1. Harbour Master's Office,
2. Port Authority,
3. Border police,
4. Phytosanitary and veterinary inspections,
5. Sanitary inspection, and
6. Custom office.

Commercial users providing the data are:

1. Waste disposal concessionaires,
2. Mooring, piloting and tug service providers,
3. Ships' agents,
4. Freight forwarders,
5. Cargo terminal concessionaires, and
6. Land transport companies.

At the moment, PCS is not implemented in the Port of Rijeka, even though implementation was initially planned for 2008., and an international competition request for quotation was announced that received four valid offers and vendor was selected and started with initial analysis and implementations. Project was temporarily suspended in 2011, partly due to the development of the CIMIS system and change of focus. The effectuation of PCS has been continued mid-2017. with preparations for the involvement of the project Technical assistance (TA) and the full implementation is planned for the yearearly in 2021. The project is financed with support of Connecting Europe Facility, in the amount of 1.6 million EUR. The Government of the Republic of Croatia will provide 15% of that amount. The project is well underway and executed on time. Contract for Technical assistance for design and implementation of PCS in Rijeka whose value is 2.97.312,50 Croatian kunas was signed on theat 19th April 2018. and the Technical assistance team comprised of subject matter experts from Sarda LLc, Aksentijevic Forensics and Consulting, LLc, Faculty of Maritime Studies Rijeka and Kiss Patterns has started immediately with activities whose final goal is to produce required PCS tender documentation including involved port stakeholders' process description, required hardware, system software and information security levels, rules for transfer of intellectual property and business continuity. Public counseling process was announced on time at 24th December 2018. and after comments of interested public members were incorporated, the public procurement announcement was issued on 31st December 2018. Currently, offers are being collected, requests for clarifications isare being issued and offers will be technically and financially evaluated within rules set by public procurement legislation rules according to which Port of Rijeka Authority has to abide, with final goal being to select economically most viable offer for implementation of PCS in Rijeka, that will serve as a base for nation-wide implementation of PCS after specific adjustments, including Port of Split.

For the purposes of Port coordination, Port Call Synchronization and the concept of "just in time arrival" of vessels and related planning of port logistics, PCS in Rijeka shall have capability to receive estimated time of arrival of the ship, to evaluate ships time of arrival against port and port actors availability, to agree upon improved arrival time for ship, to send recommended time of arrival of the ship, to receive estimated time of departure of the ship,to receive planned time of departure of the ship,to evaluate ships time of departure against port and port actors availability, to agree upon improved departure time of the ship, to send recommended time of departure. The above will be implemented at least through the following standards in the latest version available:

1. STM REQ 1.0 Capability to connect and act within security domain SeaSWIM and Maritime Connectivity Platform (MCP),
2. STM REQ 1.1 Capability to receive Voyage Plans in RTZ format according to IEC61174:2015 and S-421 standard on Port Call Synchronization, and
3. STM REQ 1.2 Capability to compose and send recommended time (RTA) and ETA using the Schedule in RTZ format according to IEC61174:2015 and S-421 standard.

Port of Rijeka is situated on a Pan-European route called Corridor 5b, its route is Rijeka – Zagreb – Budapest. Apart from the corridor, the oil pipeline of great significance is connecting Rijeka to refineries in Croatia, Hungary, Serbia and Bosnia and Herzegovina.

Rijeka GATEWAY project's goal is to develop and modernize the above-mentioned traffic route, i. e. to develop and modernize Port of Rijeka as the point of intersection of maritime and land traffic. This project signifies a large breakthrough for Rijeka as a port hub. The following activities are planned as parts of the project: extricating piers from the city's center, modernizing all segments of operative port business and implementing a modern PCS system. Particularity of

Port of Rijeka, in regard to comparison with Port of Ploče, is the dispersion of port basins, which is limiting the development of the project since it requires additional human and financial resources to support diverse locations and modalities of cargo transport inside the port itself. The development project should include all possiblethe future users and stakeholders, and especially companies which operate within the seaport cluster. This applies most of all to ports that have dislocated basins and different concessionaires of piers concessionaires. Current processes require multiplication of data, i.e. the same information needs to be entered several times delivered to multiple addresses which increases the possibility of errors and reduces the efficiency of the administrative and cargo-related procedures.

4.4 CASE STUDY 4: SINGLE WINDOW (REPUBLIC OF KOREA)

4.4.1 Initial considerations

In the early 1990s, a national project was elaborated to enhance the public sector's work. This entails changing the paper-based process into an electronic (EDI) process. In addition, the Government of the Republic of Korea has implemented and provided web-based systems for the sector's convenience since the late 1990s. In so doing, the Republic of Korea has launched e-business for the clearance of ships through electronic technologies (EDI and web systems). Based on these environments, the Republic of Korea launched a single window service in 2004, bringing together several national Government agencies.

4.4.2 Challenges of the single window and implementation strategy

Initially, there was little or no cooperation between Government ggencies owing to varying work styles. Less consistency of laws and policies related to logistics and transportation. Duplication of requests for the same or similar contents owing to individual organizations' processes.

Low reusability of resources due to little or no association between logistics entities.

High level of discontent among users owing to inefficient processing of individual organizations' officers and to lack of association between and lack of integration of Government systems.

Strengths of the project:

1. Powerful leadership of the Government of the Republic of Korea,
2. Recognizes the importance of national logistics business,

3. Shares the vision of a national logistics plan for the public sector as well as the private sector, and
4. Set up the outstanding strategy for national logistics.

Work process standardization provided by the project:

- Merge or remove steps covering duplicate or similar processes,
- Set up seamless logistics flow plan (policy) between logistics hub or logistics entities, and
- Modify laws and policies related to logistics.

Implementation of single-entry-point service within the project has enabled:

- Provide user-oriented one-stop service for the logistics business,
- Improved user convenience by system and network upgrade, and
- Consolidated connectivity between Government agencies and logistics entities or related organizations.

Information linking and common use has contributed towards:

- Enhanced information distribution functionality with information common use, and
- Improvement of the accuracy of logistics planning for a timely transportation environment

Promotion of the work automation and systemizing the private sector was done through:

- Proposal of the new technology to the private sector, and
- Set up of the strategic plan and construction of the system.

Related organizations and documents inclded are:

- The number of Government organizations that adopted the single window is 12, which includes authorities related to ports, customs, rail, immigration and quarantine. They cooperated to build the SP-IPC (Shipping and Port Internet Data Centre), and

- Documents analysis - Analyse the export-/import-related documents in order to set up form consolidation. Perform document simplification and unification for the analysed documents (similar or same documents).

As a result, the Republic of Korea analysed approximately 130 documents (including electronic and paper documents), such as:

1. The general declaration (FAL Form 1),
2. Manifest (FAL Form 2),
3. Crew and passenger list (FAL Form 4),
4. Dangerous cargo manifest (FAL Form 7),
5. Export and import cargo report,
6. Container discharging and loading report and
7. Container gate in/out report.

4.4.3 Single window construction

The Republic of Korea single window is called "SP-IDC", which stands for Shipping and Port Internet Data Centre. SP-IDC supports a single-entry-point service and also provides global or domestic maritime information to users in the Republic of Korea. In summary, SP-IDC is an information and operating system that processes userrequest operations (input) through a single entry point. The characteristics of SP-IDC are the following:

1. User-oriented service viewpoint for domestic export/import business,

2. Enables access through a single entry point,
3. Provides customer service for authorization and permission,
4. Provides connectivity with other government agencies,
5. Distributes electronic documents to the related organizations, such as customs and immigration, and
6. The primary protocol is SOAP (standard) and the second is TCP/IP. The protocol is determined depending on each organization's environment.

Orchestration of components inside SP-IDC single windows is shown in the following Figure 12.

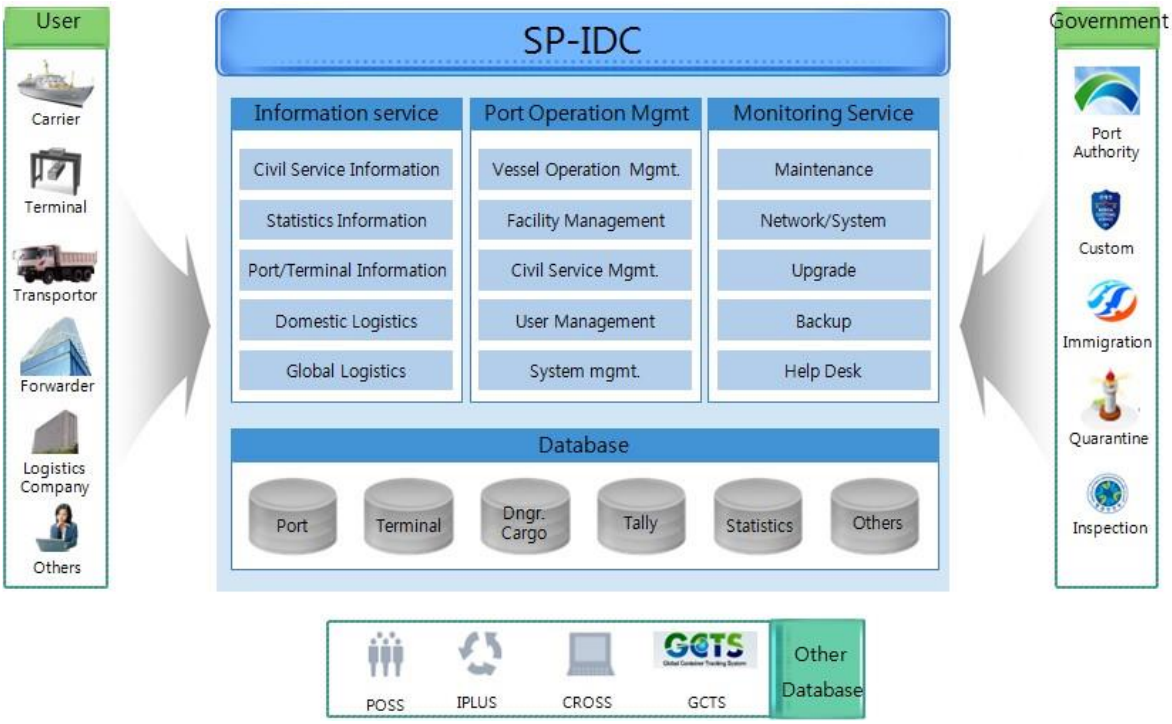

Figure 12: Service Configuration of SP-IDC

Basic functions of SP-IDC are:

1. Port operation management,
2. Vessel Operation Management: Vessel arrival/departure notice (oceangoing/coastal), Crew/passenger list, Vessel security information and Vessel arrival/departure approval (ocean-going/coastal),
3. Facility Management: Request/Approval for facility use, Facility use records,
4. Civil Service Management: Vessel particulars report/approval, Port-MIS application/approval, Company registration/approval, Customized information and application send/receipt status notification,
5. Information service: provides statistics, Logistics information, tally information, etc., and
6. Monitoring service: System/network maintenance, upgrade, help desk, backup, etc.

4.4.4 Construction Process

The Government of the Republic of Korea had applied the steps of analysis, definition of the strategy, establishing the service model, implementation and, finally, operation, to build SP-IDC. This process is the national construction process released by the Government of the Republic of Korea, and shown in the following Figure 13 on the next page.

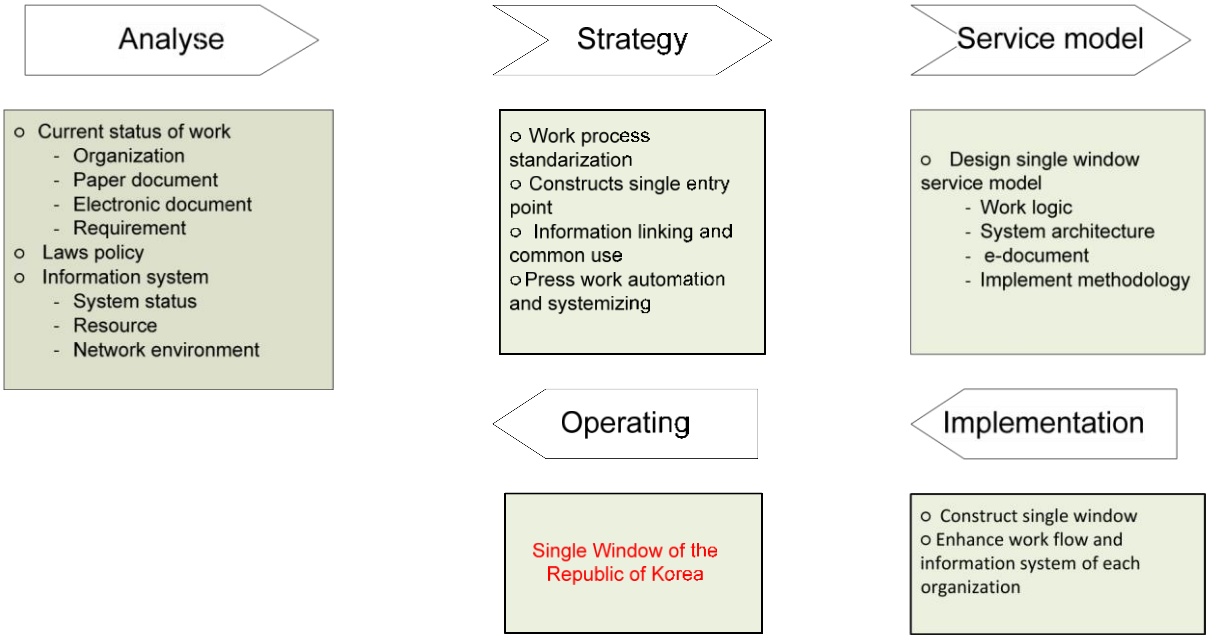

Figure 13: Service Configuration of SP-IDC

4.4.5 Expected benefits

Institutions of the Republic of Korea had in mind tentative qualitative and quantitive effects as expected benefits of the project's execution.

Qualitative effects achieved by the project are:

1. Minimizes double declaration and increases work efficiency with a single entry point
2. Reduces work processing time and costs to users as well as Government agencies
3. Secures and maximizes national competitiveness
4. Enhances convenience and interoperability through the unification and standardization of forms

5. Solves information disruptions through information linking and common use
6. Raises accuracy in demand forecasting logistics lead time is reduced
7. Enables transparent policymaking

Quantitative effects measured as a consquence of the project are:

1. Work innovation: Reduce about USD 7.8 million thanks to the enhancement of logistics work through process and form unification
2. Public service: Reduce about USD 5 million per year though e-documents and single window
3. In particular, it reduced about USD 1 million per year in the maritime transport area
4. Example: transport and transhipment - reduce processing time from 13 hours, 30 minutes, to 3 hours, 37 minutes, as a result, work efficiency improves by about 80%.

4.5 CASE STUDY 5: MNSW (THE NETHERLANDS)

The Dutch maritime single window envisages streamlining the transmission of data in the maritime sector between trade and Government agencies, reducing the administrative burden and coordinating feedback from Government agencies to trade. The main results should be trade facilitation and more effective and efficient Government action.

The starting point for the maritime single window should be, as far as possible, compatible with that for a single window for air transport and consecutive inland transport and should be attainable for all actors in the supply chain. Any single window remains within the responsibility of Government but must be developed in cooperation with trade partners.

The maritime single window in the Netherlands involves combining lots of already existing initiatives and partial solutions and systems, like information technology systems and coordinated border-management initiatives. Only should be done what is necessary and what is advantageous based on a cost-benefit analysis.

The maritime single window in the Netherlands is applicable to means of transport, goods and persons; aligns sea and inland transport; is part of a larger supply chain; and is an intelligent window that consists of four stages. Founding the single window on these stages facilitates management, research and implementation. Very basic single window layout is shown in Figure 14. on the next page.

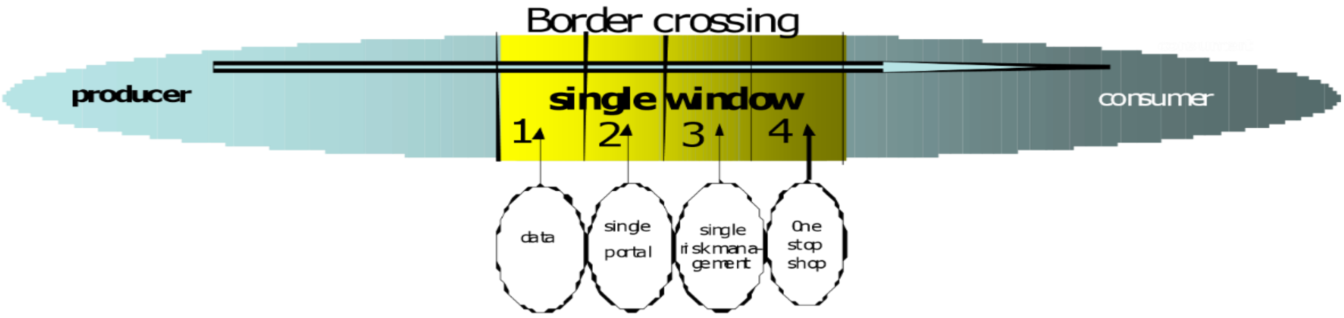

Figure 14: Stages of the maritime single window development

The oval represents the supply chain (in this case sea–inland transport and vice versa).

4.6 CASE STUDY 6: NACCS DEVELOPMENT (JAPAN)

4.6.1 Introduction

In 1999, an electronic applications system of arrival and departure procedures etc. for port administrators and harbour masters (hereinafter referred to as the "Port EDI system") was completed and launched. Electronic application systems for customs, immigration and quarantine etc. were respectively developed for the promotion of electronic applications. In 2003, the "Single Window of import/export and port-related procedures" (hereinafter referred to as "the First Single Window") was realized, and was the first of its kind in the world.

The First Single Window is a system that connects electronic systems for customs, the Port EDI system and crew landing permit support systems to one another. (The crew landing permit support system was developed for the realization of the First Single Window).

Basic layout of the First Single Window is shown in Figure 15.

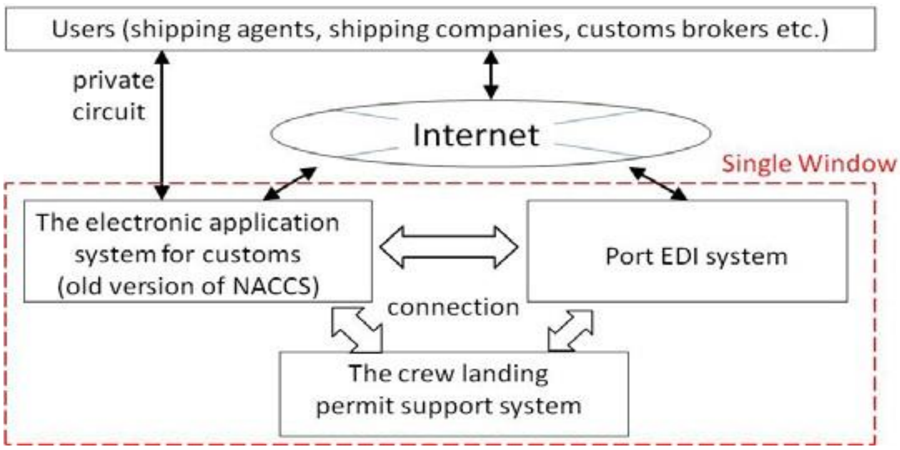

Figure 15: Japan's First Single Window

However, the separate Figure 1 — First Single Window development made it difficult for users to use these systems — except for the First Single Window — because users were required to access each system and to input the same items individually. Therefore, the systems were requested to allow users to submit documents of port-related procedures to many port-related Government offices in only one single transaction without inputting similar items several times.

