DaGoB Background Report

IT SYSTEMS AND CONTROL OF DANGEROUS GOODS IN BALTIC SEA REGION PORTS

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Concepts and abbreviations

ADR	=	Accord européen relatif au transport international des marchandises Dangereuses par Route, the European agreement on cross-border transportation of Dangerous Goods by road.
AIS	=	Automatic Identification System is a system used by VTS principally for identification of vessels at sea.
ASCII	=	American Standard Code for Information Interchange is a character encoding based on the English alphabet.
ATA	=	Actual Time of Arrival is the eventual arriving time of a vessel.
ATD	=	Actual Time of Discharge is the eventual discharge ending time of a vessel.
BSR	=	Baltic Sea Region
CACIS	=	Cargoes And Commodities Information System is the IT System used and developed in the Klaipeda State Seaport Authority.
CBIS	=	Computer Based Information System
CIS	=	Commonwealth of Independent States is the international alliance, consisting of 11 former Soviet Republics.
DaGoB	=	Safe and Reliable Transport Chains in the Baltic Sea Region. An Interreg IIIB funded project, led by Turku School of Economics. www.dagob.info.
DBMS	=	Database Management System is computer software designed for the purpose of managing databases.
DG	=	Dangerous Goods
EC	=	European Commission
EDI	=	Electronic Data Interchange is a set of standards for structuring information that it can be electronically exchanged between and within organizations.
EMSA	=	European Maritime Safety Agency is working to reduce the risk of maritime accidents, marine pollution from ships and the loss of human lives at sea.
ERP	=	Enterprise Resource Planning refers to a hardware or software system that serves all departments within an enterprise or an organization.
ETA	=	Estimated Time of Arrival of an vessel
ETD	=	Estimated Time of Discharge of an vessel
EU	=	European Union
FRS	=	Fartygs Rapporterings Systemet. (Vessels reporting system) used by Swedish Maritime Administration.
GPRS	=	General Packet Radio Service is a mobile data service available to users of GSM
GPS	=	Global Positioning System is the only fully functional Global Navigation Satellite System consisted by 24 satellites.
GSM	=	Global System for Mobile Communications is the most popular standard for mobile phones.
GT	=	Gross Ton, or Gross Tonnage refers to the volume of all ship's enclosed spaces (from keel to funnel) measured to the outside of the hull framing. It is always larger than gross register tonnage, though by how much depends on the vessel design.

IATA-DGR	=	International Air Transport Association - Dangerous Goods Regulations
ICAO	=	International Civil Aviation Organization is an agency of the United Nations.
ICT	=	Information and Communication(s) Technology
IMDG	=	The International Maritime Dangerous Goods Code
IMO	=	International Maritime Organization
IOS	=	Interorganizational system
ISPS	=	The International Ship and Port Facility Security Code
IT	=	Information Technology
MARPOL		Marine Pollution. Marpol 73/78 is the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978.
MRCC	=	Maritime Rescue Coordination Centre
OTIF	=	The Intergovernmental Organization for International Carriage by Rail.
PSN	=	Proper Shipping Name
REACH	=	Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) is a European Union law, regulation 2006/1907 of 18 December 2006.
RFID	=	Radio Frequency Identification is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.
RIB	=	Räddningsverket Informationsbank (Swedish Rescue Services Information Bank)
RID	=	Règlement International concernant le transport des marchandises Dangereuses par chemin de fer, the international regulations covering transportation of Dangerous Goods by rail.
SOLAS	=	Safety of Life at Sea is the most important treaty protecting the safety of merchant ships dating back to year 1914.
SQL	=	Structured Query Language is a computer language designed for the retrieval and management of data in relational database management systems.
SSL	=	Secure Sockets Layer is cryptographic protocols that provide secure communications on the Internet for such services as web browsing, e-mail, Internet faxing, instant messaging and other data transfers.
SSN	=	SafeSeaNet is a vessel traffic monitoring and information system developed by EMSA.
TEU	=	Twenty-foot Equivalent Unit is the international standard measure of containers.
TMS	=	Transport Management System aids logistics management in various modes along with associated activities.
UMTS	=	Universal Mobile Telecommunications System is one of the third-generation (3G) cell phone technologies.
UN	=	United Nations
VTS	=	Vessel Traffic Service is a marine traffic monitoring system established by harbor or port authorities, similar to air traffic control for aircraft.

WLAN	=	Wireless Local Area Network is the linking of two or more computers without using wires.
WMS	=	Warehouse Management Systems are a key part of the supply chain and primarily aim to control the movement and storage of materials within a warehouse and process the associated transactions.
WP	=	Work Package
XML	=	Extensible Markup Language is a general-purpose markup language used i.e. websites.
PHP	=	PHP: Hypertext Preprocessor is a reflective programming language originally designed for producing dynamic web pages.
HTML	=	HyperText Markup Language is the predominant markup language for web pages.

