

Maritime Transport Single Windows: Issues and Prospects

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ABSTRACT: In the trade, transport and shipping sector, the Single Window (SW) concept has been evolved over time in a number of forms, reflecting respective policy, regulatory, market and technological regimes of the domain. A SW primarily addresses the need for efficient electronic transactions between governmental and business entities; however the SW service model adopted by the responsible authority and the offered SW system functionality differ; currently at least two distinct approaches are observed, namely a customs-centric SW approach, and a maritime and port centric approach. In all respective cases, the SW service model, the SW ownership model (public, private or Private-Public-Partnership), legal and regulatory aspects and the SW revenue model (free or with a fee) consist pertinent SW service design issues. Thus, different types of SW systems evolve in terms of offered service bundle, namely ship clearance, cargo import/export, or port clearance SWs, where often vested interests and policy choices dictate the dominance of one model implementation over the other. Modern ICT tools may significantly help to organize and improve the efficiency of a SW design and implementation process. In this paper, admissible development frameworks and methodologies are examined towards the efficient implementation of SW service models that are explained. Our analysis is based on experiences gained in the Norwegian SW national initiative (<http://www.sintef.no/Projectweb/MIS/>) and the EU eFreight project (<http://www.efreightproject.eu/>).

1 INTRODUCTION

The one stop shop business model has been exhaustively researched and applied in the context of e-business and e-government service provision over the last decade (Wimmer, 2002; Lambrou et al., 2008). In a similar vein, in the trade, transport and shipping sector, the "Single Window" (SW) concept was formalized by the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT 2005) to enhance the efficient exchange of information between trade and government agencies. The Single Window concept has its origin in the Trade Facilitation and Customs field focusing upon efficient import and export institutions and mechanisms, where declarations of goods related to regulatory information must be reported in cross border activities.

A SW primarily addresses the need for efficient and collaborative electronic transactions between governmental and business entities; however the co-

ordinating SW authority and the core functionality may differ, thus we typically observe a customs-centric, import and export oriented approach, a port and ship oriented (maritime focus), and a safety and security centric approach. In both cases pertinent SW service design aspects include the SW ownership model (public, private or public-private partnership - PPP), and the SW cost model (e.g., free use, membership or transaction fee). The organizational level of the SW competent authority, e.g., international, national, regional, or local is an important differentiating factor, as well. Often, vested interests and policy choices dictate the dominance of one model implementation over the other.

In this paper we discuss different types of single window systems and enabling development methodologies and platforms, focusing in particular on a maritime centric model where ship clearance, cargo import/export, and port clearance services are supported. This means that we extend the Single Window Concept to cover not only regulatory infor-

mation, but also other information related to maritime transport.

2 A TAXONOMY OF SINGLE WINDOW SYSTEMS

There are different reference models of existing and emerging SW systems supporting intermodal transport activities, as explained in Table 1. A SW system can cover the cargo reporting activities where import and export declarations are the main processes supported, another SW model is organized around ship or vessel clearance activities offered by national governments, whereas a third model is a port clearance oriented SW. The purpose of a ship oriented SW is to support all mandatory information reporting concerning a ship sailing from abroad to a EU or associated country, as based on the SafeSeaNet (SSN) system notifications and formalities.

All countries in EU and Associated countries are connected or will soon be connected to the central SSN system. Every country has to dedicate an internal authority as a National Competent Authority that will be the official connection between the country and the central SSN system that is under the responsibility of the European Maritime Safety Agency, EMSA.

A Port Single Window (PSW) can in many cases be defined as a Port Community System (PCS). It is a community system which based on an integrated series of procedures, rules, standards and ICT solutions supports the automatic exchange of data and documents related to the port authorities' clearance of ships and cargo upon arrival, stay and departure of vessels.

A PSW is primarily supporting the requirements of governmental agencies, but also the requirements of the cargo parties' interests. So a PSW covers Customs requirements and document handling, and the information exchange dealing with the necessary services in a port and the handling of ship and cargo. It is also likely that a PSW will have a stronger focus upon private information and more commercial oriented regarding sale and ordering of port services than the one for ship clearance.