In 2008, the Port EDI system and the electronic application system for customs were integrated on the demand of users. (Hereinafter, the integrated system is referred to as the "*NACCS system*"). In addition, the Inter-Ministerial Common Portal (unified electronic application single window) was set up to facilitate connections to the electronic application systems of plant and animal quarantine. As a result, the single window was accomplished in Japan (hereinafter referred to as "*the Next Generation Single Window*"). After accomplishing the set-up of nextgeneration single windows, things became very convenient for users because it became possible to submit applications to all port-related Government offices at one time through one single transaction. This document describes the concept behind the port-related procedures system (NACCS system).

Layout of the Next Generation Single Window is shown in Figure 15a on the next page.

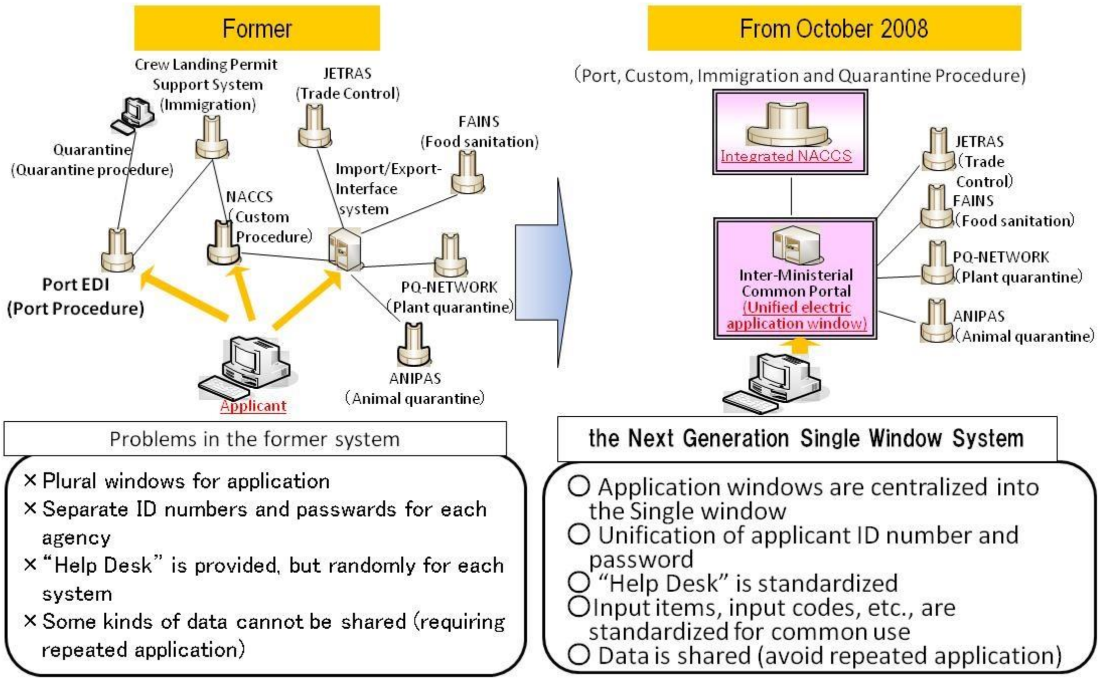

Figure 15a: Changes in systems for port-related procedures

4.6.2 Port-related procedures in Japan

The NACCS system is used by many types of users (for example, shipping companies, shipping agents, customs brokers and terminal operators, etc.). Electronic applications by these users are submitted to each port-related Government office through the NACCS system. In the NACCS system, users input one form and send it; after that, each port-related Government office receives these applications at the same time in one single transaction. Each port-related Government office then sends responses, including permissions etc., through the NACCS system.

Processing scope of NACCS system is shown in Figure 16. on the next page.

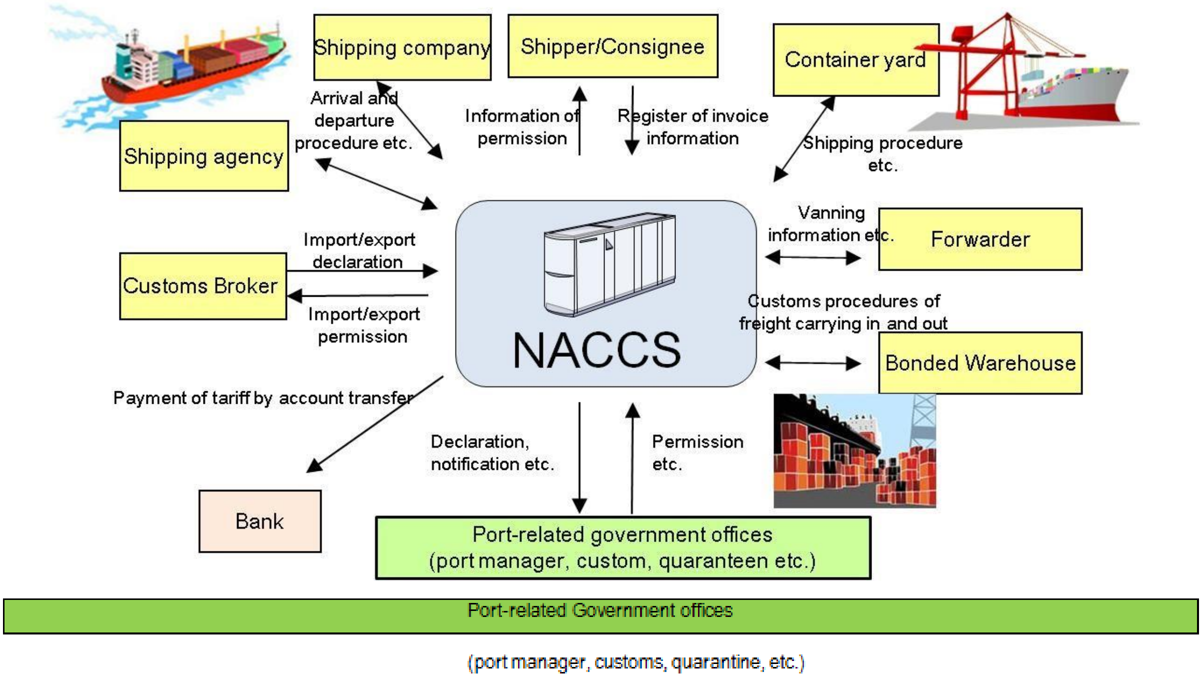

Figure 16: Processing scope of NACCS system

In 2005, port-related procedures were simplified as follows along with the conclusion of a FAL treaty by Japan, before the NACCS system was developed.

Arrival/departure procedure documents etc. were streamlined from 16 types (Japanese formats) to eight types (FAL formats).

1. Pre-arrival procedure documents that were not in FAL formats were streamlined from eight types to a single type.
2. The number of input items of port-related procedures was greatly reduced, from 600 to 200.

Also, with regard to electronic applications that make use of the NACCS system, the United Nations Standard Message (UNSM) in relation to FAL forms are as follows:

1. FAL form 1: General Declaration→CUSREP,
2. FAL form 2: Cargo Declaration→CUSCAR,
3. FAL form 3: Ship's Store Declaration→CUSCAR,
4. FAL form 4: Crew's Effects Declaration→ PAXLST,
5. FAL form 5: Crew List→PAXLST,
6. FAL form 6: Passenger List→PAXLST, and
7. FAL form 7: Dangerous Goods Manifest→ does not correspond with IFTDGN.

United Nations correspondence forms are sent in a different way from the UN/EDIFACT message. The policy efforts taken towards electronic applications, a single window and simplification of port-related procedures have helped to simplify and speed up port-related procedures.

4.6.3 The features of port-related procedure systems in Japan

The features of port-related procedure systems (after inegration of the Port EDI and the electronic application system of customs) are the following:

1. High degree of convenience,
2. Anyone can submit applications from anywhere through the Internet after he/she registers to become an administrator of the NACCS system,
3. It is not necessary for users to submit applications by both paper and the NACCS system because of the systemization of all basic port-related procedures. (This system covers all basic procedures including arrival/departure procedures, mooring facilities and cargo-handling equipment),

4. As a result of the integration of the Port EDI system and the electronic applications for customs, computer systems and passwords were integrated, alerting users to the fact that the NACCS system is a single window system, and
5. It is possible for users to utilize past input records; consequently, the procedures have become very efficient.

As a result of the project, compliance is achieved with internationally recognized formats for data exchange:

- FAL formats,
- Permit applications for mooring facilities and ship security information, which are not regulated under the FAL format, and
- UN/EDIFACT (International Standard).

Wide-ranging national application targets:

- 104 important ports in Japan, and
- Domestic/International ships.

High cost-performance of the project is also achieved. The cost of operation is inexpensive because new system is fully integrated as a system - with integrating the Port EDI system and the NACCS system, the operational cost was decreased by 30% or more.)

4.6.4 Future developments

In addition to port-related administrative formalities and procedures between businesses and the government bodies, additional project is under way to facilitate information-sharing between businesses (booking registration information by shippers, and similar activities). Through these efforts, the NACCS system has progressed in terms of its performance, and it became positioned as a total logistics platform. Additional efforts are being made to further enhance efficiency in international logistics in ports.

There are initiatives to establish a fully integrated system by integrating the NACCS system and the electronic application systems of plant and animal quarantine, etc.

4.7 CASE STUDY 7: SAFESEANET (NORWAY)

4.7.1 Introduction

Ships entering Norwegian territorial waters and ports are required to announce and report arrival and departure information to several national governmental agencies. The execution of these reporting requirements is time-consuming both for mariners as well as for shore-based personnel. In 2002, a community-wide vessel traffic monitoring and information system called SafeSeaNet (SSN) was established in Europe through the European Union. The Norwegian Government appointed the Norwegian Coastal Administration (NCA) to coordinate the development and implementation of the national component of this EU-wide system. Accordingly, the SafeSeaNet-Norway ship reporting system was established in 2005.

The establishment of SafeSeaNet Norway as a national ship reporting system was the first step towards simplifying reporting and information flow between ships and shore-based facilities in Norway.

4.7.2 SafeSeaNet Norway; the single window portal for ship reporting

The United Nations Economic Commission for Europe has described "single window" as "a system that allows traders to lodge information with a single body to fulfil all import- or export-related regulatory requirements" (according to ECE/TRADE/324).

The development of SafeSeaNet Norway has been implemented as closely as possible to the above-mentioned definition.However, current implementation emphasizes regulatory reporting requirements more than fulfilling information requirements related to international trade. Electronic Port Clearance in this context is a single window solution for the electronic clearance of ships arriving at or departing from a port and it does not normally include cargo clearance for import or export.

Application using single window portal is performed for announcement, arrival, departure and HAZMAT reporting requirements applicable to all SOLAS Convention ships (passenger ships and cargo ships of 300 GT and upwards) entering Norwegian territorial waters with the intention of crossing the Norwegian baseline or entering any Norwegian port. The system handles on average over 7,000 ship reports every month.

SafeSeaNet Norway enables Norwegian governmental agencies to receive, store, retrieve and exchange information reported by SOLAS Convention ships in national waters. The system contributes to maritime safety as well as port security and logistics.

After the establishment of SafeSeaNet Norway, a process of replacing traditional, non-electronic national reporting schemes, such as those related to customs, border control and port State control, was initiated in order to make ship reporting more seamless and smooth for all stakeholders involved. The inclusion of notifications relating to customs and border control also requires non-SOLAS ships to report through SafeSeaNet Norway.

Figure 17 on the next page illustrates the information flow between ship and port via SafeSeaNet Norway and the information distribution to other Norwegian governmental agencies

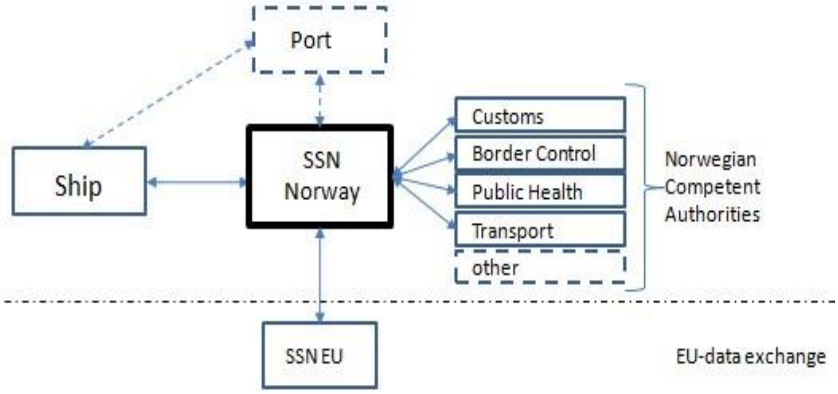

Figure 17 — Processing scope of NACCS system

There is a consensus between matter experts that there is a need to set up national maritime single windows, taking into account and building upon existing standards. The development of SafeSeaNet Norway takes into account the European Union's efforts to progress and align development of single windows within European Union countries, including the exchange of data reported between countries. These efforts are primarily concerned with the Electronic Port Clearance (EPC) of the ship as a transport means, and less with the trade- and cargo-related issues. Norway considers single window systems as future components of the IMO e-navigation concept. Therefore the development of SafeSeaNet Norway takes into account the IMO e-navigation development.

4.7.3 The involvement of governmental agencies

Since the national reporting system was established, NCA has continuously encouraged other governmental agencies to participate in the NSW, and to implement their reporting requirements using SafeSeaNet Norway. Through SafeSeaNet Norway, information reported by ships is distributed to the relevant governmental agencies according to their mandatory reporting requirements.

Mandatory pre-arrival announcements to Norwegian Customs were launched in SafeSeaNet Norway in January 2011. Before the transition, Norwegian Customs annually received and processed approximately 180,000 paper-based pre-arrival announcements (notifications). The integration of electronic reporting into SafeSeaNet eases the administrative burden for Norwegian Customs personnel, mariners and agents. Electronic notifications also provide Norwegian Customs with relevant vessel information at an earlier stage of the voyage, giving the agency more time to organize and plan operations in the national waters.

An example of the reporting interface is shown below in Figure 18. This shows the interface for the collection of customs declarations where the users have an option to upload a prepared file containing crew information or enter the same information manually.

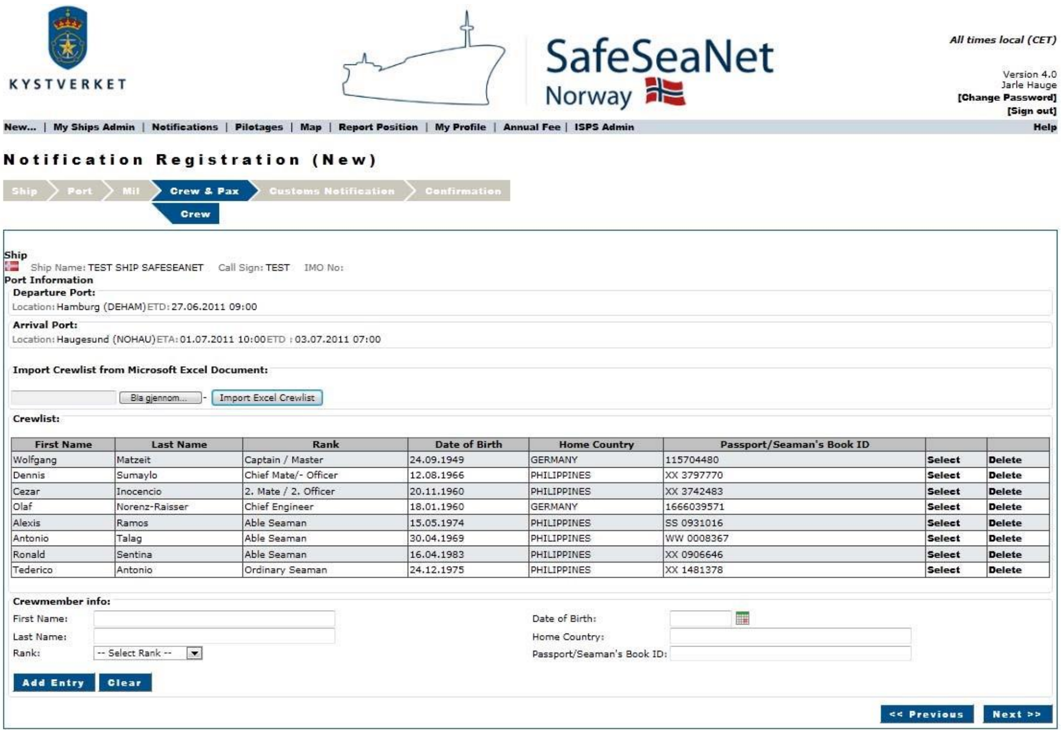

Figure 18 — SSN Norway Customs interface

Early in 2011, NCA and the Norwegian Maritime Directorate launched electronic port State control (PSC) pre-arrival notifications in SafeSeaNet Norway. Inclusion of PSC notifications represented another step towards more efficient ship reporting and information flow between ships and shore-based stakeholders.

4.7.4 SafeSeaNet Norway — recent developments

NCA cooperates with the Norwegian Police Directorate to include border control reporting requirements, containing crew and passenger information, in SafeSeaNet Norway. Also, in cooperation with Norwegian Defence Forces, NCA is now finalizing the implementation in SafeSeaNet Norway of ship reporting requirements prior to entry into Norwegian waters.

SafeSeaNet Norway is utilized beyond its original intended purpose because of its ability to receive, store, retrieve and exchange information. This is exemplified by the Norwegian Climate and Pollution Agency, that uses derived information to monitor for the potential illegal transport of hazardous waste in 160 port terminals. Also, the Norwegian Radiation Protection Authority and the Norwegian Coast Guard are using SafeSeaNet Norway for accident prevention and maritime safety and security within the Norwegian waters. Statistical functions have been established to meet both national and international needs and demands for specific types of information.

Experience indicates that SafeSeaNet Norway has become an important information platform for several governmental agencies by removing paperwork, simplifying information flow and reducing the need for telephone, email and fax exchanges.

Norway continues to develop SafeSeaNet Norway until all maritime ship reporting required by all relevant Norwegian agencies is fully consolidated and electronic. The development is based on constant evaluation of the needs of onboard and onshore users as well as mandatory reporting requirements.

4.8 CASE STUDY 8:MAINSYS AND SEAMEN CONTROL SYSTEMS (ISRAEL)

4.8.1 The solution for crew identification

The ship's agent had to transmit the data to about five separate authorities, a step that then had to be repeated by the captain. The process was rife with errors (unintelligible handwriting, typographical errors, misspelled names, etc.). This sometimes led to cases where an individual would be registered several times in the system and under a different name at each port. Checking a seaman's history was problematic owing to the aforementioned inaccuracies in the data. If a seaman had several credentials (e.g. passport, seaman certificate), the system would fail to identify him as a single individual and would store his personal data twice. Identification was done visually (using photographs): an unreliable process. Papers were also inspected visually, so that forged papers could easily pass as authentic.

A nationwide system that documents all seamen that arrive in the country. The advance reception of crewmembers' personal information via electronic communication. The one-time transmission of the data and the subsequent distribution of the information to all relevant authorities through MAINSYS (Port Community System). Seamen undergo a biometric inspection, and their paperwork is checked electronically by means of a mobile kit (stored in a suitcase) on board the ship. New seamen are enrolled while still aboard the ship. The distribution of data regarding the seamen to all the country's ports. Shore passes are issued and biometric inspections are made at the port gates whenever a seaman enters or exits the port.