Key stakeholders in seaports

The following actors represent the some of the key organizations or individuals in today's seaports. The concepts are essential to understand at basic level since they appear quite frequently in this research.

Accident and rescue services

In case of emergencies i.e. leakage or fire the ports usually have equipment and vehicles, but in larger incidents the municipal fire brigade or police can assist the port authorities (Norddeutsche wermögen - glossary).

Coast guard

An organization devoted to saving the lives of shipwrecked mariners or people in danger at sea. In some countries it is part of the military. In other countries it is a civilian or even volunteer organization. Most coast guards operate ships and aircraft including helicopters and seaplanes for this purpose (wikipedia).

Customs

The department of the Civil Service that deals with the levying of duties and taxes on imported goods from foreign countries and the control over the export and import of goods e.g. allowed quota, prohibited goods.

Forwarder

The party arranging the carriage of goods including connected services and/or associated formalities on behalf of a shipper or consignee.
Synonym: Freight Forwarder.

Operator

The party responsible for the day to day operational management of certain premises such as ware-houses, terminals and vessels (Eye of Transport 2007).

Port Authority

The entity whose duty is to construct, manage, maintain, and improve a port. Ports may be administered by States, municipalities, statutory trusts, or private or corporate entities. Also known as harbor authority, harbor board, port trust, or port commission (Welby & McGregor 2004). In most countries the port industry is organized by a central port authority, which in most cases regulates both investment and pricing in individual ports (Ojala 1991, 20).

Port charges

Fees assessed against a vessel, cargo, and passengers while in port, including harbor dues, tariff charges, towage, etc (Welby & McGregor 2004).

Ship Broker

Acts as intermediary between ship owners or carriers by sea on the one hand and cargo interests on the other. The functions are to act as forwarding agent or custom broker, fixing of Charters, and acting as Chartering agent.

Ship Operator

A ship operator is either the ship owner or the (legal) person responsible for the actual management of the vessel and its crew.

Shipper

The merchant (person) by whom, in whose name or on whose behalf a contract of carriage of goods has been concluded with a carrier or any party by whom, in whose name or on whose behalf the goods are actually delivered to the carrier in relation to the contract of carriage.

Synonym: Consignor, Sender.

Stevedorer

Terminal operator who is designated to facilitate the operation of loading and discharging vessels and various terminal activities (Shipping Glossary) Is also the person or company taking care of the loading and unloading of the vessel.

1 INTRODUCTION

1.1 Purpose of this study

Globalization increases the cargo volumes in all seaports throughout the world. This leads to state when the port organizations and operators must cope - not only the physical shipments - but also with growing amount of related data flow. Efficient IT Systems in seaports diminishes the lead times and improves the control of ingoing, stored and outgoing cargo. Well designed software or a system reduces manual labor and provides essential information for all parties involved at the same time. This study discusses about the IT Systems in six Baltic Sea Region (BSR) seaports and in more details IT Systems controlling Dangerous Goods transportation. The target ports were Port of Helsinki, Port of Tallinn, Freeport of Riga, Klaipeda State Seaport Authority, Port of Hamburg and Stockholm Ports. The first four are DaGoB[1]-partner ports and all represent one of the biggest ports in each country. The connection to partner-ports already existed through the project which made the first contact much easier. It was also crucial to have enough target-ports in this study to be able to achieve a wide coverage of the ICT Systems in Baltic Sea area. Only Russia, Poland and Denmark were excluded so an adequate picture of the current overall status was received.

In spoken language port is understood as a facility situated at the edge of an ocean or sea, river, or lake. Its purpose is to take care of the logistics process of receiving ships and transferring cargo to and from them. Harbors and ports are often confused. A port is a man-made coastal or riverside facility where boats and ships can load and unload. It may consist of quays, wharfs, jetties, piers and slipways with cranes or ramps. A port may have magazine buildings or warehouses for storage of goods and a transport system, such as railway, road transport or pipeline transport facilities for relaying goods inland. A harbor on the other hand is a place where ships are stored or they may shelter from the weather. Harbors can be constructed by man or be formed by natural development. A man-made harbor will have sea walls or breakwaters and may require dredging. A natural harbor is surrounded on most sides by land (Princeton University WordNet). The harbor can also be seen, especially in logistics concepts, as a larger organization including several a ports and terminals.

In logistics literature the port logistics process can be modeled i.e. by using structured analysis and design technique. The model was used i.e. by Roh, Lalwani & Naim (2007) when they defined the functions of port and the role of port IT Systems.

[1] See Section 1.4

According to their studies the port cluster system is divided into seven phases: voyage supporting system, port entry system, stevedoring system, transit system, storage system, inland transport connecting system and port information system. The last one serves as a support for all other six phases and includes all related IT activities in the organizations related to ordinary seaport.