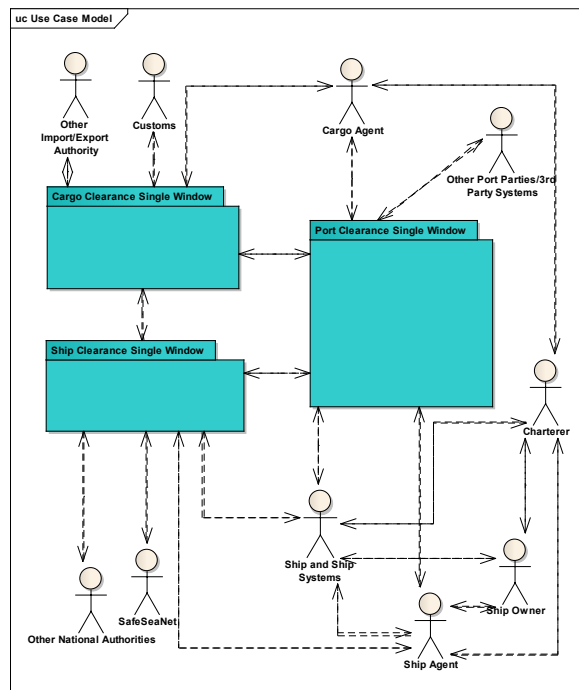


Figure 1. Single Window Taxonomy

EPC (Electronic Port Clearance) is the concept used to refer to vessels visiting a port and their electronically (without the use of paper documents) dealing with all formalities, documentary requirements and procedures associated with the arrival, stay and departure of ships engaged on international voyages. On the one hand, EPC aims to replace the paper documents such as the FAL Forms currently in use; on the other hand EPC tries to make the exchange of information more efficient, through the rationalization of the procedures and simplifying the related data. Figure 1 gives an overview of the three dimensions of Single Window systems and how each of them relates to each of the actors. Note that the actors *Ship Owner* and *Charterer* only interacts with the Single Window through other systems, not as separate actors. The actor *Other Port Parties/ 3rd Party Systems* includes parties involved in the port business other than the port authorities, for instance systems to handle resource bookings.

One of the challenges in the specification of SW system is to decide the dimensions and geographical areas the SW system should cover.

Examples of such dimensions are:

- International dimension
- National dimension
- Regional dimension
- Local dimension

Another dimension could be an Ad-hoc solution.

Table 1. Types of Single Window

Single Window for cargo	
Description	A SW for customs clearance normally contains information about cargo for either import or export.
Users	The users are Consignor's and Consignee's, the Customs, as well as cargo agents
Characteristics	The goods to be defined for import and export will need a release number before the transport can progress from an import area at a terminal. A main functionality for this SW is the cargo clearance process.
Objects	Cargo information and definition, Ownership, The itinerary of the goods, Handling instructions, General status information about the cargo
Functionality	Registers: Goods group, Location register, Tax code Automation: XML and Web-based user interface Accessibility control Hand-over mechanism with other SW-solutions
Single Window for ship clearance	
Description	A SW for Ship clearance contains information about the ship, the voyage, the cargo, the passengers, the crew and information that is required by the SafeSeaNet directive.
Users	The users are the ship itself, agents, the providers on the ship, or the governmental bodies that need statuses and information for controlling duties, for mainly safety/security purposes. Governmental bodies can be Police, Coast Guard, Navy, Coastal Administration, Health authorities, or the ports.
Characteristics	The main purpose of such a SW is to have a good overview of the safety and security issues regarding sea transport. It could be either a site where information about a ship transport could be achieved in a distressed situation, or it could be more used in a controlling purpose where i.e. the crew and passenger list is matched with the list of criminals by the Police authorities. A main functionality for this SW is the ship clearance process.
Objects	Ship information, Cargo information, Crew and Passenger information (also effects), voyage information. Notification messages (hazmat, security, alert, ship) between the different states should also be considered
Functionality	Registers: Goods group, Vessel, Location Automation: XML and Web-based user interface (both ways) Acceptance report/Clearance notification (automatic) Use of sensor data for report purpose Ordering of transport services such as pilot age services Hand-over mechanism with other SW-solutions as well as commercial systems from service providers
Single Window for port clearance	
Description	A SW for port clearance is a reporting site for needed information regarding an entrance to a port. The information could also be about information classified as private, and used within a commercial aspect.
Users	The ship, the ship operators, the agents, the port management, the port service providers
Characteristics	This SW is used to achieve a port clearance of a ship. The information is both of a private and a public character. The ports are using the information to plan the ship entrance, to achieve the port safety and security regulations, and to calculate the fees to be sent to the users. A main functionality for this SW is the port clearance process.
Objects	Ship, Cargo, Load units, Service needs, Security information
Functionality	Registers: Goods group, Vessel, Location, Port services. XML and Web-based user interface (both ways). Acceptance report/Clearance notification (automatic), Use of sensor data for report purpose, Safety and security, Ordering of port services, Accessibility control, Hand-over mechanism/communication mechanisms with other SW-solutions as well as commercial systems from service providers, Statistics, General port information, Site for laws and regulations.