Interacting systems and MAINSYS are shown in Figure 19. on the next page.

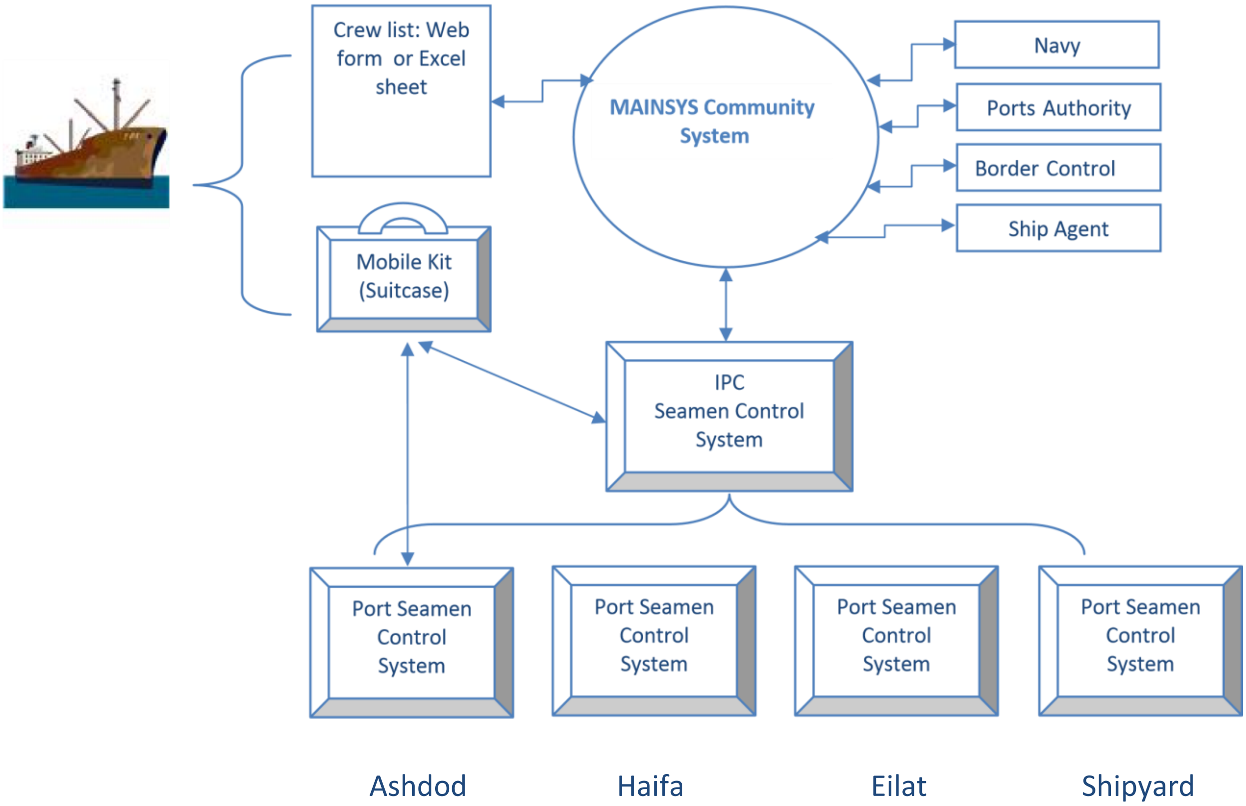

Figure 19: Schematic depiction of MAINSYS Community Systems and its main dependancies

The combined system consists of two modules: IMO crew list module, and a Seamen Control System. Seamen Control System will be described in more details in the following chapter.

4.8.2 The IMO Crew List module and the Seamen Control System

The captain reports his crew members by means of an integrated Microsoft Excel file that is sent by e-mail to MAINSYS. This minimizes satellite communication expenses. Using an Internet-based screen, the captain files a crewmember manifest directly to MAINSYS. This minimizes the potential for errors, since online logical validation algorithms are applied to the incoming data.

Afterwards, the ship agent, the navy and other relevant authorities receive an automatic e-mail notification that the report has arrived. Using MAINSYS, they can read the computerized crewmember report and approve it. At the same time, they receive the data via electronic transmission and are able to store it in their systems. A computerized electronic report transmission of the crewmember manifest is also sent to the Seamen Control System, which loads it into its database. Thus, the list is already available to the inspectors when the crewmembers undergo the onboard security checks.

Exact outline of the Seamen Control System's client hardware package is shown in Figure 20.

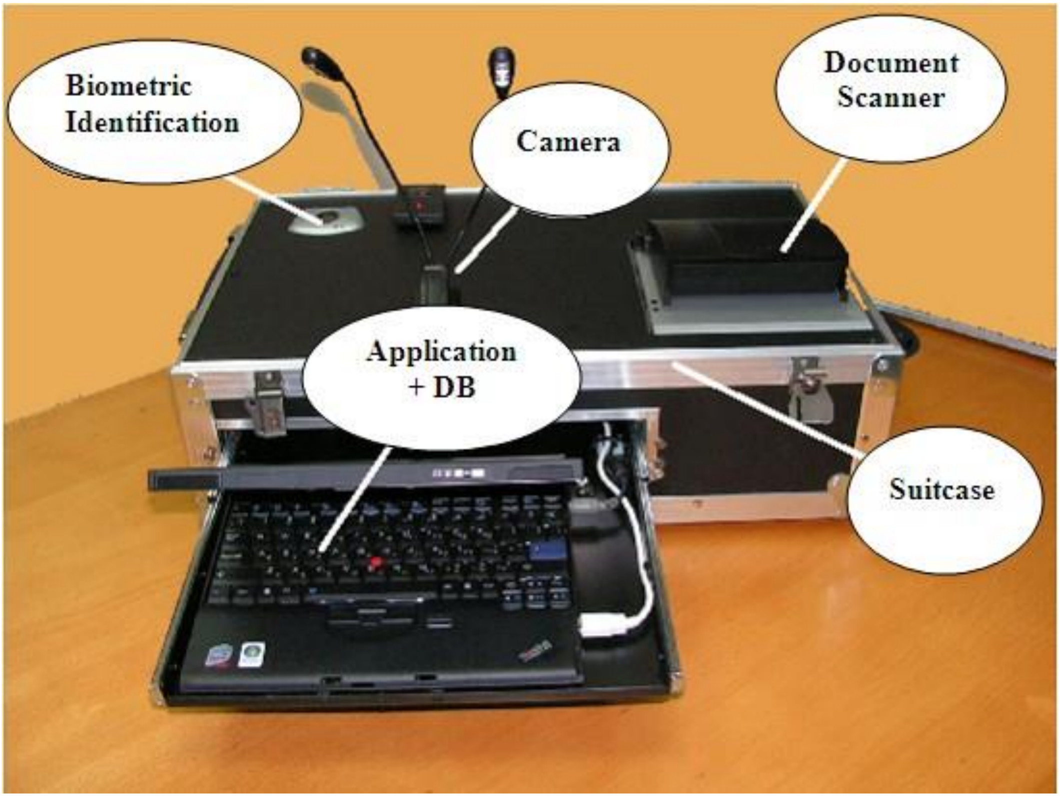

Figure 20: A schematic depiction of the Seamen Control Systemćs

Seamen Control System contains the following modules:

1. *Seamen and ships management module:* responsible for managing the seamen and ships whose records are stored in the system.
2. *Crew reporting module*: responsible for transmitting crewmembers' personal data from the seamen reporting system to the Seamen Control System.
3. *Biometric module*: a technological module responsible for managing the system's fingerprints database.
4. *Image acquisition module*: a technological module responsible for acquiring imagery obtained from the mobile suitcase.
5. *Document acquisition module*: a technological module responsible for acquiring new documents by means of a designated program for scanning.
6. *Interface with ships system module*: a technological module allowing communication with the port's ships system.
7. *Reports module*: a module that allows users to generate reports based on various criteria.
8. *Shore pass production module*: a module capable of issuing shore passes for seamen.
9. *System management module*: a module responsible for managing users and system definition tables.

4.8.3 Achieved results and deployed technology

At the current stage of adoption, most of the improvements are concrete and evident in the work process.

A nationwide system that documents all seamen arriving in the countr provide for the following:

1. Early reception of information about the seamen through electronic transmissions,
2. Single transmission of data and the subsequent distribution thereof to all relevant authorities using MAINSYS (Port Community System), which improves efficiency and prevents mistakes,
3. An onboard biometric inspection process for seamen and electronic inspection of documents, using the mobile kit (suitcase) on board the ship,
4. Onboard enrolment of new seamen,
5. Distribution of seamen information to all ports in the country,
6. Production of shore passes and biometric inspections at the gates of any port whenever a seaman passes (entering or exiting).

Obstacles that were overcome and chalenges that were solved with implementation of the project are:

1. The conservativeness of several authorities, which made it difficult to introduce new methods for reporting crewmembers,
2. **Difficulties** in quantifying benefits when it came to data quality and examinations,
3. Some of the authorities have yet to install community interfaces,

4. Satellite communication from ships is costly,
5. Quality of data in the file transmitted by e-mail,
6. The necessity of technical solutions for synchronizing the inspection systems of the various ports (the databases stored in the mobile kits are not always connected to the network), and.
7. Integration of physical aspects of the seamen inspection into a suitcase that can be carried manually onto a ship.

Main characteristics of the implemented Seamen Control System are:

1. Number of seamen currently recorded in the national system: 20,000
2. Average number of seamen per ship: 15
3. Number of ships visiting each port daily: 10-20
4. Number of mobile kits in use: 9

A designated suitcase of the portable system contains a computer, camera, document scanner and printer. The suitcase's relatively light weight makes it easy to scale a ship's ladder while carrying it. The suitcase is impermeable to water and buoyant. A built-in power supply allows it to operate for an entire shift without an external power source.

A special program for scanning and checking passports is developed and installed on the embedded computer. The software can identify passports from all over the world, and has implemented algorythm for forgery recognition.

The system also deploys biometric identification technology capable of operating under rough conditions (oily hands, etc.). It also uses software and technology for synchronization of scattered Oracle databases and the databases of the mobile kits.

The integration of external Microsoft Excel files arriving via e-mail at the MAINSYS Cyber Ark electronic safe system is enabled, and the feedback is generated in case of erroneous data. The system also contains external connectivity conduits and it can be accessed from an Internet platform.

5. Overview of disruptive technologies applicable to multimodal transport ICT projects

5.1 IoT and Big Data analytics

Internet of Things (IoT) is a new and upcoming paradigm relating to networking of various applicative physical devices ("*things*"), as opposed to a more traditional arrangement situation where networking refers primarily to computer and network devices and peripherals. "*Things*" are embedded with electronics, software, sensors and connectivity that enable them to achieve functional value and exchange data with other devices and systems. They communicate over Internet and cover a variety of protocols, domains and applications.

Some of the current use-cases for this technology in the multimodal chain are:

1. Automatic traffic routing based on the real-time information of conditions of traffic (rail, road, also air, water) congestion, yard occupancy, by using route selection and multimodal selectionand change,
2. Ability to automatically react on the anomalies to prevent traffic congestion and waiting times,
3. Better planning of deliveries based on the real-time and predicted traffic conditions,
4. Connectivity to upcoming new communication standard like v2v (vehicle to vehicle) and v2i (vehicle to infrastructure) for peer-to-peer (p2p) real-time information gathering,
5. Integration of autonomous driving (robotic) solution in the restricted (port community) for traffic optimization, and
6. Optimization of movement of cargo manipulation machines based on real-time, IoT and big-data based information.

5.1.1 An overview of IOT and Big Data technologies

Typical applications of IoT are various sensors or transponders used on farms or in search and rescue missions, vehicles with built-in sensors, biochips, wearable computers in any form and home or industrial automation systems. IoT technology in logistics is used to ensure quality of shipment conditions (monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes), item location (search of individual items in big surfaces like warehouses or harbors), storage incompatibility detection (warning emission on containers storing inflammable goods closed to others containing explosive material) and fleet tracking (control of routes followed for delicate goods like medical drugs, jewels, perishable or inherently dangerous merchandises).

IoT paradigm emerged due to convergence of various technologies approximately as of 2013., even though it has been in some its aspects discussed for decades and has been a topic of science fiction even longer than that.

IDC has predicted that IoT spending will reach $745 billion by the end of 2019. and surpass the $1 trillion mark in 2022. That presents a 15% increase over 2018's $646 billion. U.S. and China will be the spending the most at $194 billion and $182 billion respectively. They are followed by Japan, Germany, Korea, France, and the U.K. However, the fastest increase in spending growth will be from Latin American countries: Mexico, Colombia, and Chile.

Presently, there are over 23 billion IoT connected devices worldwide. This number is expected to reach 30 billion by 2020. and over 60 billion by the end of 2025. Gartner's report predicts that by 2020. more than 65% of enterprises will adopt IoT products. However, the report also stats that a lack of data science specialists will inhibit 75% of organizations from achieving the full potential of IoT.

The convergence of various technologies will raise numerous questions in industries logistics sector certainly will not be left out of the development. These questions can be divided in several categories that need to be addressed, among them the most important being information security, design, sustainability and environmental impact and privacy, autonomy and control.

The ever more rapid development of cheap low consumption sensors has resulted in ever more "*items*" being equipped with such sensors. This effectively means all such items can be tracked and that any activity such item is engaged in, or any circumstances it is exposed to, can be "*measured*". Thus, the item "*senses*" an activity, event or an environmental factor. Such item is also capable of receiving information from other "*sense-like*" items. A network of such communicating items can be labelled as an *Internet of Things (IoT)*.

Effectively, the IoT refers to a wide and increasingly large range of physical objects ("*things*"), that are connected to a system and that are able to send and receive data.

The IoT is a development that is rapidly taking place across all industries and throughout society. It is obvious that such a network of communicating "*things*" opens up a large array of possibilities for logistics.

These "*sensorized*" items will allow all things, including autonomous and robotized vehicles and equipment as described earlier, port equipment, infrastructure as well as the goods themselves to become connected.

This will result in massive amounts of data being produced and being available. It is not hard to imagine this offers an almost infinite array of possibilities for logistics and port operators and stakeholders to optimize and automate processes, and to gather an ever more precise and real-time insight.

In order to effectively and successfully implement applications that build on the IoT possibilities, robust communications systems need to be in place. Ports, with containers and equipment interfering with signals, and warehouses with attenuated and scattered signals, are notoriously difficult environments. Even though many ports and warehouses have network infrastructure available, many of it is about a decade old and is often not suited to the new IoT applications' requirements of high bandwidth and secure protocols.

New cloud computing solutions will make data instantly and simultaneously accessible in many locations and across many devices. This massive amount of data requires the collection, curation, analysis and storage of large and complex datasets. This is often defined as the use of *big data.*

Having discussed the "*sensing*" of data and the collection and storage of it, the true challenge lies in the use of this data. The data will thus "*actuate*" new processes or decision making. It can be used in port operations such as preventive maintenance schedules of either infrastructure or equipment, create intelligent inspections systems, sensor track data on speed, direction and driving performance of large numbers of vehicles in order to optimize future routes, or support resilience management tools in order to adjust routing of supply chains in real time.

The possibilities are almost endless and consequently, the evolution of IoT and the use of big data creates the prospect of logistics becoming a data-centric industry where information takes precedence in logistics services' value propositions over the actual ability to move cargo

The growing interest and developments in the area of IoT and big data analytics gives rise to new business models and partnerships and questions on who is best positioned to lead these partnerships. IoT and big data analytics have an impact on a large number of processes, which implies many stakeholders have to work together to make it work.

There are five key groups of players: device providers, operators, platform providers, systems integrator and application providers. None of these players can deliver integrated IoT solutions, so partnerships are crucial. Device providers are basically vendors who might capture more value in the chain if they succeed to develop a service model. The operators are very critical stakeholders as they provide the connectivity.

However, they need a partner to go to market and are unlikely to play a leading role in any partnership/alliance. The platform providers bring together the hardware, the connectivity, the service providers and the vertical applications to provide industry with specific solutions. Most of the serious players are eyeing to become platform providers. System integrators make the individual components of IoT to work together in the most optimal way for the customer. They are typically niche players and enter into partnerships with large platform players. The application providers are often small and might be integrated in larger IoT players.

Current venues of development of IoT and big data analytics applicable to multimodal transport are related to the following undertaken efforts and technical challenges:

7. Digital identification of cargo with smart sensors, IoT solutions, and utilization of real time analytic computer vision,
8. Digital identification of passengers (with respect to GDPR) with smart sensors, IoT solutions, computer vision and through personal mobile devices
9. Timestamping of passages position at strategic locations (with IoT, computer vision, artificial intelligence) with goal being to timely identify gaps for process improvements
10. Loading of acquired data into visible, trustworthy and secure blockchain
11. Loading of data in big data repositories for data analysis
12. Usage of big data to feed machine learning algorithms for:

   a. Assement of the desired speed of mobility of cargo / passengers
   b. Correlation of other logistic data to identify mobility anomalies / errors
   c. Prediction of the bottlenecks based on recognized patterns
   d. AI-assistedd decision making for corrective measures (for traffic automation,...)
13. More efficient loading /unloading procedures and planning of resources based on real-time data and AI algorithms
14. Connectivity to environmental IoT sensors and other environment data to maintain the sustainable operation in the local communities
15. Usage od the digital twin concepts for simulation of mobility efficiency in respect to different loads

5.1.2 Use-cases of IoT implementation projects in multimodal logistics

The usage of smart devices in transportation industry is nothing new, but with IoT devices**,** this becomes even more widespread and used in new, innovative ways. IoT devices can be used in various places in multimodal logistics. From the control of individual components of a vessel to cargo containers, trucks, trains, fleet management and connected ports.

The usage of smart devices in transportation industry is nothing new, but with IoT devices**,** this becomes even more widespread and used in new, innovative ways. IoT devices can be used in various places in Maritime Industry. From the control of individual components of a vessel to cargo containers, fleet management and connected ports.

The growing use of sensors attached to both products and the enclosures that move them from point A to point B opens a new window into real-time discovery of actual conditions, with clear ramifications for cost control and accountability. This is interesting particularly for some special types of cargo, like perishable goods or dangerous cargo, where quick and careful delivery is of key importance.

Smart IoT devices are very interesting also for ship owners. In a recent research done recently by Inmarsat, maritime industry seems more inclined to adopting analytic, management and operational tools applied through IoT than previously supposed. According to report, ship owners are far more open to deploying IoT tools than some other industries, including mining and agriculture.

IoT applications in shipping vary from route optimisation to maintenance and smart cargo storage. It can improve transport and logistics thru measurements: weather, movements, maintenance and state of cargo. It can vastly improve safety in the logistics operations and handling dangerous goods. Another cost-cutting application of IoT systems is their ability to reduce insurance premiums, providing insurers with more data.

One of best real-life examples of usage of IoT technology is Port of Rotterdam, where there is in place a system for collecting data regarding ships in dock, cranes in the yard and individual containers. The port's operators now have greater transparency, better prediction of estimated time of arrival and completion of operations than any other shipping hub in the world, helping them to movie 25-50% more containers per hour than any other of its competitors in region.

Interestingly, quite a large number IoT adoption is being driven by environmental legislation. Internet of Things are one of key technologies that will be integrated and complementing existing products of DBA Group. To prove the benefits of IoT technology in ports, the company developed and publicly presented some years ago a pilot project named ISMAEL in the Port of Bari, Italy, that integrates environmental IoT sensors (temperature, wind and sea currents), traffic sensors monitoring truck movements with the advanced digital twin 3D graphics representation of current status and operations in port community. With this Decision Support System (DSS) solution, Port operators and administration can better mitigate the environmental impact of logistic operations and take appropriate measure to correct or even prevent unwanted situations.