The Baltic Sea Region is from a global viewpoint an active maritime area although it is frozen in the northern parts in winters. In the BSR, roughly 50 percent of all foreign trade is transported by sea. Maritime transport to and from destinations outside the BSR reached 76 percent in year 2003 of the total maritime transport, while non-BSR transport accounted only for 24 percent. More than 50 percent of total maritime transport is connected to Finland and the three Scandinavian countries (Baltic Maritime Outlook 2006, 4-5). The shore countries have been and still are quite dependable of sea transport for geographical reasons. Although the countries surrounding the Baltic Sea are normally seen socially and economically highly developed and moving on the IT frontline the container ports have been seen as inefficient in global viewpoint. The studies made By Wang & Cullinane (2006) reported that Scandinavian and Eastern European ports were clearly less efficient than their counterparts in British Isles and Western Europe. These kinds of reports reveal that the competence of Baltic seaports can and must be enhanced and it can partly be made by developing the current IT Systems and ease the data-exchange in overall. As the sailing distances are relatively short the importance of on-time and correct information rises in crucial role.

This survey is targeted for all people working with port IT Systems, not just in Baltic Sea Region or in Europe. The size of the port is not a notable factor either since in practice all modern seaports have some sort of an IT System to support the data-flow. The written text is not too complicated or technical so it should be relatively easy to read even if reader is not an IT System expert. The best contribution from the survey is that all Baltic Sea countries become aware of the different systems in different countries, and evolve their own systems based on these new ideas.

First part of this study was to detect different ICT Systems for handling of Dangerous Goods in target ports. The aim was to find out what is the level of integration of IT Systems in port operations and what kind of technical characteristics each system have.

The second part is to compare different systems in the Baltic Sea Area countries and as a result a "fictional" optimal IT System for controlling and surveying DG-flows is presented. The research does not cover the IT Systems controlling traffic in the sea, but only inside port areas.

The research's aim was to find answers and solutions to three major issues. First one can be reviewed as:

What kind of IT Systems for handling of Dangerous Goods exists in the Baltic Sea Region seaports and how the people working with them experience the "goodness" of the system on their viewpoint?

This part's goal is to give an overview of the current status from outside observers view but also from the different user-group's view. It is important that the results do not rely purely on the one actor's opinion as they tend to differ quite much even inside the smaller Port organizations.

What is the level (or capability) to connect current systems to interact with other IT Systems in the national and international level?

A modern seaport can not operate without an effective data exchange between various stakeholders. The interconnection issues are studied in local level, covering stakeholders inside the port community, port hinterland[2], province and the whole country. Naturally the sender and receiver must be included in this framework as well and the difficulties of exchanging data appear usually in the cross-border situations between different countries.

What is the current capability to interact with SafeSeaNet and future plans to develop the system?

SafeSeaNet (SSN) is a European Platform for Maritime Data Exchange between Member States' maritime authorities. It is an Internet solution based on the concept of a distributed database and works as a central information system for EU member countries to exchange data of Dangerous Goods shipments in the sea areas. As the system is going to be mandatory in 2009 the interaction capabilities of current Port IT Systems are included in this study as one of the most important research questions.

1.1.1 Other relating studies and research projects

The starting point for the study was that there is very little information about the port IT Systems already in use in Baltic Sea Region. Some ports, especially in liner traffic, have some co-operation with each other, but IT Systems have mainly developed inside each country and each port. The overall IT infrastructure in ports has been studied in some extent, but very seldom the main target has been Dangerous Goods.

There are ongoing BSR-wide projects to study and develop logistics IT Systems in overall such as the BaSIM[3] (Baltic Sea Information Motorways) which creates a sustainable basis for investments in the future aiming at solving existing and coming up bottlenecks in BSR and transnational communication and co-operation (BaSIM General

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[2] The inland region lying behind a port claimed by the state that owns the coast. It can be seen as the area from which products are delivered to a port for shipping.

[3] For more detail from the BaSIM-project, please visit www.basim.org.

presentation). In more detail the project aims to standardize the IT architecture, secure the supply chain, develop the Maritime Transport Corridor and support information services. The BaSIM derives from the development of "Motorways of the Sea" which was introduced in the Transport White Paper promoted by the European Commission in year 2001. The concept can be seen as a competitive alternative to land transport by introducing new intermodal maritime-based logistics chains in Europe. The Transport Research Cost 330 studies the "Teleinformatics Links between Ports and their Partners" and was completed in June 1998. The project made a widespread survey which was conducted throughout Europe to gather the data needed to analyze the logistics chain and to describe IT projects and their operation in the ports.

The purpose was to comprehensively study the reasons for the slow start-up of the use of IT in the shipping sector and plan a set of recommendations allowing for the development of tools and actions to improve and facilitate the use of teleinformatics. The result recommendations covered IT system and Port Community telematics harmonization, training, EDI standardization and legal issues. In wider perspective the Cost 330 laid the foundation of the future development of maritime IT Systems in Europe (COST 330 - Teleinformatics Links between Ports and their Partners 1998).