For all those dimensions there are different needs and a different legal basis to follow that also differs within one dimension. An example can be that within a port, which is defined as a local dimension solution, there are some port specific regulations to follow regarding mandatory reporting and the configuration of the SW must therefore follow the properties defined at the port where also the private-public partnership relations must be placed, Figure 2. This means that a Single Window system for one port may differ in several respects to a Single Window system in an adjacent port.

It is likely that the different systems that represent the different solutions must exchange information with each other. A ship normally crossing the defined dimensions where coming from an abroad country and visiting a port, is mirroring the process when returning to an abroad port. In such a case, the ship must first follow the local dimension from departure port, where regulations and other procedures

are followed (reporting time, place, etc). Then, in some cases, new reporting and procedures must be followed when sailing in a certain region such as a fjord or vulnerable regional areas. Then, when the ship is leaving the national waters, information must be reported to the NCA (National Coastal Authorities) or the Coast Guard of the departure nationality, and finally follows international conventions in open international waters. The same approach will be relevant when sailing into the arriving port.

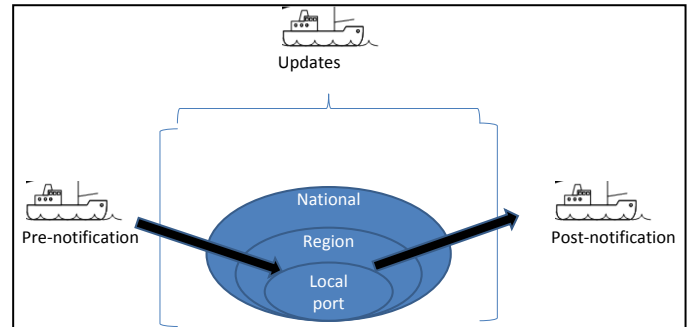


Figure 2. Geographical dimensions of SW

3 DEVELOPMENT METHODOLOGIES FOR SINGLE WINDOW SYSTEMS

Several methodologies relevant for the development of Single Window systems can be exploited. A number of available methodologies focus on the analysis and design phase using various process modeling techniques, while other methodologies are related to the technical implementation of a SW system (e.g. SoaML).

3.1 Zachman Framework

The Zachman framework (Zachman, 1997) was first presented in 1987 and has since then evolved in several directions and several versions. For maritime Single Window development, it is most relevant to view it as a taxonomy for organizing architectural artifacts, design documents, specifications and models. The framework addresses the question of who is the target for the description and also what is described, for instance data and functionality. In this sense, the Zachman Framework is not a methodology since it lacks methods and processes for collecting the information, and also for managing or using the information. Rather, Zachman describes the framework for enterprise architecture as follows: *“The Framework as it applies to Enterprises is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise’s systems.”* A key point in the Zachman framework is that the same complex item can be de-

scribed for different purposes in different ways using different types of descriptions.