Although the information gathered with IoT sensors is needed and useful to monitor the environmental situation through the ISMAEL application, the acquired data is even more useful, having the possibility to predict unwanted environmental conditions based on the machine learning of data from the past, meterological forecast and port traffic estimates for the future. The more data will be acquired over time, the more precise and useful will be the predictions. Acquired data will be then reused as trigger to handle other operations and activities in the port communities, which will streamline the operations and at the same time diminish the peek burden and impact on environment and local community.

Artitficial intelligence (AI), with its field of machine learning, is a group of new technologies that will have a big impact on many, not just one particular area of Maritime Industry. DBA Group is researching the possibility for usage of AI in various parts of software packages and IBIS systems for integrated port activities supervision and administration (PCS, TOS, VBS and railshunting modules), that can help even better process automation, business planning and resource usage. It is belived that this will lead to a new cycle of operations streamlining and cost reduction that will pay off the investment in a reduced time period.

5.2 DISTRIBUTED LEDGER TECHNOLOGIES

The supply chain is tied to the complex processes of creation and distribution of goods. Depending on the product, the supply chain can include many phases, multiple geographic locations, several accounts and payments, several individuals, entities, and means of transport. Therefore, procurement of supplies can be extended over several months. Because of the complexity and the lack of transparency of traditional supply chains, it is of great interest for the stakeholders involved in the logistics process to introduce and develop blockchain technology to enhance the logistics processes in the supply chain, making them more sustainable. The blockchain technology is most often mentioned and used in crypto currencies, but the extent of possible applications is significantly larger. Blockchain is a distributed book (ledger) with many potential applications. It can be used for any data exchange, whether it is contracts, tracking of shipments and financial exchanges (payments). Each action is captured in the block and the data is distributed over many nodes (computers) making the system transparent. Every block connects to the one before and after, which makes the system safer. Blockchain can increase the efficiency and transparency of the supply chain and positively affect all logistic processes, from storage to delivery and payment. In addition to increased transparency and security achieved through blockchain, it is possible to speed up the physical flow of goods. Tracking goods through blockchain can improve the decision-making process with end result being a more satisfying service for the end user. Blockchain technology possesses the potential for creation of new logistics services, as well as new business models. This paper researches the potential of blockchain technology and its applications, with special emphasis on blockchain technology in logistics. It should be emphasized that no available literature sources have been found that comprehensively explain the exclusive application or blockchain technology principles in logistics. The goal of this paper is to explore possible use of blockchain technology in logistics processes, to identify impact of blockchain technology on business transparency and why it is important to implement blockchain technology in every part of the supply chain.

5.2.1 Blockchain Technology

The blockchain technology is based on a method by which previously unknown parties can jointly generate and maintain practically any database on a fully distributed basis where transaction correctness and completeness if validated using consensus of independent verifiers. The idea behind blockchain technology can be traced to 1991 when Stuart Haber and W. Scott Stornetta published their work on cryptographically secured chain of blocks. In 1992, they incorporated Merkle trees into the design allowing several documents to be collected into a block. Blockchain technology gained significance in 2008 when pseudonymous Satoshi Nakamoto published the Bitcoin white paper.

The system works in a way that a copy of the database or its partial copy is distributed to each party, and such party may then make changes to the database subject to collectively accepted rules. The changes made by the various parties are collected and stored in the database at regular intervals as bundled packets called '*blocks*.

For better understanding, blockchain is defined as follows: „Blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding time stamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity.

Once the block is full, nodes simultaneously perform Proof-of-Work - mathematical operations that are difficult to solve but whose correct solution is easy to verify. These mathematical operations are indispensable to the operation of the system, as they force the verifying nodes to expend processing power which would be wasted if they included any fraudulent or invalid transactions. The first node that succeeds in solving a Proof-of-Work problem broadcasts the solution, along with the block of transactions, to all other nodes. Nodes can quickly and cheaply verify the accuracy of the transactions and solutions, and when 51% of the processing power of the network votes to approve a block, nodes begin recording new transactions to a new block, amending them to all previous blocks.

The blockchain technology solves double-spend problem with the help of public-key cryptography, whereby each user is assigned a private key, and a public key is shared with all other users. The main idea of the blockchain is a distributed database comprising records of transactions that are shared among participating parties. Every transaction is verified by the consensus of most of the participants in the system, making fraudulent transactions unable to pass collective verification. Once a record is created and accepted by the blockchain, it can never be altered.

It allows for the creation of a jointly generated electronic time stamp that all participants can trust, even if they do not trust one another. In this manner it is easy to verify the origin and accuracy of the information whatever its source. No external intermediary (such as a centralized server) trusted by all the parties is required to validate the data.

This mechanism of work includes three most important properties of the Blockchain: decentralized, verified, and immutable, as shown in Figure 21. on the next page.

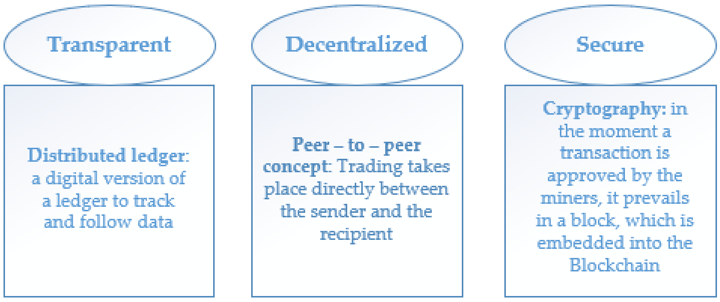

Figure 21. Basic properties of Blockchain

The system is decentralized because the network is entirely run by its members, without relying on a central authority or centralized infrastructure that establishes trust. To add a transaction to the ledger, the transaction must be shared within the blockchain's peer-2-peer (P2P) network. All members keep their own local copy of the ledger. It is verified because the members sign the transactions using public-private key cryptography before sharing them with the network. Therefore, only the owner of the private key can initiate them. The members can be both transparent and stay anonymous because the keys are not linked to real-world identities. It is immutable through its consensus algorithm: one or more transactions are grouped together to form a new block. All members of the network can verify the transactions in the block. If no consensus on the validity of the new block is reached, the block is rejected. Likewise, if consensus exists that the transactions in the block are valid, the block is added to the chain. A cryptographic hash is generated for each block. Each block not only holds transaction records but also the hash of the previous block. This creates a block interdependency linking up to a chain – the blockchain. Altering a transaction on the blockchain would retroactively require not only to alter the local records on most of the networks members' devices but also altering the cryptographic hash of every block down the chain.

Blockchain tackles an elusive networking problem by allowing for transactions that are not relying on the centralized authority. Values, goods and rights can be exchanged without central institutions. Such transactions are verified, monitored and enforced by means of the blockchain technology. It offers confidence to everyone involved in the process.

This kind of technology changes the way transactions are conducted - a decentralized system, without using centralized system (banks, companies, etc.). In industry, blockchain technology transactions can be initiated and carried out directly “from peer to peer”. As a result, the industry companies can cut costs and speed up processes; they become more flexible, as many, previously manual work tasks are carried out automatically through smart contracts.

One major promise of blockchain is to create transparency – every member of the network has access to the same data, providing a single point of truth. This can be the most important benefit of blockchain technology in logistics industry. The blockchain could be applied in many sectors in the future.

5.2.2 Possibilities of blockchain technology usage

The blockchain technology can be utilized advantageously in different domains, from finance to more general societal applications.

Zyskind et al. proposed a decentralized personal data management system that ensures the user ownership of their data. This system is implemented on blockchain. They improved the efficiency of blockchain by using off-chain data storage and heavy processing where blockchain has the potential to improve the security of privacy sensitive data. The authors have proposed a decentralized personal data management system that ensures the user ownership of their data. For the first time, users can share their data with their privacy being cryptographically guaranteed. Only references to data and lightweight processing tasks are handled in the blockchain. The system can protect the data against these privacy issues using three safeguards:

1) Data ownership,
2) Data transparency and auditability, and
3) Fine-grained access control.

The first blockchain was applied in the financial sector to serve as the basis for the cryptocurrency Bitcoin. Bitcoin uses P2P technology, and it operates without any trusted third-party authority that may appear as a bank, a Chartered Accountant (CA), a notary, or any other centralized service. An owner has full control over owned bitcoins, can spend them at own discretion and without geographical constraints or involvement of any centralized authority. Bitcoin design is open source, nobody owns or controls it. Moreover, it is a cryptographically secure electronic payment system, and it enables transactions involving virtual currency in the form of digital tokens called Bitcoin (BTC or bitcoins).

Although Bitcoin is one of the most famous blockchain applications, blockchain can be applied in diverse applications far beyond cryptocurrencies. The spectrum of blockchain applications ranges from cryptocurrencies, financial services, risk management, Internet of Things to public and social services. Since it allows payments to be finalized without any bank or any intermediary, blockchain can be used in various financial services such as digital assets, remittance and online payments.

Reputation is an important measure of the community trust. There is a rising number of cases of personal reputation records falsification. For example, in e-commerce, many service-providers enroll a huge number of fake customers to achieve a high reputation. Blockchain can potentially solve this problem.

Blockchain can improve the security in distributed networks. Charles proposed a novel anti-malware environment named BitAV, in which users can distribute the virus patterns (signatures) on blockchain. Blockchain technologies can also be used to improve the reliability of security infrastructure. Such application may be of significance for information security in multimodal logistics IT platforms.

In addition to the increasing risk of the exposure of private data to malwares, various mobile services and social network providers are also collecting sensitive data. For example, Facebook has collected more than 300 petabytes of personal data since its inception. Usually, the collected data are stored at central servers of service providers, that might be susceptible to malicious attacks. Blockchain has the potential to improve the security of privacy sensitive data.

Blockchain technology includes several preventive mechanisms (e.g., distributed consensus and cryptography) to reduce risks of cyber-attacks. It has also been proposed as an innovative solution for areas such as clearing and settlement of financial assets, payment systems, smart contracts, operational risks in financial market, etc.

Mattila et al. had contributed in 2016 a new understanding on design patterns for managing product life-cycle information through blockchain technology. An effort is made to analyze how blockchain technology could be applied to overcome the digital trust and data synchronization issues related to the product-centric information management architectures.

In 2015 Nasdaq developed a cloud-based platform called LINQ (Language-Integrated Query), built on a private blockchain, which stores information on current shareholdings and related changes, the prices of shares issued in each investment round and information on available stock options. The platform records individual steps before and during transactions. Users can thus keep track of who purchased shares of a particular company and how they were later sold. At the end of 2015. this system replaced the previous manual process based on documents and records maintained by lawyers, accountants and consultants as well as based on spreadsheet data provided by the start-ups themselves, which used to be prone to errors. Such a platform might also find its use in logistics and interconnected e-procurement IT platforms. The difference in approaches (traditional vs. LINQ) is shown in Figure 22.

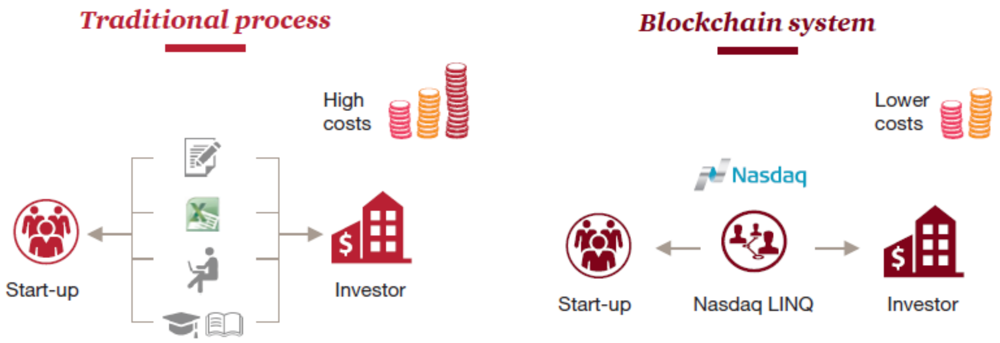

Figure 22. Nasdaq`s LINQ platform

According to Nasdaq, the first transactions carried out for a total of 6 start-up companies and their investors have been successful, subsequently the application being migrated also to other areas. Other than improving transparency and providing a record keeping functionality, the platform delivers additional user benefits by reducing costs and accelerating the process. Nasdaq does not pass on entire cost savings to customers as a benefit but continues to charge a fee in exchange for service provision.

Blockchain technologies can potentially improve the IoT (Internet of things) technology. Internet of things (IoT), one of the most promising information and communication technologies (ICT), is ramping up recently. IoT is proposed to integrate the things (also named smart objects) into the Internet and provides users with various services. The typical applications of IoT include the logistic management with Radio-Frequency Identification (RFID) technology, smart homes, e-health, smart grids, Maritime Industry, etc. The maritime industry is part of a complex and information-intensive maritime supply chain comprising a set of organizations that are globally connected and distributed, including other critical infrastructures that support world trade, such as transport and port structures. Although the maritime industry is technologically advanced, innovations in the maritime sector have been primarily related to ship construction, oil and gas exploration, seabed exploitation technologies, and other—mainly engineering-based—innovations. The industry lacks innovations related to operations procedures and logistics, which represent both a challenge and an opportunity. One of the most promising areas of maritime innovation is related to digitalization, including the development of smart ships, smart fleet and smart global logistics.

5.2.3 Perspective of blockchain technology in logistics

The supply chain is the network of organizations that are involved, through linkages, in the different processes and activities that produce value in the form of products and services in hands of the final customer.

Increasingly connected world is every day more demanding regarding nearly everything. This is true also for the Maritime Industry, where customers and stakeholders demand more speed, less cost, more transparency, bigger security, less impact on environment, bigger efficiency, to name only a few key indicators with which we can measure success.

These goals can be achieved by streamlining all the aspects of transportation chain processes, mostly with the smart technologies that will help resolve the biggest burdens of transportation industry, like long paperwork paths, efficient use of resources and coping with ever increasing quantity of cargo.

Technologies like Blockchain, a distributed electronic ledger system that allows transactions to be verified autonomously by everybody involved in the cargo transportation. A technology that originated in cryptocurrencies, like Bitcoin, soon found its usefulness in the business world where it can guarantee authenticity of transaction, visible to everybody with the proper access.

Development of the Industry 4.0 creates opportunities processes improvement in the supply chain. Industry 4.0 is a holistic, with a (partial) transfer of autonomy, intelligence and autonomous decisions to machines. It improves the flexibility, speed, productivity and quality of the production process, greatly increasing sustainability. It lays the foundation for the adoption of new business models, production processes and other innovations. This will enable a new level of mass customization as more industrial producers invest in logistics 4.0 technologies to enhance and customize their offerings. Logistics 4.0 enables integration and optimum alignment of processes within corporate boundaries; when it is successful, logistical issues relating to input and output streams of materials, can be significantly simplified. When it comes to transport, smart trucks, containers and pallets are opening up for new approaches to monitoring. Internet of things and big data are the basis of industry 4.0 development. Sensors and the Internet of Things (IoT) are enabling goods containers to report when a value limit has been exceeded, e.g. temperature, tilt or incoming light intensity. The freight being forwarded remains in clear view across the entire supply chain.

To make full use of logistics 4.0 and Industry 4.0., it is necessary to apply big data approach. The term ‘big data’ encompasses large volume of structured and unstructured data which is growing exponentially and is analyzed using data analytics and warehousing. Big data analytics allows to ensure better decision making. The big data is the basis for the development of blockchain technology. The data analysis provides accurate information using which timely decisions can be made. The blockchain technology allows more secure tracking of all types of transactions, for example money transactions, data transactions, information transactions, etc. In the supply chain this technology could dramatically reduce time delays, added costs and human errors. With blockchain technology in the supply chain every time a product is exchanged between sides, the transaction could be documented, creating a permanent history of the particular product, from manufacture to sale (from suppliers to customers).

The challenges in logistics parameters, such as delays in delivery, loss of documentation, unknown source of products, errors, etc., can be minimized and even avoided by blockchain implementation. Benefits of integrating the supply chain with blockchain are the following: increased sustainability, reduced errors and delays, minimized transport costs, faster issue identification, increased trust (consumer and partner trust) and improved product transport and inventory management. Blockchain technology enables complete supply chain visibility. Under full visibility, it is considered to show the movement of goods both spatially and temporally throughout various phases and processes of the supply chain, from the physical condition of the consignment at any given moment, through various variations of the goods (eg. temperature deviations) and to support the decision making of logistic operators. This way of doing business or developing a business process would fulfill the main task of logistics, which is to bring the goods to the right place at the right time in the right amount and in the original state.
The main features of blockchain could be very useful for application in the supply chain: public availability gives the opportunity to track products from the place of origin to the end customer, decentralized structure gives the ability for participation for all parties in the supply chain and cryptography-based and immutable nature gives the assurance of security.

Supply chain transparency is one of most important (and hardest to achieve improvement in) areas for logistics. Abeyratne S.A. and Monfared R.P. provided a review of the current status of this technology and some of its applications. They discussed the potential of such technology in

manufacturing supply chain and proposed a vision for the future “blockchain ready “manufacturing supply chain. Manufacturing of cardboard boxes is used as an example to demonstrate how such technology can be used in a global supply chain network.
Logistics and supply chains processes can be significantly improved by introducing the blockchain technology. Even the simplest application of the blockchain technology could bring the supply chain great benefits. Registering the transfer of products on the digital ledger as transactions allows to identify the main data relevant for the supply chain management.

5.2.4 Benefits and challenges of blockchain applications in logistics

Companies in the logistics and manufacturing industries can implement decentralized concepts for goods and transport containers tracking. Driven by the demand for greater transparency in the supply chain, which allows traceability from start to finish, comprehensive technical solutions are required. This is often a challenge for IT solutions that focus on centralized solutions with complex access rights. Blockchain or derived concepts can provide a remedy because they have already addressed these issues.

Some supply chains are already using the blockchain technology, for example, the start-up UbiMS (A Global Supply Chain Revolution), is using blockchain technology. UbiMS is the world's first patented, cloud-based meta-platform as a 3D (three-dimensional) supply chain process system for connecting multiple providers of goods with worldwide consumers and for a complete reinvention of the global supply chain process. It is a shared supply chain infrastructure for entrepreneurs and SME`s model as a 3D globally interconnected e-marketplace and e-supply chain process system both for communication and distribution of material goods. The most obvious example of a 3D network is the Internet in the sense that it is simply a meta-platform for information, connecting multiple information sources to multiple information recipients. Moreover, UbiMS will be developed using blockchain technology. UbiMS is the first decentralized open supply chain infrastructure system. Therefore, it is possible that UbiMS 3D process platform with blockchain technology will disrupt the whole global supply chain industry.

In the paper "*An agri-food supply chain traceability system for China based on RFID & blockchain technology* ", the authors analyzed the advantages and disadvantages of using RFID (Radio-Frequency Identification) and blockchain technology in building the agri-food supply chain traceability system. They demonstrated the building process of this system. It can achieve the traceability of trusted information in the entire agri-food supply chain, which would effectively guarantee the food safety, by gathering, transferring and sharing the authentic data of agri-food in production, processing, warehousing, distribution and selling links.

IBM has tried to streamline the leverage of blockchain in the supply chain. IBM, in partnership with Samsung, has developed a platform ADEPT ("*Autonomous Decentralized Peer to Peer Telemetry*") that uses elements of the bitcoin's underlying design to build a distributed network of devices, or decentralized Internet of Things. ADEPT uses three protocols in the platform: Bit Torrent (for file sharing), Ethereum (for Smart Contracts) and TeleHash (for Peer-To-Peer Messaging).