Other popular research areas in IT related issues in logistics in recent years have been ERP (Enterprise Resource Planning) –systems, EDI (Electronic Data Exchange) – solutions and Tracking & Tracing. The most modern research topic in logistics IT Systems is probably RFID (Radio Frequency Identification). Leavitt (2005) discusses about the time savings provided by automated identification of containers in a port area and Ruokonen & Hätönen (2006) have interviewed logistic operators for the advantages in port environment. Ojala & Menachof (2002) review the maritime IT solutions used in Baltic Sea Region quite well in their article "IT in Logistics and Maritime Business" to mention some example studies in the same field as this study.

1.1.2 Regulatory framework of Dangerous Goods

From historical perspective the EU regulatory framework in the field of maritime transport has been standardized in large extent. Since the 1950's four different periods can be identified with regard to the implementation of rules concerning shipping sector. Perhaps the last two are most interesting in the view of transporting Dangerous Goods; Setting up of a common maritime safety police (period 1993-2001) and The 2001 White Paper on Transport Policy including the Maritime Safety Regulations Packages "Erika" and "Prestige". Since the 1990's EU has adopted a significant amount of legislation, which is binding rules of maritime safety for all the Member Countries. Such legislation is fully based on internationally agreed standards, regulations and recommendations settled in the framework of the International Maritime Organization (IMO). The 2001 White Paper put the regulatory action in the shipping sector into the wider perspective of the common transport policy. The focus was set to improve multimodal transportations and connect shipping as a part of a transportation system combining road, air, railway and pipe-lines. It also applied to maritime safety issues and to the importance of promoting the re-flagging into the ship registers of the Member States of as many vessels as possible. Since the adoption of the White Paper, the European Commission has introduced several of initiatives for the promotion of short-sea shipping, the development of the so-called “highways of the sea” (Urrutia 2006, 202-217).

In a global level most of the regulation and legislation are set by International Maritime Organization, which is an agency of the United Nations established in 1948. Bichou (2004, 322-323) suggests that from maritime security point of view perhaps the most important global security initiative is the International Ship and Port Facility Security (ISPS) code. It is a set of security measures and procedures that have been outlined and developed by the IMO after the 11th of September 2001 terrorist attacks in the United States. It has an influence for the entire international maritime industry and beyond. The implementation of the code tested the ability, reliability and liability of active members across the logistics and supply chain. Other important global regulatory frameworks are International Safety Management Code (ISM), International Maritime Dangerous Goods Code (IMDG) and ISO 9002. This legislation is discussed in more detail in Chapter 2.2.

1.2 Delimitations

Modern port has numerous different functions from accounting to sanitation which usually are managed by various IT Systems. These applications can be a part of larger organization-wide software, but in many cases they are stand-alone applications to meet the specific need of the company function. In many ports the individual systems are unconnected with each other which might hinder the information-flow since the data can be structured in a way that it can not be transferred from system to system easily. The term “DG-software” was also controversial as it some cases was i.e. seamless part of another cargo-system and sometimes individual application. In this study the focus of the studied system can be an individual stand-alone application or a part of a whole port IT-system. In the first case the target is only the DG-system, but in the latter situation we must also review about the main-software as well.

This study is limited to contain only the following ports in The Baltic Sea Region: Tallinn, Riga, Klaipeda, Hamburg, Helsinki and Stockholm. Other ports were not studied partly due to the nature of research method, which was too time-consuming to take more subjects. The first four ports are DaGoB-project partners so the access was relatively easy and the three latter on represent one of the biggest ports in the countries. All ports are also mixed-cargo-ports and operate mostly with Dangerous Goods connected to IMDG-legislation. The movement of the DG-cargo outside the port perimeters such as in the sea and in hinterland was ruled out of the study. Naturally the information flow starts already well before the arrival of the vessel and the whole data-chain was included in the study although it can relate of the journey of incoming cargo. In more detail this delimitation rules out the tracking and tracing functions which usually are parts of systems covering the whole transportation chain. Selecting the right IT System in Port of Helsinki was a troublesome task, since Finland has a highly evolved nationwide maritime and port IT System called PortNet4. It is maintained and developed by Finnish Maritime Administration working in close co-operation with Finnish Customs and 20 of the biggest port in the country. Although the Port of Helsinki uses PortNet on daily basis it was excluded since it can not provide tools for organizing Dangerous Goods handling inside the port premises. In this viewpoint the delimitations of this study concerning the IT System itself can specified as follows: The system must have capabilities to handle Dangerous Goods inside the port area (for example show the locations of each cargo unit). The system must have capabilities to organize DG cargo on daily-basis.

The studied organizations were all Port Authorities[5] and private companies were left out. Corporations usually are not involved in all functions relating to cargo movements but only parts that are strictly concerning their business. By studying private enterprises operating in a port could outcome to constrained results. In some cases private companies were also interviewed to get a user-opinion of the IT system as well.