The framework has 36 categories for completely describing anything related to the enterprise, organized with six columns and six rows. Each row represents a total, distinct and unique view of the solution from a particular perspective. Each column represents a category of the enterprise architecture component, called focus. These are data description (what), function description (how), network description (where), people description (who), time description (when), and motivation description (why).

Some aspects of the Zachman framework that are convenient for analyzing SW systems include:

- 1 Analysis of several organizations that have to cooperate in an interoperable SW system:
A SW is an environment which has to support interoperability among highly heterogeneous environments. This means that a structured way to present the analysis of the organizations with different viewpoints is important. The Zachman Framework for systematically describing changes to an organization based on various viewpoints and various abstraction levels is very useful in the analysis phase of a SW development.
- 2 Clarification of different views of the same artifact:
The Zachman Framework focuses on different views of the same artifact (process, data), which is important in a SW system covering processes and data originating from various applications, both cargo, port, and ship clearance, but also originating from both public and private organizations.
- 3 Presentation of analysis results throughout several organizations:
The Zachman Framework can be useful to present the analysis of a SW system. Important here is the fact that new third party systems that want to collaborate with the SW may have easier access to the taxonomy of the SW.

Some aspects of the Zachman framework that are missing for SW systems:

- 1 Lack of a structured methodology:
The Zachman Framework does not include a methodology per se, however, a methodology is needed for the Single Window design and implementation process, for instance for describing how to integrate a third party system with the Single Window, and how to handle and share data that is specific for the third party systems.
- 2 Description of both the SW and the third party systems are needed:
The Zachman framework seems to focus on the description of a single enterprise, however, when designing a SW system, we have to consider several organizations and environments as a whole.

This is because each service provider and service user may represent distinct organizations with their own Zachman matrix related to Single Window. What is needed, is a Zachman Framework analysis of the Single Window itself, but in addition, we would need to have descriptions of the third party organizations, at least the parts that are most relevant for the Single Window system.

3.2 CIMOSA

CIMOSA (Computer Integrated Manufacturing Open System Architecture) is an enterprise modeling framework, which aims to support the enterprise integration of machines, computers and people. The framework is based on the system life cycle concept, and offers a modeling language, methodology and supporting technology to support these goals. Three dimensions of CIMOSA are outlined (Zuesongdham, 2009):

- 1 The generic dimension (Instantiation of Building Blocks) is concerned with the degree of particularisation. This dimension differentiates between Reference Architecture and Particular Architecture.
Reference Architecture resembles a catalogue of reusable building blocks which contains generic and partial building blocks applicable to specific needs.
Particular Architecture serves the use of a specific case in process modelling which is not intended to be reusable for other models.
- 2 The modelling dimension (Derivation of Models) provides the modelling support for the system or work life cycle starting from requirements to implementation.
- 3 The view dimension (Generation of Views) offers the users to work with partial models representing different aspects of the enterprises: function, information, resource and organisation with the option for other views to be defined as needed.

Advantages of CIMOSA:

- 1 Strong inter-organizational process modeling:
The CIMOSA is strong on modeling complex organizations and has constructions to model different views of the same things in an organization.
- 2 Use of reference architecture:
The reference architecture can be used to build up an library of Single Window concepts which may be useful when new third party systems are to connect to a Single Window. Then, reuse of common descriptions and concepts may be facilitated through the use of CIMOSA.
- 3 Focus on common understanding of terms:
CIMOSA has focus on defining a glossary for common understanding of terms and definitions.

Problems with using CIMOSA:

- 1 Process descriptions separate from implementation aspects:
CIMOSA does not cover the technical implementation phase, for instance related to ICT architecture or software services. However, attempts have been made to extend this framework (Zuesongdham, 2009)
- 2 Complex framework:
The framework may look complex, since it has a three dimensional matrices describing the modeling framework.

3.3 SOA and SoaML

SOA (Service Oriented Architecture) is an architectural paradigm whose goal is to achieve loose coupling among a collection of interacting software services. Services are usually defined as autonomous, platform-independent computational elements that can be described, published, discovered, composed and consumed using standard protocols for the purpose of building distributed, collaborative applications within and across organizational boundaries (Manolescu et al., 2005, Rødseth et al., 2011).