Blockchain can help digitally trace and authenticate food products from an ecosystem of suppliers to store shelves and ultimately to costumers (figure 3). IBM, Walmart and Nestle are aspiring to use blockchain for more transparent, authentic and trustworthy global food supply chain. Several existing applications combine blockchain and food technology, with the primary idea being to solve food safety issues. Their motivations are consistent with the objective to build a safe, sustainable and transparent food supply chain.

The cloud-based IBM Blockchain Platform delivers end-to-end capabilities that clients need to quickly activate and successfully develop, operate, govern and secure their own business networks. IBM and Maersk see the adoption of blockchains as one way to achieve this improvement: by providing a single view of all transactions taking place among a complex network of parties, blockchain can help eliminate considerable resource waste. Blockchain can help all parties involved in shipping to increase sustainability: reduce or eliminate fraud and errors, improve inventory management, minimize courier costs, reduce delays caused by paperwork, waste and identify issues faster. This could increase worldwide GDP by almost 5% and total trade volume by 15%. Envisaged blockchain-based supply chain is shown in the following Figure 23. on the next page.

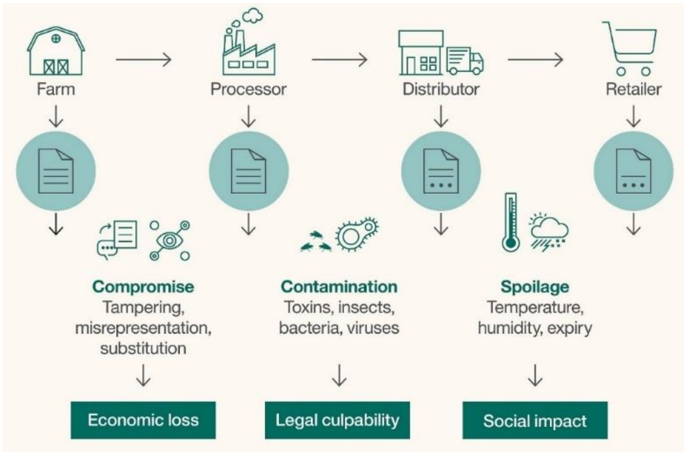

Figure 23. IBM Blockchain Supply Chain

Hackius and Peterson have also conducted a research about blockchain in logistics. They conducted an online survey and asked logistics professionals for their opinion on the following use cases: barriers, facilitators, and the general prospects of blockchain in logistics and supply chain management. Most of their participants were positive about blockchain technology and the benefits it offers. They reason that the benefits over existing ICT solutions must be carved out more carefully and use cases must be further explored to get a rather conservative industry, like logistics, more interested in blockchain. Participants can query transaction data in the blockchain, which ensures the transparency of the whole platform. Additionally, data in the system is protected by encryption algorithms and distributed data storage.

They have accordingly concluded the following about the blockchain's potential (Figure 24 on the next page):

1. EASE PAPERWORK PROCESSING (global container shipping involves a lot of paperwork – costing time and money. Also, freight documents are prone to loss, tampering, and fraud);
2. IDENTIFY COUNTERFEIT PRODUCTS (counterfeit medicine is a growing problem for pharmacy supply chains. This especially pertains to expensive, innovative medicine like cancer drugs. Pharmacies must make sure to sell "the right thing" to the consumers);
3. FACILITATE ORIGIN TRACKING (in the food supply chain, foodborne outbreaks are a challenge for retailers. They must get a quick overview of where the food came from and which other products are also affected and must be removed from the stores);
4. OPERATE THE INTERNET OF THINGS (logistics objects are equipped with sensors that generate data along the supply chain – e.g. about the status of a shipment. This data must be stored in an immutable, accessible way).

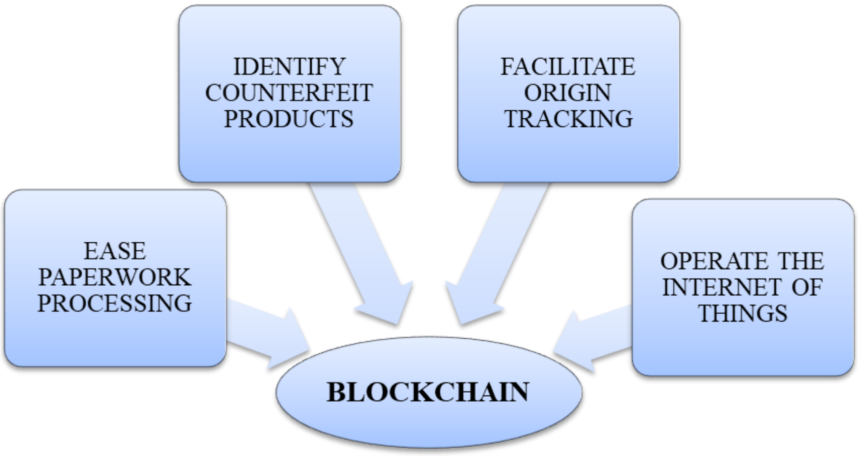

Figure 24. The potential of blockchain technology in logistics

In this case study authors have identified business processes that are part of logistics. They presented a study of the current state and knowledge of blockchain technology in logistics and supply chain. The research and analysis were conducted by examining the opinions of owners and employees in logistics industry about implementation of the blockchain technology. According to their analysis, based on the data collected during the testing, implementing the blockchain technology into logistics activities was considered very positive.

According to information published on official DHL Web pages, up to 10 % of bills of lading contain incorrect data that may lead to litigation and disputes. Blockchain technology might have a significant role in improvement of processes in logistics and consequently, mitigate these issues. This will be especially apparent with further implementation of blockchain technology in creation of smart contracts. Such type of contracts could digitize commercial services and improve underlying business processes. One of the first startups that used smart contracts in maritime logistics was ShipChain. ShipChain is a company that has envisaged a system based on blockchain to track goods from the moment they leave the factory until delivery to final destination (customer). Process automation is based on digital currency (so called “SHIP tokens”) Stakeholders of the ShipChain platform purchase tokens to pay for the cargo and transactions executed using ShipChain platform. This business model enables data and transaction permanence and facilitates information sharing, thus elevating platform transparence to the highest possible level.

5.2.5 End-to-end utilization of blockchain in supply chain

Blockchain technology offers an innovative platform for a new decentralized and transparent transaction mechanism in industry and business. Features of this technology increase confidence through transparency within any transaction of data, goods, and financial resources. Blockchain technology can easily provide secure business operations in logistics. The technology platform is based on a decentralized system, and it creates a permanent record that can be shared and publicly accessible. In the second paragraph, "Blockchain technology", a brief overview of underlying decentralized ledger technology is given along with basic properties of the protocol.

Except for financial services (such as digital assets, remittance and online payment) and cryptocurrency, blockchain technology can be used for applications in risk management, Internet of Things (including the logistics management with RFID, smart homes, e-health, smart grids, maritime Industry, etc.) and in public and social services (for example, in e-commerce blockchain technology can potentially solve the problem of fake customers).

The blockchain technology allows more secure tracking of all types of transactions (money transactions, data transactions, information transactions, etc.). In the logistics sector, blockchain technology could dramatically reduce time delays, added costs and human errors.
The use of RFID and blockchain technology in building of the agri-food supply chain traceability system can enable the traceability with trusted information in the entire agri-food supply chain,

which would effectively guarantee the food safety, by gathering, transferring and sharing the authentic data of agri-food in production, processing, warehousing, distribution and selling links. Some supply chains are already using the blockchain technology. In the third paragraph, "Possibilities of blockchain technology usage", an overview of ongoing implementation projects and applications of the blockchain technology is described with examples in financial and logistics sectors.

Blockchain can help digitally trace and authenticate food products from an ecosystem of suppliers to store shelves and ultimately to end customers. IBM blockchain platform delivers end-to-end capabilities that clients need to quickly activate and successfully develop, operate, govern and secure their own business networks. Blockchain technology can be the solution for overall improvement of logistics, it can help reduce or eliminate fraud and errors, minimize costs, reduce waste and delays, improve inventory management and it can help to identify issues faster. Fourth paragraph, "Perspective of blockchain technology in logistics", is a central part of the paper where various facets of implementation of the distributed ledger technology in logistics are described.

Finally, by using blockchain technology, the challenges encountered by the logistics sector can be minimized or even eliminated, and sustainability can be greatly increased. In the final, fifth chapter, based on previous research, appropriate conclusions are derived about possible obstacles and advantages in blockchain technology implementation. This technology can facilitate logistics tasks: it can be used to track purchase orders, order changes and freight documents, and it can help in information sharing about manufacturing process and delivery. The blockchain technology has a huge potential for development and application in the logistics sector and supply chain, presenting challenges for further research.

5.2.6 Real-life implementations of blockchain in logistics

Today, many trials and blockchain pilot projects are appearing all around the world, but for now they are mostly linked to smaller communities or groups of companies. But we can assume that the successful projects will experience a fast expansion in larger areas along the cargo transportation routes.

The beauty of all these new technologies is that their scope is not tied to one particular part of the process in the transportation chain. Blockchain for example can improve one of the biggest burdens, reliance on paper documents. Global logistics still relies on millions and millions of paper documents. Anything that can be done to improve present condition can have a huge impact on the whole industry.

The shipping paper trail begins with booking of space on a ship to move goods. Documents need to be filled in and approved before cargo can enter or leave a port. A single shipment can require hundreds of pages that need to be physically delivered to dozens of different agencies, banks, customs bureaus and other entities. There are literally dozens if not hundreds of paper processor involved in the transportation route of cargo. There is also a variety of different languages, laws and organizations involved in moving cargoes. Because of that standardization efforts in the past were quite a slow process.

A good example is a research experiment made by Maersk in 2014 that followed a refrigerated container filled with roses and avocados from Kenya to the Netherlands. The research showed that almost 30 people and organizations were involved in processing the box on its journey to Europe. The shipment took about 34 days to get from the farm to the retailers, including 10 days waiting for documents to be processed.

As it often happens, one of the critical documents went missing and was found later in a pile of paper. One of the problems in the paper trail of shipping industry is that there is no single party that can access all aspects of the supply chain, lack of accountability and inefficiency of some parties then affects all the participants in the transportation chain. Blockchain can in this case register all the document changes and give visibility of where they are to all other interested parties. All over openly accessible distributed blockchains that are not proprietary to one company and with the guarantee that nobody can easily forge the paper trail.

This is only one example of implementation of Blockchain in Maritime Industry. There are many others, like Tradelens that records information ranging from vessel movement times in port to customs releases, commercial invoices and bills of lading. IBM and Maersk, which together established Tradelens, state that today there are 94 organizations actively involved or have agreed to participate on the TradeLens platform built on open standards. In August 2018 the first ever container processed with the revolutionary new blockchain-based Smart Bill of Lading was released successfully in the Port of Koper, Slovenia (EU). The Bill of Lading for this shipment has been issued electronically and transferred with the help of an ultra-secure and reliable public blockchain network in just minutes instead of days or weeks.

EY and Guardtime recently announced the world's first blockchain platform for the marine insurance sector. This is a first of its kind in insurance industry and the platform will bring the benefits of blockchain for end-to-end use across the marine industry. Backers of the platform state that the platform will enable claims to be paid »in hours, not years«, and for premiums "*to be agreed and settled in seconds*". Port of Antwerp is active in Blockchain adoption with a Blockchain based document workflow, such as certificates of origin and phytosanitary certificates that are transferred via blockchain technology and the document flow is automated by means of so-called Smart Contracts.

And there are many alliances forming around blockchain solutions. Nine leading ocean carriers and terminal operators signed a memorandum of understanding (MOU) to form a consortium to develop the Global Shipping Business Network (GSBN), an open digital platform based on distributed ledger technology. Similar efforts are going on in Singapore, China and Abu Dhabi.

DBA Group is actively investing in research and development regarding blockchain technologies. Thru partnerships with innovative services providers and solution it will bring the possibility for gradual implementation of blockchains and smart contracts to the key logistic processes in port community solutions. Thanks to open and extensible architecture of its PORT-LINE software suite with PCS, TOS, VBS and Railshunting modules, all the products are being prepared for relatively easy integration in one or more blockchains that will be stablished in the future in Maritime sector.

5.2.7 Challenges of blockchain implementation in logistics

Like with many new technologies, Blockchain brings a lot of opportunities, but also associated risks. One of the biggest concerns today is that it might not outlive the smaller pilots and become a widespread solution. Most of experts agree that Blockchains will be only as successful as comprehensive and widespread they will become.

In order to succeed they will have to be accepted by all stakeholders in the process: shipping lines, terminal operators, manufacturers, banks, insurers, brokers and port authorities. If this will succeed, the prospects are very good: documents could be processed in minutes rather than hours or even days.

Another big question is, if there will be one or several Blockchains standrads handling cargo transportation routes. Not all stakeholders are looking at deploying the same blockchain solutions and platforms, so there will emerge a question of interoperability. Currently there are quite a few initiatives to overcome this problem, but this is still a work in progress.

Related to this concern is also the question of closed versus open Blockchains. A big factor of success for cryptocurrencies was until now, that these chains are »permissionless« with no central authority granting or prohibiting the access to publicly accessible data. In Maritime Industry, this may be a challenge which will have to be addressed. Hopefully, there are ideas, how to resolve this important aspect.

If these risks are properly mitigated, benefits could really change the whole industry. According to World Economic Forum with improved communication and border administration Blockchain could generate an additional $1 trillion in global trade, a 15% increase compared to today. At the same time, the returns on investments would be quite fast: according to Bloomberg analysts, only in two years.

To have realistic expectations, one should realise, that many new technologies are still emerging, sometimes promoted with too much hype and not entirely proven. However, at the same time, one should not dismiss the opportunities that come with their implementation. Moreover, early adopters do not always pay the highest cost – if handled with appropriate vision and knowledge, these technologies could be a competitive advantage in comparison to the adopters with more conservative approach.

Some of these new and upcoming technologies, like blockchain, will be successful if there will be a collective effort to sustain and support them. Other new technologies can yield immediate benefits also for single transportation communities.

One thing is for sure: more and more logistics operators are becoming aware of the blockchain technology and most of them are eagerly following pilot projects and comparing their initial results with the plans.

It should not be a surprise if the investment in blockchain will surge rapidly in the next few years.

5.3 DIGITALIZATION

The Electronic Chart Display and Information System (ECDIS) revolutionary changed traditional way of navigation in the second half of the 1990s, and there is a tendency for its full implementation at the global level. The concept of e-Navigation is a step forward in comparison to the ECDIS navigational support system. It should provide smooth communications at bidirectional relations ships-ports-on shore safety, legal, business, industry and other entities. It should reduce risks of accidents, environmental
impacts, and costs. The Maritime Cloud is conceived in a way to support these communications by means of old, e.g., radio, Navigation Telex (NavTex), Automatic Identification System (AIS), etc., and new communication channels, e.g., VHF (Very High Frequency) Data Exchange (VDES), Navigation Data (NavDat), Narrow-Band Digital Printing (NBDP), and much more over the seas .

On the other side, sea ports as enablers of berth-to-berth navigation and key nodes of sea-land transportation use different ICT solutions like: Electronic Data Interchange (EDI), Vessel Traffic Service (VTS), Vessel Traffic Management Information System (VTMIS), Port Community System (PCS), Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) system, access to the Electronic Logistics Marketplace (ELM), etc. Additionally, the concepts of e-Maritime [6], National/Maritime Single Window (N/MSW) and/or Single Window Environment (SWE) are currently in the focus of maritime research community

All these speak in favor of rapid and huge digital turbulence in maritime community, especially for those organizations that function in transitional environments with rigid administrations and without clear development strategies. Within this context, we considered it important to do an examination of how intelligently some maritime business entities in South-Europe (Montenegro, Albania, Croatia, Slovenia and Italy) exploit presently available ICT resources, since obviously their rapid development and expansion is on the road.

Digitalization is already impacting business environments and the way of working in logistics chain. Neglecting digitalization could create a risk of staying behind in the game in the highly competitive multimodal transport . Digitalization can impact a company's entire operation environment and internal functioning, but also the connections with other stakeholders in the transport chain. Digitalization can also bring new business opportunities, change the roles of operators in a value chain, and end existing business, but also extend cooperation with other parties having more focus on the technical aspect if adaptive sourcing model is selected. For example, digitalization may remove traditional intermediates in the supply chain and create new intermediates. This can be due to, for example, direct access to consumers and the increased use of mobile devices. Thus, the impact of digitalization, and the goals of digitalization for an organization, can be identified from three different viewpoints:

1. *Internal efficiency* - improved way of working by digital means and re-planning if the internal processes,

2. *External opportunities* - new business opportunities in existing business domain (new services, new customers etc.), and

3. *Disruptive change* - digitalization causes complete change of the business roles.

These three goals arranged in appropriate order are shown in the following Figure 25 on the next page.

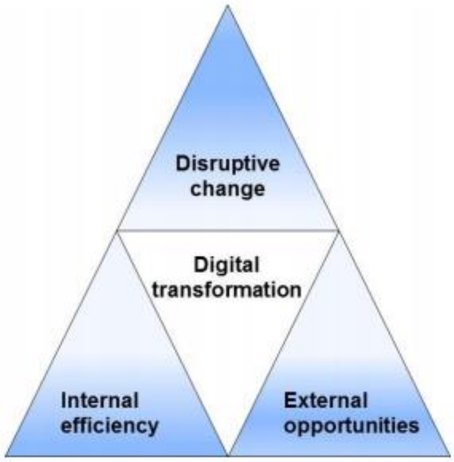

Figure 25: Digital transformation in relation to logistics process improvement viewpoints

Within this context, examinations of how intelligently some maritime business entities in South-Europe (Montenegro, Albania, Croatia, Slovenia and Italy) exploit presently available ICT resources, since obviously their rapid development and expansion are on the road, have been conducted. Their aim was to achieve identification of weak points and to propose directions for their smooth overcoming. adapting common ICT solutions that would be compatible with current ICT trends in wider maritime community. This should provide them greater competitiveness at the growing,

Such panel research has shown that, for example, Montenegro and Albania lag behind Italy, Slovenia and Croatia in this context, should establish closer collaboration with stakeholders and responsible governmental bodies. It can help them overcome the existing gap between ICT potentials and their actual use in everyday reality. Further research experiments in the field should include more respondents from larger number of maritime institutions and also in-depth interviews instead of, or besides the polls. New ICT concepts like e-Navigation, Maritime Cloud, e-Maritime, National/Maritime Single Window, etc., should be explicitly included in the interviews by taking into account the respondents' attitudes towards (each of) them.

5.4 ROBOTICS, AUTOMATION AND AUTONOMOUS VEHICLES

Ever since the introduction of automated stacking cranes at the European Container Terminal in Rotterdam in 1990, automation in ports has firmly progressed. Automation has developed into almost all terminal functions ranging from water to land side; from ship-to-shore activities straight across the terminal into and including the handling activities on or from the land connected modes.

The extent of automation ranges from remote controlled operations under safe and efficient conditions to fully autonomous terminal operations.

Also in the field of safety there is continuous progress with research projects such a SaLsa that aim to safely test autonomous transport vehicles in yards that link into the Internet of Things world. Sensors installed in the yard infrastructure enable vehicles to detect other objects and their position which allows the combined operation of automated vehicles, forklifts, and people in an efficient and safe manner.

Software is also used to monitor and optimise the flow of goods through the port, which provides savings in time, fuel and personnel and optimisation of capacity and space. The drivers of automation are cost of labour, land cost and the need for efficient handling of larger sized ships.