The interviews were made on November - December 2006 and this study focuses only on the current status of the IT Systems. Naturally the future development plans were also focus on interest but only 2-3 three years onwards.

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[4] For more information see Appendix 6

[5] The entity whose duty is to construct, manage, maintain, and improve a port. Ports may be administered by States, municipalities, statutory trusts, or private or corporate entities. Also known as harbor authority, harbor board, port trust, or port commission (Welby & McGregor 2004). In most countries the port industry is organized by a central port authority, which in most cases regulates both investment and pricing in individual ports (Ojala 1991, 20).

1.3 Structure

In this study we discuss about the Dangerous Goods and their characteristics in general. First we go thorough the Classification of DG and introduce all the nine Classes. Then we review shortly the legislation side and list the four main transportation modes. Naturally the sea going traffic plays the major role of this study, but it is essential to know the basics about other means of transportation because they usually are closely linked to port operations. At the end of the theoretical part of the study we introduce the basics of IT Systems in general and the IT Systems in logistics and especially in shipping.

In empirical part we go the through the systems in target ports one by one. The viewpoint is rather technical but it also includes a list of all features and user comments. Discussion part summarizes all the attributes and makes a logical comparison of the different system. This part also includes an overview of each attribute with a small introduction. The last part makes a conclusion of the status of the current field of DG IT Systems in port areas and makes recommendations as well as guidelines how to develop these systems.

1.4 Background of the DaGoB –project

1.4.1 General information

Transport of Dangerous Goods comprises a wide variety of commodities governed by international conventions, which together with supplementing EU and/or national regulation are mostly implemented in the Baltic Sea Region. Despite formal implementation, operational practices between DG-related authorities vary between countries, and unnecessary friction exists between authorities, shippers and logistics operators in DG supply chains. No BSR-wide analysis on DG cargo flows or DG-related accidents exists, nor does publicly available comparative studies on border-crossing supply chains of DG. (DaGoB Project Manual 2006, 7).

DaGoB (Safe and Reliable Transport Chains in the Baltic Sea Region) is a two year (2006 – 2007) EU funded project, which was initiated by TEDIM, a joint organ for Ministries responsible for Transport in the BSR and prepared by an expert team selected via competitive tendering. The lead partner of the project is Turku School of economics.

Units dealing with DG in BSR Ministries responsible for Transport usually have 2-3 staff preparing national DG legislation. Maritime, Rail and Road Administrations have a small number of DG specialists in central administration, and field inspectors in main ports, rail and road districts. Other DG authorities comprise, for example, port officials, coast guard, customs, traffic police, rescue services and healthcare units. Their exposure to international cooperation is limited, and best practices are seldom shared across borders. There is much need for better information exchange between DG authorities, and between authorities and the private sector. DaGoB comprises Partners from several DG authorities, ports, universities and industry associations from 8 countries (DaGoB Project Manual 2006, 7-10).

1.4.2 Work Packages

The project is divided into four work packages. WP 1 produces a survey of Dangerous Goods flows in the Baltic Sea Region (BSR) and provides an overview of related incidents and accidents in the region. WP 2 gives an overview of authorities dealing with Dangerous Goods and identifies their roles and responsibilities. It also provides information on co-operation between authorities on a national and international level through specific case scenarios. Field demonstrations and actual exercises monitored by expert teams of partners are an essential part of WP2. WP 3 establishes the DaGoB Action Plan based on a synthesis of recommendations from WP1 and public sector practices from WP2. A road map will be created introducing key development areas including prevention of health hazards, damage prevention, training, supply chain security, environmental issues and competitiveness of BSR industries working with Dangerous Goods. WP 4 disseminates and transfers the knowledge gained from the project on local, regional, national and international level using the already existing organizations (DaGoB Project Manual 2006, 7-10).

1.4.3 Objectives and expected results

DaGoB aims at improving the co-operations between public and private stakeholders related to DG transport in the BSR by connecting the stakeholders on different levels, providing up-to-date information on cargo flows, supply chain efficiency and risks related to DG transport and producing an Action Plan. DaGoB will (DaGoB Project Manual 2006, 9 -10):

- Promote the correct implementation of the DG regulations among the action directed stakeholders,
- Search the information for better control of the DG supply chains,
- Enable better information exchange between public and private sector stakeholder,
- Disseminate good practices and other produced information on local, national and also EU level,

The DaGoB project has a successor called Safe and Reliable Transport of Dangerous Goods in the Russian-EU Logistics Chain (DaGoRus) and it will continue from 2007 on led by VTT Technical Research Centre of Finland. This continuation project is and it focuses in more extent to DG-transportation between the EU-states and Russia.

1.5 The contribution of this study

This research main purpose is to give an overview of the different means of coping with the extensive data-flow regarding to the transportation of Dangerous Goods. The overview can help the readers to get an adequate overall picture of the field that other Ports are currently operating. If and when the Port is developing its current system benchmarking other systems can save considerable amount of money and planning time. Mixed cargo ports in Northern Europe are quite homogenous concerning the nature of the cargo and the need to meet similar legislation. This leads to the fact that the port IT Systems must assist in similar tasks in each Baltic Sea Region Country.