SoaML (Service oriented architecture Modeling Language) is an open source specification project from the Object Management Group (OMG), describing a UML profile and metamodel for the modeling and design of services within a service-oriented architecture (Casanave, 2009). SoaML meets the mandatory requirements of the UPMS (UML Profile and Metamodel for Services). SoaML includes descriptions of how to identify services, the requirements they are intended to fulfill, the functional capabilities they provide, what capabilities consumers are expected to provide, the protocols or rules for using them, and the anticipated dependencies between them.

Advantages of using SoaML for Single Window Systems:

- 1 Closer connection between the design and the implementation phases of the Single Window development:
SoaML ensures a close connection between the description and the implementation of services, since SoaML works at the level of services. This means that the connection between for instance web services to implement the services can be very tight to the description of the service architecture of the Single Window system.
- 2 Focus on services both at the design and implementation level:
Using SoaML means that both analysis and implementation will focus on services. This is important in at least two aspects: to avoid silo thinking regarding the systems, and to facilitate the

creation of complex services based on basic, already existing services in the Single Window environment.

- 3 Intuitive way to describe third party systems:
This is important in the sense that the third party systems can be described as legacy systems being wrapped up in a new service. The third party systems can be described with a clear interface to the Single Window system regarding information exchange, functionality and payment regimes.
- 4 Reuse of services in new, complex services:
A SW system will make more information than before available as a whole. This means that the information can be combined in new ways offering new services. This leads to the need to combine new and existing services into complex services. SoaML is suitable for describing such complex services.

Difficulties of using SoaML for SW Systems

- 1 Unclear notion of data model since the focus is on services and processes:
The semantics of data in a Single Window environment is very important since several systems with heterogeneous data models have to cooperate. In this context, the notion of *three level architecture* for data model is important, that is, the *conceptual schema* describing all concepts (entities and relationships) in the Single Window, and the *external schema* describing only the part of the data that is relevant for each third party system. Separate from this, we have the *internal schema* describing the implementation. SoaML does not contain explicit description of this.
- 2 Complex syntax:
The notation and syntax of SoaML may appear to be complex for those who are not familiar with it. This may lead to difficulties in the communication with practitioners in the port and logistics domain.

In (Zuesongdham, 2009), it is argued that a combination of CIMOSA and SOA modeling is the most attractive approach to develop interoperable port community systems. This is because the inter-organizational process modeling capabilities from CIMOSA is needed in addition to the more technological related implementation view.

4 CONCLUSIONS

Several definitions of Single Window exists, most of them are focused on handling regulatory information. The future will show a more integrated information society between public and private systems as this paper has shown. However, we have argued that the taxonomy and the use of commonalities between them must be in place to have a harmo-

nized way of doing trade and transport. If each of them will be developed as a proprietary system than lots of engineering between them is needed to get any valuable benefits of using the Single Window concepts as described. One of the key points is use of standard information and code values.

Several initiatives related to the development and operation of maritime Single Window systems exist, including the description of Single Window frameworks by IMO (IMO/FAL36/1 2010, IMO/FAL/36/2 2010), UN/CEFACT recommendation on Single Window (UNCEFACT 2005, 2010), and (APEC 2009), and the description of several data models related to Single Window including (ISO/FDIS 28005-2 2010) on Electronic Port Clearance (EPC), and (ISO 7372 2005) on TDED data model. However, it is important to further proceed in obtaining a distinct and unified framework and methodology for developing Single Window systems, which will crucially support a smooth and manageable integration of heterogeneous systems into a Single Window environment. Single Window systems need to be developed based on the compatible standards regarding formal description of logistics processes, interfaces and information content. Cooperation between several national and regional Single Window solutions will be simplified if the systems are developed based on a unified framework and compatible methodologies. Also, integration of the numerous third party systems into the different national Single Window environments will be more efficient as based on a unified methodological background, and if systematically applied.

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