The trend in ever larger ships enabled further by such events as the expansion of the Panama Canal, as well as those of the increasing costs of labour and ever more efficient and low cost of technology, will further push the need and desire for automation.

Automation can also play a key role in the transformation of logistics service provision. For example, technological advances make it increasingly possible in real time to dynamically integrate pricing, schedules, bookings, shipment visibility with customers, carriers and

marketplaces. Rate automation and shipment visibility technology facilitates online sales.
The most advanced and also the most “visible” types of “robot” being developed in all forms are autonomous vehicles, from small last mile solutions to full sized autonomous sea-going vessels. Next to the already described terminal dedicated autonomous vehicles such as autonomous straddle carriers, the type of vehicles being developed will undoubtedly have an impact on the way operations will have to be organised. The development and implementation of these “robots” in the relative short term will entail its own threats and opportunities.

5.4.1 Utilization of autonomous vehicles in logisics

The development of driverless trucks is in full swing and vehicles like Daimler’s 18-wheeler Freightliner, unveiled in May 2015, already have been licensed for road tests. It operates on autopilot on highways but switches to a human driver for lane changes and parking. It uses radar sensors, cameras, and servomotors to detect objects around it, and then takes over actions from the driver such as steering and braking.

In 2013, the US Department of Transportation’s National Highway Traffic Safety Administration (NHTSA) dened five different levels of autonomous driving. The levels of autonomy describe the system, not the vehicle:

1. *Level 0:* The driver (human) controls it all: steering, brakes, throttle, power,
2. *Level 1:* Most functions are still controlled by the driver, but specific functions can be done automatically by the car (like steering or accelerating),
3. *Level 2:* At least one driver assistance system of “*both steering and acceleration/deceleration using information about the driving environment*” is automated, like cruise control and lane centering assist. It means that the “*driver is*

disengaged from physically operating the vehicle by having his or her hands off the steering wheel and foot off pedal at the same time," according to the SAE. The driver must still always be ready to take control of the vehicle,

4. *Level 3:* Drivers are needed, but are able to completely shift "safety-critical functions" to the vehicle, under certain traffic or environmental conditions. It means that the driver is still present and will intervene if necessary, but is not required to monitor the situation in the same way as for the previous levels,

5. *Level 4:* "Fully autonomous". These vehicles are "*designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip*". However, it is important to note that this is limited to the "*operational design domain (ODD*)" of the vehicle meaning it does not cover every driving scenario, and

6. *Level 5:* This refers to a fully-autonomous system that expects the vehicle's performance to equal that of a human driver, in every driving scenario, including extreme environments like dirt roads that are unlikely to be navigated by driverless vehicles in the near future.

In October 2016, the NHTSA updated their policy to reflect that they have officially adopted the levels of autonomy outlined in the SAE International's J3016 document.
Considering the continued investments in the field, it is only a matter of time that in the future fully automated driverless trucks and delivery vans will be used by logistics firms. The main purpose and expected impact of autonomous trucks is increased efficiency and greater safety. For some, a key motivation effectively is to reduce the liability firms face when a human driver makes an error. In this way of thinking, once the technology has a solid track record and a clear

safety record, implementation of such vehicles will become self-evident. It is clear that contrarily to what is stated by some proponents, for others it effectively raises awkward liability questions. For example, does liability lie with the logistics firm or with the truck manufacturer in case of incidents?

Increased implementation of autonomous trucks and vans will effectively reduce transportation costs and result in faster transit times. Considering the expertise and reliance on data driven models to control such vehicles this might change the type of companies running such solutions. Effectively, companies like Uber or Amazon already have plans to expand into the logistics sector.

Considering the fact that autonomous trucks will still be required to carry “drivers” for the foreseeable future and levels 4 and 5 of autonomous driving are still some time away, the immediate impact on port operations will most likely exist of increased efficiency because of assisted manoeuvring, improved planning and synchronized timing, allowing for increased terminal and truck operator efficiency.

Drones are already being used for security surveillance in some ports (such as Abu Dhabi’s Khalifa Port), and could also have a role in monitoring port operations and detecting problems requiring maintenance in both port equipment and ships. The main barriers for the use of drones in the ports and port terminals are regulatory, but it may be expected that this will only be a short term obstacle. Still, international harmonization is needed.

Technology is developing fast, especially in the field of autonomous flight. These represent the business cases for industry and there is a lot of interest from the logistics sector, but mainly in supporting a range of monitoring and inventorying activities as well as deployment in restricted and secure areas.

Implementation in the public domain such as last mile logistics or public access areas in ports, are highly questionable considering the complexity of implementation in relation to the risks involved. Despite boastful declarations of several service providers' real life proof of concept testing by companies such as DHL clearly highlighted this complexity which somewhat reduces the outlook of intense use of flying drones in the public domain. Also others such as UPS are focusing on understanding how flying drones can be applied.

Considering that most acclaimed applications seem to be developed for use within restricted areas, warehouses, for humanitarian aid and medical supplies to remote areas, inspection activities, and the fact that wide-spread implementations in the public domain seem a long way off, direct impact on port logistics operations where inter-connection with other supply chain actors is involved, is not to be envisaged in the near future.

5.4.2 Drone ships

Drone ships are the least "visible" type of robot being developed and as such hold a large "unlikeliness" factor to them.

The main challenges are regulatory considering international maritime conventions have clear specifications on minimum crew requirements. Another challenge is the concern about safety, especially where it concerns the aspects of weather, obstacles and in-trip repair requirements and the uncertainty how such autonomous or remotely operated ships would cope.

The main advantages regard a significant reduction in fuel consumption, and therefore emissions, by up to 20% as well as increased cargo capacity and massively (about 40%) reduced operating expenses, all according to Rolls-Royce.

And even though safety is currently considered a concern, overcoming the challenges effectively would mean that maritime safety potentially could be improved, as the majority of shipping accidents are the result of human error, often related to fatigue. The first serious initiative was only unveiled in 2014 by Rolls-Royce, and despite significant challenges to be met, the possible advantages are a strong driver for fast and furious development.

In December 2016, Rolls Royce and VTT Technical Research Centre of Finland Ltd have announced a strategic partnership to design, test and validate the first generation of remote and autonomous ships. The new partnership will combine and integrate the two company's unique expertise to make such vessels a commercial reality. In a statement Rolls Royce stated to believe a remote controlled ship will be in commercial use by the end of the decade. The company is applying technology, skills and experience from across its businesses to this development. The VTT Technical Research Centre of Finland will build on its deep knowledge of ship simulation and extensive expertise in the development and management of safety-critical and complex systems in demanding environments such as nuclear safety. On the other hand, more prudent maritime organisations such as the International Chamber of Shipping, predict that the use of drone ships will not be realised for another two to three decades.

The debate between believers and non-believers focuses mainly on the projected costs; reduced operational costs where the absence of a crew can be seen as a liability in case of need for repairs or problem solving and the operational costs this induces, and reduced construction costs where the need for increased quality for unmanned ships is to be taken into the equation.

There seems to be some agreement on the possibility to increase cargo capacity that may offset the minor savings in crew costs and questionable savings in construction costs, as reported by Roar Adland in 2017.

5.5 Simulation and virtual reality

The availability of big data applications will lead to possibilities for port operators and logistics service providers to fully exploit the advantages of simulation software. Port operations can be modelled in order to analyse operational flows, pinpoint possible barriers as well as define enhancements, and simulate and assess various scenarios of design and throughput. This can be done for existing or newly planned port layouts as well as for terminals. An additional benefit is that such simulation software can also be used to train staff.

Already, current proprietary or service based resilience predictive tools are becoming far more powerful and efficient, and such simulation tools are a valuable asset in emergency and mitigation planning.

Considering the previously described automation and robotization of various types of vehicles and equipment, simulation will be important in understanding the impact of these developments as well as how to adjust terminal processes in order to optimally integrate these developments into every day operations.

Virtual reality (VR), defined as the expansion of physical reality by adding layers of computer-generated information to the real environment, will further support such simulations. This is a technology in full development that will become part of everyday life. In a port related environment one can envisage enhanced feeds from infrastructure, port equipment, automated vehicles and various types of drones.

It is to be envisaged that VR will have a wide field of applications ranging from operational support of how to execute certain processes to active safety or security interventions.

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

5.6 E-TMS AND DECARBONIZATION

The effective transportation systems should provide an optimal route with recommended optimized non - work stops. However, not all participants are taking advantage of the vast benefits a transportation management system provides. According to Dreßler et al. , each participant organizes his own transport processes without informing other participants, although the smooth flow depends on communication.

Seaports are important nodes in the intermodal transport; their earlier narrow focus on cargo handling has been replaced with a wide range of logistic activities giving the seaports a more active role in the transport chain [6]. However, a lack of awareness of the importance of the transportation management system is still present in certain less developed seaports. Because of significant increase in international trade, port facilities are more congested and more errors and data duplication occurs because of paper-based documents [8]. Seaports should focus to the development of platforms that allow electronic data exchange such as electronic Transportation Management Systems (eTMS).

Sustainability of transportation systems could be evaluated by a set of indicators, among which the most common indicators include transport cost, transport time, emissions, noise, traffic congestion, and safety. Lack of timely planning and stakeholder orchestration yields costs incurred at seaports, as well as the harmful emissions that are to, some extent, the result of inefficient transportation management systems and inefficient or even non-existing seaport IT systems.

According to Gruyter at al., in the transport context, there has often been a strong focus on economic outcomes, with less consideration given to environmental aspects.

Although transparency and easy access to data are an important part of successful seaport business, the ecological aspect is important as well.

A Transportation Management System is a platform that’s designed to streamline the shipping process . Transportation Management Systems assist in managing certain aspects of the transportation process:

1. Planning and decision making – TMS will define the most efficient transport schemes according to given parameters

2. Transportation Execution – TMS will allow for the execution of the transportation plan such as carrier rate acceptance, carrier dispatching, electronic data interchange (EDI) etc.

3. Transport follow-up – TMS will allow following any physical or administrative operation regarding transportation: custom clearance, invoicing and booking documents, sending of transport alerts (delay, accident, non-forecast stops…) etc.

Transportation Management Systems still have some shortcomings such as:

1. The monitoring information is confined to the positioning and geographical information of the goods or vehicles without the physical status sensing during the transport procedure

2. Numerous Transportation Management Systems lack a uniform data transferring capability and storage format to achieve data sharing and integration functionalities.

Electronic data exchange facilitates data exchange between seaport stakeholders, as it represents a powerful application of computer communications technology. Its value includes such benefits as reduced paperwork, elimination of data entry overheads, improved accuracy, timely information receipt, accelerated cash flow, and reduced inventories.

Two solutions used for communication between transport organizers and shipping companies are:

1. Mediation Service Software (MSS): The mediation services include sending the compulsory data regarding the weight of goods, transport booking, sending shipping instructions, tracking the movement of containers, the exchange of bill of lading data, etc.

2. Electronic Transaction Platform (ETP): Users of electronic transaction platforms are able to communicate with a large number of global shipping companies in a standardized way. It is

possible to use a software package (dedicated web portal or an application) or to integrate own applications with the electronic transaction platform.

Seaports have to continuously improve their operations, both commercial and administrative, in order not only to optimize their business but also to achieve sustainable growth in cargo volumes [21]. The usage of information technology as a tool for conducting electronic business (with special emphasis on the electronic exchange of data and messages within the seaport systems) will ensure the efficient connection of different segments of business processes that take place among the various stakeholders of seaport operations. Modern transport and logistics environment therefore calls for investments in an integral IT solution implementation which will connect the (primariliy commercial) seaport stakeholders – a Port Community System (PCS). Faster information flow enhances cargo delivery speeed, enables the flow of goods, and boosts economic growth. As a secondary result it helps to reduce the externalities such as pollution and harmful emissions that represent the other problem caused by increased traffic volumes and traffic congestion. Close to 25% of the global CO2 emissions is caused by transport, and between 30 and 40% of this total is produced by cargo transport . The effective transportation systems should provide an optimal route with recommended optimized non - work stops However, not all participants are taking advantage of the vast benefits a TMS provides.

The most developed seaports draw attention to the priority development tasks which refer to business and the overall development of the seaport system. Unfortunately, in certain less developed seaports, a lack of awareness of the importance of the seaport system development is present. Development of Electronic Transportation Management System could have positive effect on fuel consumption and the reduction of CO2 emissions and other harmful emissions .

Transportation Management Systems, as stated before, reduce overall costs of transportation. They collect data such as rates and vendor options in a clear, simplified, and prioritized format to aid in the decision-making process. TMS are used by companies to strategize, plan, and execute shipments. According to OECD research on “Trade facilitation indicators”, harmonizing trade documents, streamlining trade procedures, making trade-related information available and using automated processes could reduce total trade costs by 14.5% for low-income countries, 15.5% for lower-middle-income countries and 13.2% for upper-middle-income countries (COMCEC, 2017).

According to the survey-based research of ARC Advisory Group from 2018., "The Transportation Management Systems Market Research Study", freight savings of approximately 8% could be achieved with the use of an TMS application. Nearly 60% of respondents indicated that less than 10% of the net savings were attributed by the TMS. These freight savings can be attributed to network design, load consolidation, multi-stop route optimization, improved data for procurement and freight audit According to G. Nimchuk and D. McKinney, "Drivers using this system may be given the ability to manipulate portions of dispatched trip plans through selection of alternative stop locations. The transportation management system may also be configured to calculate and frequently update the ETA for every stop on a planned trip; such updating of the ETA may be performed by the system during the trip planning stage and during actual execution of the trip plan".

Transparency and easy access to data are of the utmost importance for successful seaport business. The most advanced seaports draw attention to the priority tasks related to business development and the overall seaport system development. Unfortunately, in less developed seaports, there is lack of awareness about the importance of seaport system development. The development of e-TMS enables the stakeholders to centralize the monitoring of business processes. Its implementation provides a number of advantages such as the optimization of the transport chain management, as the key stakeholders such as seaport administrative bodies, freight forwarders and carriers become interconnected. The e-TMS arranges all available information in an accurate and easy-to-read manner, and it helps to make optimal business decisions. Furthermore, not just economic but also ecological issues have been considered, where damaging environmental effects could be reduced by the adoption of e-TMS. It enhances the level of business organization which also reduces harmful emissions that may be caused by, for example, traffic congestion.

Mediation Service Software and Electronic Transaction Platforms represent solutions for communication between transport organizers and shipping companies. The main issue thwarting the adoption of the TMS software is the lack of uniform standards for message formatting and means of their exchange. The consequence of insufficient networking on the intermodal level leads to many problems such as increased costs and time loss caused by non-harmonization of business information systems, with the final consequence being reduced interoperability between the information systems.

6. Basic guidelines for implementation of the maritime and multimodal ICT systems

Basic guidelines for the implementation of a single window solution for maritime are briefly described. Detailed information on thhis topic can be found in the IMO FAL Compendium on Facilitation and Electronic Business (FAL Compendium).

6.1 Determination of scope and stakeholders

It is necessary to determine what functions the single window will have and who the main stakeholders are. For each group of functions, the list of stakeholders that have to be identified as a part of formal stakeholder identification process may change.

Main issues to be addressed are:

1. *List of covered domains*: Cargo import/export or transit, ship entry into national waters and ports, national transit lines, ship reporting issues.
2. *Implemented clearance functions.* This includes FAL-referenced clearance, additional national ship-related clearance, administrative port formalities, regional or international legislation, private and commercial caro-relatedfunctions, etc.
3. *The type of shipping to be supported*. A significant difference exists between bulk shipping requirements and containership requirements.
4. *The geographic scope and types of ports covered.* This includes determining is it a NSW or a PSW types of port coverage?

6.2 IDENTIFICATION OF POLICY ISSUES AND USE OF LEGACY SYSTEMS AND PROCESSES

Legislation and other related policy issues are the most complex factors in the establishment of a single window. Particular consideration should be given to some of the experiences gained during execution of other comparative projects. The introduction of any new single window system neccessarily changes some business processes. While the purpose of the single window is simplification of the trade and transport processes, overall cost of a new system is determined by the costs of necessary software and hardware investments as well as by the costs of changes to processes. To keep the costs down, careful consideration should be given to which legacy systems, processes and information flows can be kept without unneccessarly harming the overall objective of simplification.

Some issues to can be considered are as follows:

1. Existence of tools that let users interface with electronic systems without needing overly specialized software. Several common tools like Adobe Reader, Microsoft Excel and others can read and write XML files with a graphical user interface that looks, for example, like standard paper FAL forms.
2. An automated information transaction system may in some cases simplify the overall design of the single windos system by allowing legacy document formats to be used. Use of legacy systems in a sense increases reliance on formal description of the data or information items that are exchanged.

However, in all cases the emphasis should be on the harmonization of processes and data models.

6.3 FORMATION SECURITY REQUIREMENTS

As the single windows are used for transactions that can have commercial as well legal importance, it needs to address the issue of information security. Adequate emphasis needs to be put on implementing technical features that address the relevant security issues.

Information security involves some or all of the following concepts:

- *Confidentiality*: Assurance that information is not disclosed to unauthorized individuals or systems.
- *Integrity*: Assurance that the received (or sent) information is correct and logically consistent.
- *Availability: Single window system needs to be available when needed.*
- *Authentication*: The identity of the sender (or receiver) is the one specified.
- *Authorization*: The sender or receiver has the authority to provide or receive the information.
- *Non-repudiation:* Assurance that the sender or receiver of information cannot deny that the information was sent or received.
- *Message transmission*: Assurance that messages through the single window are traceable and that some concept of guaranteed delivery is applied.

6.4 SNGLE WINDOW MONETIZATION MODEL

The selection of a suitable business model is important because of well known fact that the success of the single window will also depend on the level on which business model matches the expectations of the stakeholders. In case that there are no single window usage fees, the stakeholders tend to adopt usage of the system faster. This also enables immediate savings for included stakeholders, but this model also requires long-term funding and centrallized planning to be in place before implementation of the model.

There are several business models applicable to single windows solutions and their monetization, and most of them are hybrid solutions:

- Fully operated and funded by public authorities, no fee exists for immediate users
- Funded by commercial port companies with no direct pay for usage. This may make sense as a single window can significantly simplify many port processes.
- Fee per transaction paid for by the users. In this model, single windows operation costs are assigned directly to the users of the system. Usually, this is the case with port community systems operated by private companies.

6.5 SELECTION OF THE MODELING METHODOLOGY

Modern ICT tools may significantly help to organize and improve efficiency in a single window design process. Generally, best practice in development of the single window is technological neutrality. Today, this will most likely be based on the Unified Modelling Language (UML), which is the most popular baseline specification. However, there are a few issues related to tool selection that may be of interest:

- *Enterprise Architect Project* (EAP) by Sparx Systems is used to produce some of the development frameworks that are available on the Internet. Native format of the files is called EAP. Maritime Navigation and Information Services (MarNIS) architecture and the UN/CEFACT International Supply Chain Reference Model (ISCRM) (section 11.3.2) are available as EAP files.

- *ARKTRANS* is a modelling methodology and framework for ICT systems in multi-modal transport (http://www.arktrans.no/).

- *UN/CEFACT* has developed a modelling methodology (UMM) (http://umm-dev.org/) available as EAP files.

7. BEST PRACTICE SYSTEM ARCHITECTURE FOR DEPLOYMENT OF MARITIME AND MULTIMODAL ICT SYSTEMS

7.1 SYSTEM ARCHITECTURE DESCRIPTION

Single window systems for maritime and multimodal transport are generally envisaged as independent of hardware systems, scalable, an reusable. System architeture description defines all the necessary business processes and low-level functions as simple service components stored in a service repository, that can be used as they are, or composed (assembled) into more complex services when neccessary.