The business competition of the Ports naturally diminished the information the interviewees wanted to reveal about their systems. This was not an actual problem since the starting point was only to give a basic picture of each studied system. If the systems would have been studied in deeper focus the amount of data be so large that this report would grow in multiple times compared to its current size.

This survey is targeted for all people working with port IT Systems, not just in Baltic Sea Region or in Europe. The person can be a representative of the Port IT Department but quite as well be working in the upper level of the organization. In best cases the signal to start changing or developing current system comes from the board of directors or similar high level. The size of the port is not a notable factor either since in practice all modern seaports have some sort of an IT system to support the data-flow. The findings can be adapted to any kind of software at least in some parts. Many of the private software companies provide solutions for DG surveillance and therefore every does not have to develop the system from scratch.

2 TRANSPORTING AND HANDLING DANGEROUS GOODS

2.1 Classification of Dangerous Goods

Dangerous goods are liquid or solid substances and articles containing them, which have been tested and assessed against internationally-agreed criteria - a process called Classification - and found to be potentially dangerous when carried. Dangerous Goods are assigned to different Classes depending on their predominant hazard (Dangerous Substances - European Agency for Safety and Health at Work).

Dangerous Goods can be defined as those goods that have the potential to cause harm to people, property or the environment. Certain properties, for example flammability or radioactivity, represent hazards that can result in harm or damages if the Dangerous Goods are released during transport. (Ellis 2002, 2). There are few thousands of substances which are classified dangerous in transport legislation. On another hand the concept of hazardous goods is much broader in storage and usage point of view.

The regulations concerning the use and handling of Dangerous Goods may differ depending on the activity and type of the material. For example one set of legislation may apply to their use in the working environment while a different set of rules may apply to spillage responsibilities, sale for consumers or transportation practices. The Classification of Dangerous Goods is developed and legislated by the United Nations Economic and Social Council's Transport of Dangerous Goods Committee (Transportation of Dangerous Goods Regulations 2007). This works as a basis for each country's legislation concerning the handling of Hazardous Substances. The EU has also announced numerous of directives and regulations to avoid the dispersion and restrict the usage of Dangerous Goods, the most famous being the Restriction of Hazardous Substances Directive[6] and the REACH[7] directive.

In transport, Dangerous Substances (including mixtures and solutions) are assigned to one of the Classes 1-9 according to hazard or the most predominant of the hazards they present. Some of the Classes are subdivided into divisions. These Classes or divisions are as listed below:

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[6] The Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) 2002/95/EC[1] (commonly referred to as the Restriction of Hazardous Substances Directive) was adopted in February 2003 by the European Union.

[7] Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) is a European Union law, regulation 2006/1907 of 18 December 2006.

Table 1 Classification of Dangerous Goods (IMDG Code, International… 2004)

Class 1: Explosives	
1.1:	Explosives with a mass explosion hazard
1.2:	Explosives with a blast/projection hazard
1.3:	Explosives with a minor blast hazard
1.4:	Explosives with a major fire hazard
1.5:	Blasting agents
1.6:	Extremely insensitive explosives.
Class 2: Compressed Gases	
2.1:	Flammable gases
2.2:	Non-flammable gases
2.3:	Poison gases
Class 3: Flammable liquids	
Class 4: Flammables	
4.1:	Flammable solids
4.2:	Spontaneously combustible materials
4.3:	Water reactive materials
Class 5: Oxidizing Materials	
5.1:	Oxidizers
5.2:	Organic peroxides
Class 6: Toxic Materials	
6.1:	Poisonous liquids or solids
6.2:	Infectious/biohazardous substances
6.3:	Liquids and solids with a lower toxicity than those in group 6.1.
Class 7: Radioactive Materials	
Class 8: Corrosive Materials	
Class 9: Miscellaneous Dangerous Goods	

A given substance may have such properties that it belongs to more than one Class. The purpose of the Classification system is to distinguish between goods which are considered to be dangerous for transport and those which are not and to identify the dangers which are presented by Dangerous Goods in transport. It pursues to ensure that the correct measures are taken to enable these goods to be transported safely without risk to persons or property.

The 9 hazard Classes have been established internationally by a United Nations (UN) committee to ensure that all modes of transport (road, rail, air and sea) Classify Dangerous Goods in the same way (An Introduction to the IMDG Code 2006).

In maritime transport within each of the 9 hazard Classes Dangerous Goods are uniquely identified by two pieces of information (Study of the transportation… 1993):

- A four-digit number known as the UN Number which is preceded by the letters UN.
- The corresponding Proper Shipping Name (PSN).

UN Number together with the PSN helps to uniquely identify the dangerous good in issue. The precise information is crucial during transport and it ensures the correct handling, stowage and segregation. The PSN is mandatory for transport documentation and labeling and no alternatives or variations are permitted. The PSN is that part of the name which appears in the Dangerous Goods List or the Alphabetical Index in capital letters only. Any text in lower case is only descriptive and is not part of the PSN.

Using a four-digit UN number to identify Dangerous Goods enhances safety by overcoming language barriers. Sequence of numbers is easily understood in all languages and it avoids confusing similar goods together. In example TITANIUM POWDER, WETTED UN 1352 which is a flammable solid in Class 4.1 and has very different transport requirements to TITANIUM POWDER, DRY UN 2546 which is spontaneously combustible in Class 4.2. (An Introduction to the IMDG Code 2006).

2.2 Legislation of transporting Dangerous Goods

Each transportation mode has its own legislation to regulate the movements of Dangerous Goods. On a wider perspective there are many similarities on these rules, but each one has its own special characteristics. The Committee of Experts on the Transport of Dangerous Goods of the United Nations Economic and Social Council issues Model Regulations on the Transportation of Dangerous Goods (Recommendations on the Transport of Dangerous… 2006). Most regional and national regulatory proposals for hazardous materials are harmonized to an at least some degree with the UN Model Regulation. In example, the International Civil Aviation Organization has developed regulations for air transport of Dangerous Goods that are based upon the UN Model but modified to adapt the unique features of air transport. Individual airline and governmental requirements are included with this by the International Air Transport Association to produce the widely used IATA Dangerous Goods Regulations. Equally, the International Maritime Organization has developed the IMO Dangerous Goods Regulations for maritime transport. Many independent countries have also structured their Dangerous Goods transportation regulations to meet with the UN Model in organization (Transportation of Dangerous Goods Regulations 2007). There are also long standing European treaties such as ADR and RID that regulate the transportation of hazardous materials by road, rail, river and inland waterways, following the guide of the UN Model Regulation. This Section goes through the legislation side of each transportation mode one by one and reviews a few of the most important set of rules. The most important regulations in each of the transportation modes are:

Table 2 Key Dangerous Goods regulations by transportation modes (data collected from various sources, see following paragraphs for more detail)

Maritime transportation	MARPOL 73/78 IMDG ISPS
Road transportation	ADR
Rail transportation	RID
Air transportation	IATA-DGR

Maritime sector usually transports Dangerous Goods in large amounts on a one shipment and since the regulation is very strict and detailed. It is also notable that new set of rules are made and old ones updated as a result of each accident at sea.

The transportation of certain packaged Dangerous Goods, identified as “harmful substances” from the marine pollution point of view, is regulated by Annex III of MARPOL 73/78[8]. Handling of Dangerous Goods from the safety point of view is regulated by the International Maritime Dangerous Goods Code (IMDG) and related supplements, now having been made mandatory by connection to the SOLAS[9] Convention.

The IMDG code gives, for each substance, advice on terminology, packaging, labeling, stowage, segregation, handling and emergency response actions. This also includes Emergency Procedures (Ems1 and the Medical First Aid Guide. Substances in the IMDG Code, which come under the regulations of Annex III of MARPOL as “harmful substances”, are identified in the Code as “marine pollutants” or “severe marine pollutants” (Study of the transportation… 1993).

The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) was done at Geneva on 30 September 1957 under the auspices of the United Nations Economic Commission for Europe, and it entered into force on 29

[8] Such as the MARPOL 73/78 , which is the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978

[9] Safety of Life at Sea The development of the IMDG Code dates back to the 1960 Safety of Life at Sea Conference, which recommended that Governments should adopt a uniform international code for the transport of Dangerous Goods by sea to supplement the regulations contained in the 1960 International Convention for the Safety of Life at Sea (Development of the IMDG Code 1996).

January 1968. The Agreement itself was amended by the Protocol amending article 14 (3) done at New York on 21 August 1975, which entered into force on 19 April 1985. The Agreement itself is short and simple. The key article is the second, which say that apart from some excessively Dangerous Goods, other Dangerous Goods may be carried internationally in road vehicles subject to compliance with (ADR 2007 - Restructured ADR applicable as from 1 January 2007):

- the conditions laid down in Annex A for the goods in question, in particular as regards their packaging and labeling; and
- the conditions laid down in Annex B, in particular as regards the construction, equipment and operation of the vehicle carrying the goods in question.

The international regulations covering transportation of Dangerous Goods by rail, règlement International concernant le transport des marchandises Dangereuses par chemin de fer (RID), apply to rail shipments from one country to another within Europe. The RID and ADR regulations are virtually the same, though there are differences in the means by which substances may be transported (e.g. in tank cars) (Hazardous goods transport 1995).

Shippers of hazardous materials by air must meet the IATA Dangerous Goods Regulations, the worldwide standard reference for processing safe and secure air transportation. The IATA-DGR fulfills the minimum requirements of ICAO-TI, which are regulated by the International Civil Aviation Organization. The regulations are very similar than in another transport modes, but some components are stricter.