Users and other organizations can access this repository using standard communication protocols such as TCP/IP, HTTP, web services and SMTP. In case that the single window system is developed as a web-based system, it will contain a web server. In order to process the data transmitted to a single window system from this server, usually an enterprise service bus (ESB) is used. The set of services needed to process that data, and the sequence of the processin execution, are determined by additional external logic typically written in an object-oriented language (such as Java). SOA system architecture is shown in the following Figure 26 on the next page.

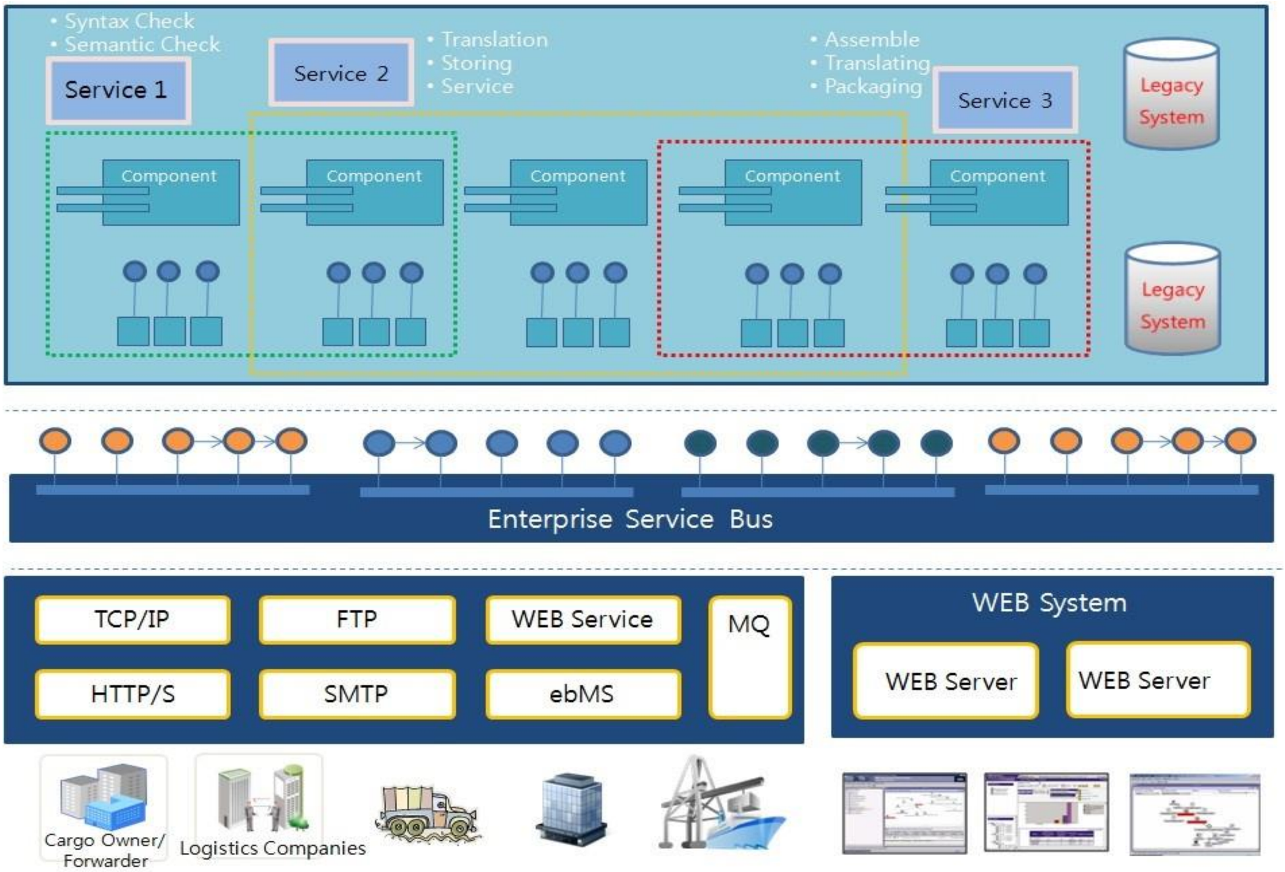

Figure 26 — SOA single window system architecture

7.2 IMPLEMENTATION BEST PRACTICE - SINGLE WINDOW SYSTEM IMPLEMENTED USING JAVA

As shown in Figure 27 on the next page, if a web-based single window system is implemented, the following best practice suggestions are applicable:

1. Web-related modules refer to programs that execute functions (such as entering values and transmitting data) by selecting options like port arrival/departure report (General Declaration, FAL Form 1) or viewing previously processed application/approval,
2. Business server system refers to a system to which the program, containing business logic for processing information input from the Web or electronic documents transmitted in EDI or XML formats, is ported,
3. Developed Web-related modules should be ported to a web service system,
4. Users access a web client and request information in order to retrieve them, required informatsion is fetched from the database by remote methods and Enterprise JavaBeans (EJB),
5. The program ported to the business server system should be implemented, based on the way the businesses is managed, by the port authority in charge.

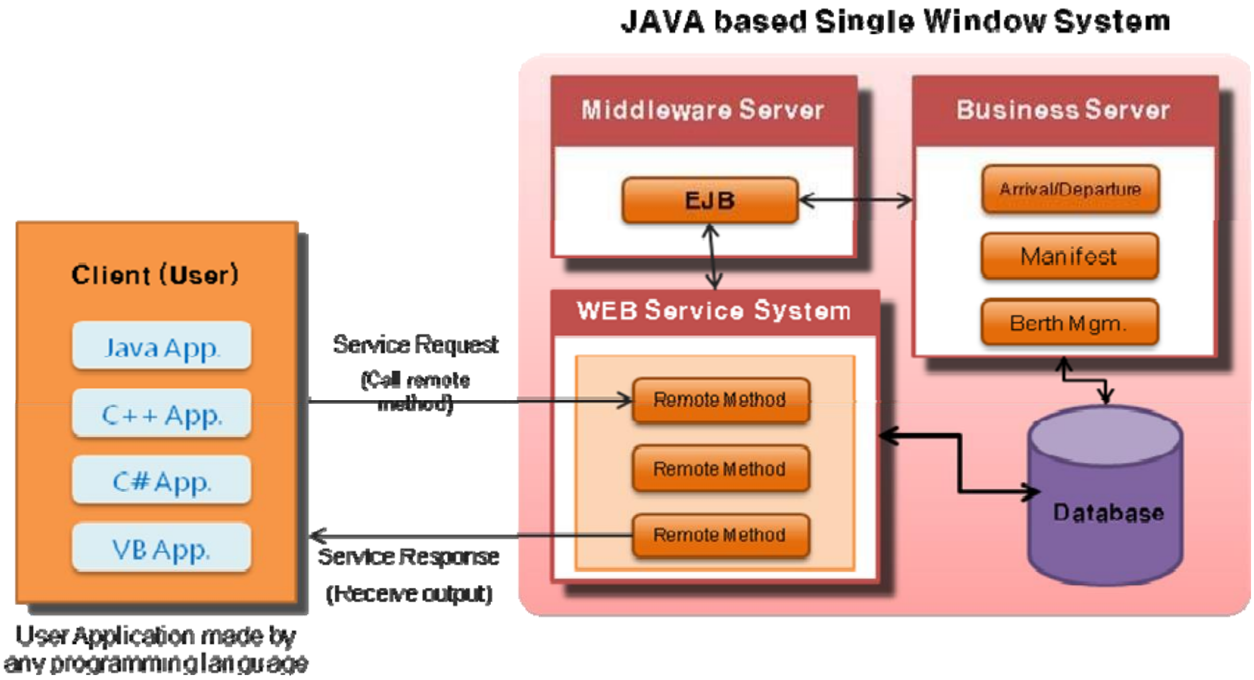

Figure 27 — The Java 2 Platform, Enterprise Edition (J2EE) system

Java is an object-oriented language developed by the Sun Microsystems in the USA in 1990. Java gained prominent attention with the emergence of the Internet and Web. Its basic features are:

a. *Simplicity*: Java was developed based on C++, but removed the difficult concepts and constructs from that language.

b. *Platform independency*: If there is a Java virtual machine present, Java can be executed anywhere, regardless of a platform.

c. *Supporting multiple threads*: Java can support multiple, simultaneous threads within a single program. A single Java program can be composed of multiple thread programs and each thread can independently perform other tasks.

d. *Operability in a distributed environment:* Java has a library that supports many protocols operating in a TCP/IP network environment, most common of the in use beingHTTP. As a result, it can control objects of a remote client using URL (Uniform Resource Locator).

e. *Object-orientation*: In object orientation, the focus is on object and functions manipulating objects rather than steps to be performed within the algorythm.

f. Use of *EJB (Enterprise JavaBeans*), a component architecture for developing and sharing distributed and object-oriented Java applications is often used in creation of single window systems. By providing various services supporting extensible application server components, it enables developers to write business applications as components.

g. Use of *MVC pattern (Model–View–Controller*) is utilized as best practice to develop an application in a division of View, Model and Control. View module is used for presentation to users, Model module (or layer) for processing business logic and Control layer for management of Model and View layers. Deployment of the MVC pattern is used to avoid difficulties in development and maintenance of complicated source codes resulting from the effort to write all the functions within an application. The advantage of the MVC pattern is that it uses both object-oriented and component-based methodologies.

7.3 IMPLEMENTATION BEST PRACTICE - SINGLE WINDOW SYSTEM IMPLEMENTED USING .NET FRAMEWORK

When a single window is developed in the .NET Framework, the services to be stored in a service repository can be developed using programming languages supported by Microsoft. Example of such programming languages are C++.NET or VB.NET respectively. When a single window system is implemented using .NET Framework, source codes of application programs implemented by different development languages are compiled and translated into codes of MSIL (Microsoft Intermediate Language). They are then converted into a code that can be directly recognized by an operating system - they are in fact converted into native codes that can be directly interpreted by an operating system through a JIT (Just In Time) compiler in the execution of CLR (Common Language Runtime).

When a single window system is implemented using .NET Framework, the configuration can be expressed in a layered structure as shown in Figure 4. The service repository, a central part of the structure, manages all the services of an enterprise. Services cannot be directly connected to systems, but they can communicate with systems through message brokers. When a user of a single window requiring a particular service executes an action using own user interface, appropriate services are called from the service repository.

Therefore, when a single window system is implemented using .NET Framework, existing source codes supported in .NET can be reused. .NET framework's main components are shown in Figure 28 on the next page.

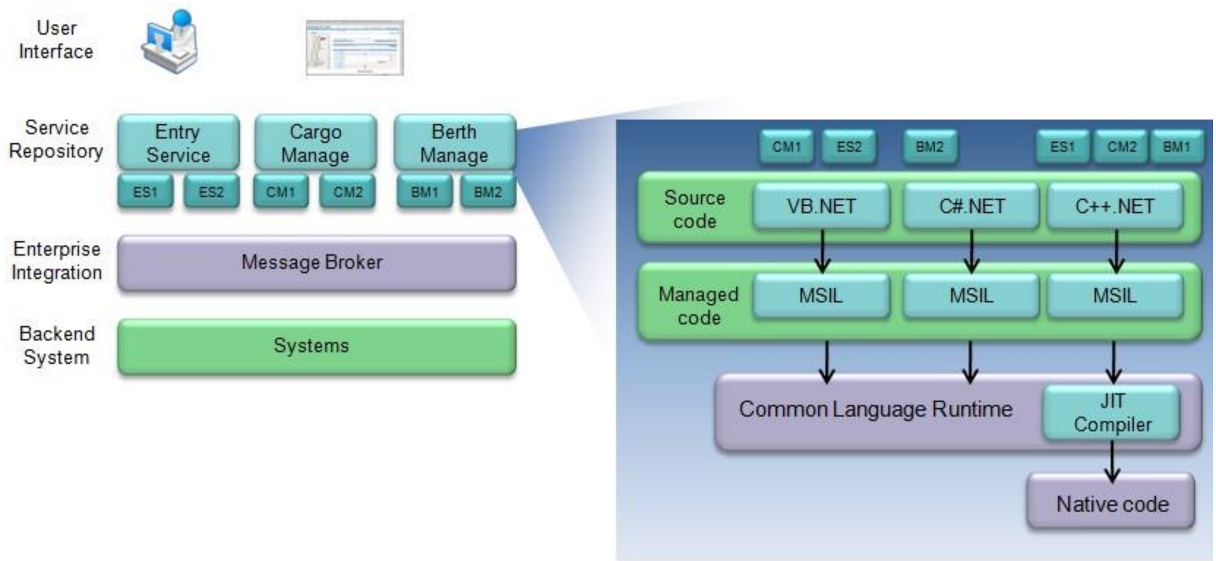

Figure 28 — .NET Framework

.NET Framework is often used in conjunction with C#. It is a programming language developed by Microsoft to strategically support the .NET platform based on C++ and further developed from C++ by standardizing C++ syntax. Therefore, it fully covers C and C++, and can use existing COM components easily.

.NET refers to a comprehensive development environment that supports all components needed to fully develop and deploy single window applications. During development of a single window project using traditional methods and C language, required and necessary components have to be collected individually. However, .NET provides a language, development tools, a library, and a collection of relevant technologies required for development. In short, it refers to a type of environment for easier development.

.NET Framework components are class library and Common Language Runtime (CLR).

.NET framework supports various class libraries necessary for development and execution. It supports the environment needed for developing databases, web application, graphics, XML and web service. Common Language Runtime (CLR) is the execution environment. It is a virtual operating system that loads, dynamically compiles and executes programs developed by languages supporting .NET, like C#, C++, VB.NET and Jscript.NET, as well as managing memory usage.

Codes written in other programming languages are translated into machine language during compilation time. In .NET, they are initially translated into an intermediate language. That language is a pre-machine language that can be easily translated into machine language. The resulting file compiled with intermediate language in .NET is called an „assembly“. In C# terminology, they are equivalent of .EXE or .DLL files.

A typical „assembly“ is composed of:

1. *Metadata* that have all the information on intermediate language and class,
2. *A manifest* that has information on assembly itself, and
3. *Resources* that are data used by programs.

The assembly can be classified into a) private assembly and b) public assembly. Private assembly refers to a simple library that is used when required. Public assembly refers to a library commonly shared by a system by registering it to a directory in a system. Because .NET programs can be operated in any operating system as long as .NET Framework is provided, it can be platform independent that is very convenient for single window system usage that can be presented using heterogeneous platforms and in some cases, in embedded systems. As long as there is a compiler for translating intermediate language into machine language, the code can be executed using any platform. For this reason, the compiler is called a JIT (Just In Time) compiler.

7.4 IMPLEMENTATION BEST PRACTICE – USE OF SERVICE ORIENTED ARCHITECTURE (SOA)

The concept of service as a part of service oriented architecture (SOA) is defined as a software component that executes a business process, from a business point of view. In SOA, service interfaces are loosely connected, platform independent and neutral. Therefore, the effects on other services are minimized if any particular service is changed. As a consequence, a system based on SOA is agile in dealing with business changes and its components can be reused in different combinations.

Main characteristics of SOA are:

a. *Service-oriented development methodology*

    1. Services are platform independent and accessed by applications in a standardized way,
    2. Services are reusable and loosely coupled,
    3. Services can be combined, and
    4. "Service orientation" is based on the "separation of concerns" concept - dividion and classificition of a complex problem into individual areas of interest.

b. *Model-driven development methodology*

    1. Process of making abstract business implementable
    2. Use of UML (*Unified Modelling Language*) as a modelling language
    3. Developing a software system is an abstraction of complicated business

Conceptual SOA configuration is shown in Figure 29. on the next page.

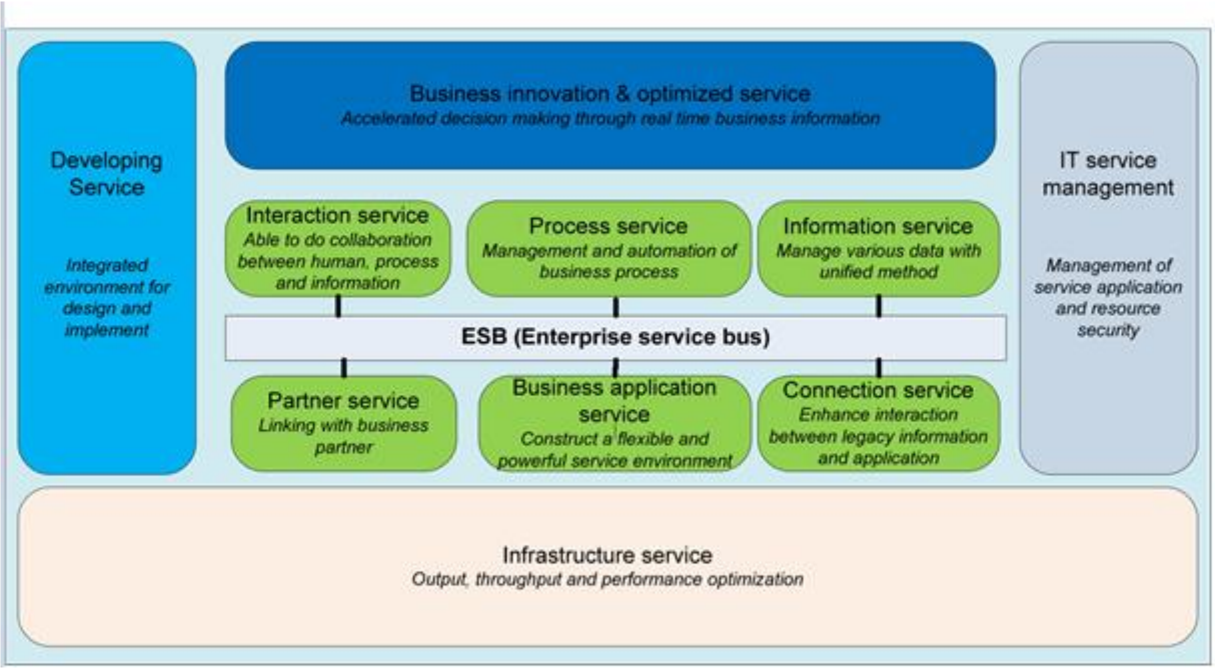

Figure 29 — SOA conceptual configuration

Explanation of the various services is the following:

a. "*Access service*" is a component supporting the connection between a single window system and users or external organizations. This service is based on a standard communication protocol.

b. "*Interaction service*" is a service for transaction among unit modules or between unit modules and the service repository within a single window system.

c. "*Business application service*" is the execution of service modules implemented within a single window system. Examples in a single window for maritime transport business include port arrival/departure, application/approval, cargo report/approval and dangerous cargo report/approval.

Figure 5 shows the conceptual configuration of SOA based on a traditional request - response mechanism. The service requester makes a request to the service providers through a common service bus (ESB). The consumer requests specific services through a standard set of communication protocols able to handle requests across the ESB. When the service request is complete, the results are communicated to the consumer using another set of standard protocols able to provide response.

7.5 Implementation best practice – use of Web services

Use of Web services best practice in implementation of single windows system usually involves usage of WSDL and SOAP.

WSDL (Web Services Description Language) is used to enable entry point for service provider. It is usually used as a service endpoint or end point and provides end point interface definition, and physical service location (address) definition.

On the other hand, SOAP (Simple Object Access Protocol) is XML-based protocol for systematic information exchange in a distributed environment that is ransport independent, and can be combined with such protocols as HTTP, JMS, SMTP and FTP. It is designed for communication among applications and on the Internet, and can be used in combination with security policies. Composition of main components of web services is shown below in Figure 30.

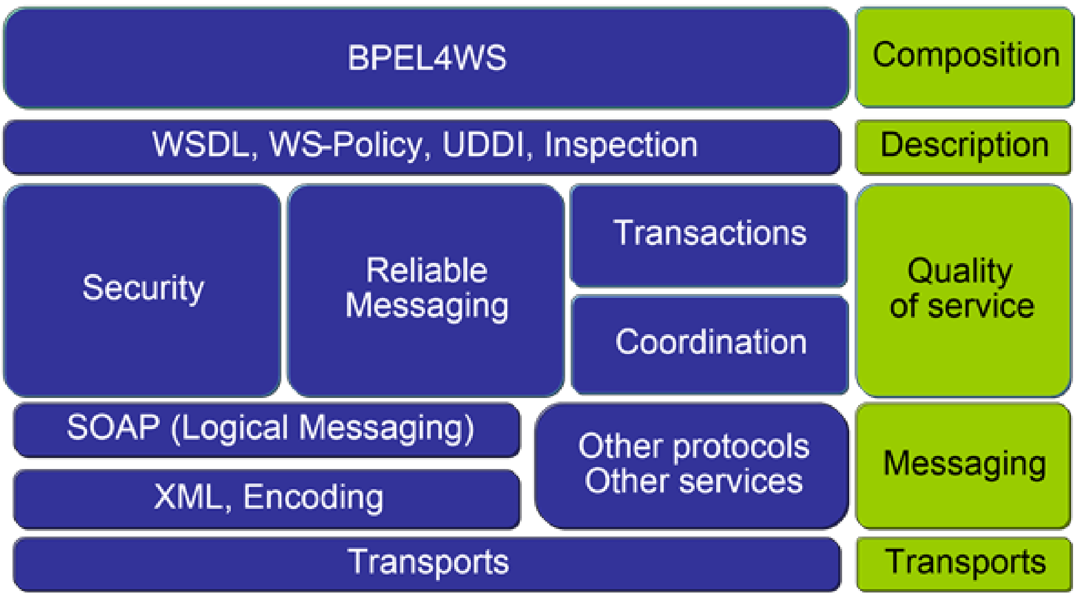

Figure 30 — Web service standard

7.6 IMPLEMENTATION BEST PRACTICE – USE OF SPRING FRAMEWORK

The Spring framework provides functions needed in enterprise applications. It supports multiple functions provided by J2EE, so it is becoming popular as a replacement for J2EE. Spring framework by its nature is a lightweight container having Java objects that manages the life cycle of these Java objects from creation to disposal and can bring the necessary objects for use when required.

It supports the dependency injection (DI) pattern, meaning that it can configure dependency among objects using configuration files. Therefore, objects do not need to create or search dependent objects by themselves. Framework also supportss aspect-oriented programming (AOP), so it can divide and apply functions that are commonly needed in various modules. Examples of such include transaction, logging, and security .

Spring Framework supports POJO (Plain Old Java Object). Java objects stored in the Spring framework do not need to implement specific interfaces or inherit particular classes. Therefore, existing codes can be used without modification.

It provides a consistent method for processing transactions. Because it inputs transaction-related information through a configuration file, the Spring Framework can use the same code in multiple environments, regardless of transaction implementation. Framework also supports various application programming interfaces (API) that are related to continuity. It supports interoperation with widely used libraries related to database such as JDBC, iBATIS, Hibernate, JPA and JDO.

Spring framework also supports interoperability with various APIs. The Spring framework enables usage of various APIs needed in developing enterprise applications (such as JMS, mail notifications and task scheduling) through a configuration file.

7.7 IMPLEMENTATION BEST PRACTICE - AJAX

Ajax is an asynchronous communication technology for exchanging XML data between client and server using asynchronous JavaScript and XML. In traditional web applications, users can see the result on a browser only after a response is sent from the gets back from a server. Using Ajax, a user can see the result in a browser in the process of sending a request and can check the result without page shift upon receiving a response from a server.

There are several available Ajax frameworks, used for creating web applications with a dynamic link between the client and the server. Some of the frameworks are JavaScript compilers, used to generate JavaScript and Ajax that runs in the web browser client. Others are pure JavaScript libraries, some of them areserver-side frameworks that typically rely on JavaScript libraries.

The following picture, Figure 31, shows clear difference in the data flow is executed in the conventional model of a web application in comparison to the Ajax model of a web application.

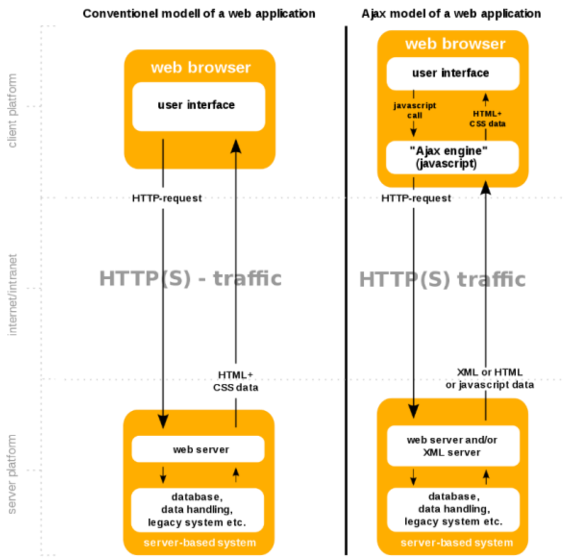

Figure 31: Data flows in conventional ana Ajax models of the Web application

Ajax can bring data without page shift and therefore can improve user interface. Using Ajax, it is relatively easy and convenienf for the user to develop maritime map or back office programs or calendar programs to develop and publish on the Web. However, Ajax technologies do not function properly in a browser that supports JavaScript because it is composed of JavaScript. Conclusion - Summary of Best Practice Analysis findings.

8. Conclusion – summary of the best practice analysis

Management and planning of up-and-coming and new technologies asks for proper identification of **potentially disruptive technologies** that will have both positive impact on productivity and efficiency of port and hinterland cargo terminal operators. Some such technologies identified during research and creation of this study are:

1. Overall **digitalization**, simplification and adaptive sourcing of non-core IT activities,
2. Creation of **custom cloud solutions** (including hybrid solutions), in order to facilitate transition from legacy systems,
3. Creation of the **common global framework** for federalization of trusted single windows,
4. Adoption of the **maritime cloud** paradigm,
5. **Extensive use of IoT and RFID** technologies benefitting from latest developments,
6. Deployment of **ultra-low energy sensor and surrounding energy harvesting** technology,
7. **Big data and data lake** analysis technologies,
8. Deployment of **robotics, automation and autonomous transport** (air drones, drone ships, autonomous internal terminal vehicles),
9. Use of **simulation, augmented** and **virtual reality,**
10. Implementation of new **total cybersecurity paradigm** involving proactive and not only reactive strategy,
11. **Distributed ledger technologies** (blockchain, smart contracts and similar)

This paragraph contains a brief overview of findings related to best practice analysis of on ICT tools and policies for enhancing maritime and multimodal transport, both in the programme area, and internationally, that are in more details explained in the next paragraphs.

1. Establishing a single window system is a main success factor in integration of all multimodal logistics stakeholders' IT systems, both those serving sea-side and hinterland-

side. Such best practice requires tight integration, but also supervisory oversight of the regulatory state bodies,

2. Influencing public policies at the international level, principally by lobbying, in order to promote the adoption of e-logistics as the key element in the development of international maritime, shipping and logistics sectors becomes a main driver in global standardization and federalization of PCS and single window systems, as demonstrated by example of the **IPCSA (International Port Community Systems Association),**
3. Visibility is a critical competitive asset in the supply chain and te information must flow among the actors. However, the quality of the information is a challenge as itis disseminated and fragmented in several points of the chain. Finding the most suitable and precise source of information is not an easy task in a global supply chain. Seaports and airports play an important role in the supply chain acting in the first place as a transportation hub, but also as an information hub. PCS are informed about the physical and documentary events that happen in their area. However, the shippers and the logistics operator need to be aware of the events in other ports to obtain visibility of traffic flows “end-to-end”. The PCS interconnectivity can be an instrument to address these challenges in an effective way with reference project best practice for global data exchange between ports being **IPCA’s Network of Trusted Networks**.
4. State and local bodies tasked with oversight of development of interconnection and single window systems that will be used by commercial stakeholders need to involve them timely and gather adequate feedback of everybody involved, in order to synchronize planning, budgeting and project management of many parallel ongoing projects. This type of cooperation is evidenced in example of Croatia and **planning for establishment of the NSW,**

5. Good business execution practice calls for tight integration of the national single window with national data bus in those countries where such development is envisaged. One such positive example is use of **national maritime single windows CIMIS in Croatia** to enter data related to seamen and voyages, that can be used for purpose of pension regulation and similar tasks performed by other ministries, but also the technology and processed used in **Israel** for the same purpose (**MAINSYS and SeaMen** control systems).
6. **Monetization model** (or lack thereof) of single window systems needs to be carefully evaluated, and considered as a part of preliminary implementation activities, and not a part of the project. Buy-in procedure also needs to be an integral part of planning, instead of ongoing project activity. Depending on the single window "owner", equal success can be yielded as a result of "free of charge" implementations and "paid for" ones, depending on the value stakeholders derive from such systems. Timely transition from free to paid model is also of high importance in implementation of commercial single window systems on the commercial cargo side of the transport.
7. While it is customary to develop single windows and IT systems from the sea-side of commercial process, some examples, like **Italy's UIRNET**, have shown that it is possible to develop equally successfully systems whose roots are in dry ports and inland freight villages who have undergone clustering process linking process management and freight transport suppliers.
8. Final goal of all local single window implementations in port is total integration of components related to ships, cargo and security, providing all involved stakeholders with high- and low-level overview of situation in the multimodal transport chain.

9. Successful but different models of monetization can be evidenced using PCS systems of several ports in the programme area - Koper and Venice.
10. Best practice requires for planning and careful selection of quantitatively measurable performance indicators prior to project execution and decision making, in order to be able to evaluate results of multimodal IT system implementation, as shown in the example of building **SP-IDC, Shipping and Port Internet Data Centre of the Republic of Korea.**
11. Unified single window platforms operated by government bodies can be also used as facilitators for information sharing between businesses. Therefore, it is prudent to envisage such development scenarios where IT systems in logistics developed by the governmental bodies do not serve only state-side, but also business-side, even business to business scenarios, as shown by using example of **Japan's NACCS system**.
12. Monitoring of regulatory framework changes affecting all integrated systems in maritime and multimodal transport, even if the anticipation is long-term, is of great importance for successful maintenance and additional upgrades of all systems. As demonstrated by the example of development of **national PCS in Croatia first initiated in the Port of Rijeka,** some such developments involve **e-Manifest and Port Call Synchronization /"just in time arrival".**
13. Best practice of technology selection when evaluating development of multimodal IT systems calls for detailed analysis of maturity of utilized technologies. While architecture of single window and other interconnected and underlying IT systems is generally technology-neutral, it is important to select those technologies that are not in late mature stages, in order to ensure longevity of used platforms.

14. It is important to identify the regulative framework used to develop IT systems in multimodal logistics, and especially, to involve hinterland stakeholders (trucking companies, warehousing companies, railway operators, air cargo transport companies and other). In Europe, existence of common legislative framework is used as facilitator for certain national and local processes, as evidenced by **examples in Italy, Croatia and Slovenia** and application of EU directives. Furthermore, such inclusion was a prudential move on the part of the **Dutch authorities** aiming to streamline transmission of data, not only originating from maritime side, but also involving air and consecutive inland transport.
15. Platforms created as a part of supranational EU system and best practices deployed in their development, can be used as starting points in creating national IT systems and interfaces. Successful adoption of **SafeSeaNet Norway** demonstrates feasibility of such approach.
16. There is an increasing trend in integration of multimodal transport IT systems of various stakeholders in order to achieve not only set business, but also **decarbonization goals.** Introduction and full scale deployment **of e-TMS systems** is indentified in this regard as a key activity.

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10. Glossary of used terms

- **Bill of lading**

A bill of lading is similar to a waybill, and the two terms are sometimes used interchangeably. A bill of lading is more formal and often negotiable, giving the person with ownership of the bill of lading the right of ownership of the goods and the right to re-route the cargo.

- **Cargo**

The freight (goods, products) carried by a ship, barge, train, truck or plane

- **Cargo manifest**

Cargo manifest is s specification of all cargo transported on a ship or other means of transport. Its purrpose is management of the transport operation and it is in fact an aggregate of all applicable waybills.

- **Carrier**

Carrier is the party of a larger multimodal supply chain undertaking the physical transport of a consignment.

- **Clearance**

Clearance is rhe process of getting the necessary permits (written, electronic or informal) to allow a certain process to be performed. The following clearances are relevant for exchange between different actors participating in NSW:

1. Clearance for a ship to enter or leave national waters,

2. Clearance for a ship to berth. It usually includes clearance for the cargo to proceed to import control,

3. Clearance for the ship to load or offload cargo,

4. Clearance for the ship to leave berth, and

5. Clearance for cargo to be imported or exported.

Other types of clearances are also in existence, for example clearance to enter ship reporting areas, port fairways, channels, locks or other restricted traffic areas. They are usually a part of maritime traffic management rather than NSW cargo related procedures.

- **Consignor/Freight Shipper**

Freight shipper is the sender and/or formal owner of the consignment. He is generally liable for the freight or the hire for the carriage of consignment.

- **Consignment**

Consignment is a collection of goods or merchandise that has a consignor and consignee. Ownership of the merchandise shipped on consignment remains with the consignor or freight shipper until the goods are disposed of as agreed.

- **Electronic Data Interchange (EDI)**

"EDI" is used to refer to any type of electronic data interchange. The interchange can take place using XML-formatted data, UN/EDIFACT-formatted data or any other formatted text files, e.g. as comma-separated fields produced by spreadsheet editing tools. Electronic commerce has been under intensive development in the transportation industry to achieve a competitive advantage in international markets.

- **Electronic messaging**

Electronic exchange of information is the most efficient way to perform the necessary administrative formalities related to ships before loading or discharging cargo. Considering that Convention on Facilitation of International Maritime Traffic (FAL Convention) still requires authorities to accept paper forms when presented, the definition of a single window does not preclude the use of paper documents, where appropriate.

- **Electronic Port Clearance (EPC)**

"EPC" is used to refer to a single window solution for the electronic clearance of ships arriving at or departing from a port. It generally does not normally include cargo clearance for import or export, but instead, it is connected with administrative procedures related to ship.

- **Electronic signature**

Electronic signature is data in electronic format attached to or logically associated with other electronic data that serve as a method of authentication that meets the following requirements:

1. Unique to the signatory,
2. Identification of the signatory,
3. Created using means that the signatory can maintain under his/her sole control, and
4. Linked to the data to which it relates in such a manner that any subsequent change of the data is detectable.

- **Freight Forwarder**

Freight Forwarder is the party arranging the carriage of goods including related services and/or associated formalities on behalf of a freight shipper or consignee. The freight forwarder is often contracted by the principal, the consignor or the consignee, depending on which terms of contract apply in the business relation between them.

- **Harbor**

A port of haven where ships may anchor.

- **IMO FAL forms**

IMO FAL forms are a number of paper forms defined in the FAL Convention defining reporting requirements for ships visiting foreign ports.

- **Intermodal shipment**

When more than one mode of transportation is used to ship cargo from origin to destination, it is called intermodal transportation. For example, boxes of hot sauce from Louisiana are stuffed into metal boxes called containers at the factory. That container is put onto a truck chassis (or a railroad flat car) and moved to a port. There the container is lifted off the vehicle and lifted onto a ship. At the receiving port, the process is reversed. Intermodal transportation uses few laborers and speeds up the delivery time.

- **Manifest**

The ship captain's list of individual goods that make up the ship's cargo.

- **Maritime**

Located on or near the sea. Commerce or navigation by sea. The maritime industry includes people working for transportation (ship, rail, truck and towboat/barge) companies, freight forwarders and customs brokers; stevedoring companies; labor unions; chandlers; warehouses; ship building and repair firms; importers/exporters; pilot associations, etc.

- **Port**

This term is used both for the harbor area where ships are docked and for the agency (port authority), which administers use of public wharves and port properties.

- **Port of call**

Port at which cruise ship makes a stop along its itinerary. Calls may range from five to 24 hours. Sometimes referred to as "transit port" and "destination port.“

- **Port Community System (PCS)**

PCS is defined as a computerized system used to simplify information exchange between non-public authorities in a port. This may include functionalities also found in single windows, such as databases and message exchanges. The definition varies depending on the contexts, and exchange of information with governmental parties could also be part of the scope of a PCS.

- **Port Single Window (PSW)**

PSW is a system that may be connected to a higher level NSW that provides local level information about a vessel to the authorities at port level.

- **Principal**

Principal is sn individual or organization that entrusts the execution of a carriage order to a contracting party in return for appropriate remuneration. It is a generic term for the entity that requests carriage; for example, the consignor, consignee, freight forwarder or any third party.

- **Ship's agent**

Ship's agent represents the ship's owner or charterer in port. In cooperation with the port, the ship's agent is responsible for arranging a proper berth and pilots, performing all administrative tasks related to the vessel with the port and other authorities and releasing or receiving cargo on behalf of the ship's owner or charterer.

- **Single Window**

Single window is a system that allows parties involved in trade and multimodal transport to provide standardized information and documents through a single entry point to fulfil all import, export and transit-related regulatory requirements, avoiding multiple data entry and other redundancies in case that information is in electronic form.

Some basic models for the implementation of the single window are:

1. *A single authority* that receives information, either on paper or electronically, disseminates this information to all relevant governmental authorities and coordinates controls to prevent undue hindrance in the logistical chain,
2. *A single automated system* for the collection and dissemination of information (either public or private) that integrates the electronic collection, use and dissemination (and storage) of data related to trade that crosses the border.
3. Integrated system: data is processed through the system. Subtype of this system is decentralized interfaced system (decentralized), where data is sent to the agency for processing. In some cases, two approaches are used simultaneously in a combination.

Single window is also an automated information transaction system through which a trader can submit electronic trade declarations to the various authorities for processing and approval in a single application. Sometimes, single window *environment* term is used because single window implementations are usually a set of interdependent facilities, regulatory requirements and cross-border regulatory agencies' business processes. The establishment of the single window environment for border control procedures is considered by customs administrations as the best solution to the complex problems of border automation and information management involving multiple cross-border regulatory agencies.

- **Terminal operator**

The company that operates cargo handling activities on a wharf . A terminal operator oversees unloading cargo from ship to dock, checking the quantity of cargoes versus the ship's manifest (list of goods), transferring of the cargo into the shed, checking documents authorizing a trucker to pick up cargo, overseeing the loading/unloading of railroad cars, etc. It performs the action of unloading of cargo at a port or point where it is then reloaded, sometimes into another mode of transportation, for transfer to a final destination.

- **UN/EDIFACT**

UN/EDIFACT is the abbreviation for the United Nations Electronic Data Interchange for Administration, Commerce and Transport. It is a special format defined by UN/CEFACT and standardized by the International Organization for Standardization (ISO) as the ISO 9735 standards.

- **Waybill**

Waybill is an agreement between consignor, carrier and consignee covering the transport of a consignment. This agreement covers the ownership and liability issues of the parties in relation to the consignment.