2.3 Transport of Dangerous Goods by modes

There are several regulations, practices and directions for transporting Dangerous Cargo. The main characteristics are that the cargo must be correctly labeled, documentation is accurate and up-to-date. The cargo should not exceed the maximum amount for the current transportation unit and it is positioned correctly on the vehicle or ship and it is segregated from another hazardous substance in sufficient distance.

Except for very small packages, all packages and containers, shipping containers, unit loads, tankers, etc. which holds Dangerous Goods for transport must carry the correct Class Label. This label (or diamond sign) shows the nature of the hazard by the color and symbol, and the Class of the goods by numeral. The responsibility for Classification of products lies with the manufacturer or person packaging the products. The regulations specify how storage areas are designed, constructed and located to minimize risks. The Regulations are designed to assist the authorities and other emergency services, and to ensure that they have enough information to deal with incidents (Classification of Dangerous Goods).

Figure 1 Example of appropriate labeling of tank truck (Photo: Author)

DG-Cargo documentation must be much more detailed compared to normal consignments. In every transportation mode at least the following entries must be found (Miettinen & Virtanen 2005, 1053):

- UN-number
- Proper Shipping Name
- Class or Subclass
- Packing Group
- Number of packages
- Total quantity for each UN-number substances
- Consigner and consignee
- Proper handling instructions

Naturally instructions on how to operate in accident situations are reasonable to attach the DG-consignments.

Segregation means keeping incompatible goods apart from one another in a room, using a barrier or intervening space. Chemicals must be segregated when either stored or shipped to ensure they do not mix in case of spillage (Classification of Dangerous Goods). There is specially designed segregation Chart to revise which substances must be kept apart.

Packaging must be suitable and adequate. It must stand up to the normal pressures of transport and repeated handling during loading and unloading. There will be specific packaging requirements depending on the Classification of the goods.

2.3.1 Air transportation

The most common substance of the Dangerous Goods list transported by air is clearly Class 7 - Radioactive materials. All other Classes are usually so weighty that it is not financially reasonable to be transported by aircrafts. Dangerous Cargo is carried both in passenger flights as in cargo planes.

Dangerous goods and their maximum amounts, packaging, handling, marking and documentation requirements are specified in detail in the Dangerous Goods Regulations published annually by IATA. These regulations are based on the regulations from the international Civil Aviation Organization (ICAO-TI), which are in turn derived from United Nations recommendations concerning the transportation of Dangerous Goods for all modes of transport.

When a shipment contains one or more of the dangerous substances from the list, the carrier requires the shipper to complete and sign a Shipper’s Declaration for Dangerous Goods. This is a legal document declaring that the shipper has complied with all relevant regulations and instructions. It must be completed duplicate and strictly following detailed instructions given in IATA DGR 8.1.6. (Dangerous goods 2007)

The captain of the aircraft signs Shipper’s Certification –document in which he approves the Hazardous Cargo to be transported on his plane. The information of Dangerous Cargo is also used in rescue missions in aviation accidents (Rauhamäki 2003, 95-96).

2.3.2 Road transportation

The most common Dangerous Substances in road transport are Flammable liquids, such as gasoline, oil and in Baltic Sea Area also heating oil. Second largest Classes are corrosive substances and gases. Road transportation routes are usually near residential areas which require additional attention to the condition of trucks and lorries. The vehicles have accurate structural orders what comes to i.e. electrical equipment and quality of containers. The vehicle, container, tank or wagon used must meet special requirements according to the Classification of the goods. For example the international and national legislation dictates that vehicles transporting flammable liquids must have fire extinction equipment and tank trucks carrying oil must have oil absorption kit in case of emergencies. The transportation equipment has to be approved by local authorities that they are capable of carrying Dangerous Cargo and very often also the drivers must have special training, not just to drive their vehicle, but also on what to do if an accident occurs. There are, however, some exceptions to the rules - for example, if you're only carrying small quantities of certain types of Dangerous Goods by road.

All the special demands for equipment and drivers raise the price for DG-transport compared to normal cargo. The advanced planning of transport routes and late-night shifts as well makes contribution of the higher prices. Often the quantity limitations of certain DG hinders the ability to fill the cargo spaces properly and in economical way, which leads to the situation that trucks move half empty on our roads. Although the level of security is already quite high in DG-road transports, the cargo flows in central Europe is partially transferred to railways (Pöllänen & Mäntynen 2002, 86).

2.3.3 Rail transportation

The congestions in European highways have transferred some of the DG-transportation from road to rail. Railwaggons suites best for transporting bulk-cargo such as petroleum and other refinery products and miscellaneous chemicals. The tank wagon is clearly the most common cargo space in railway DG-transportation, but naturally some quantities of packaged hazardous substances are carried in traditional freight cars.

Figure 2 Tanker wagon (Photo: Jim Parkin)

The framework of the regulation legislation of international rail transportation comes from OTIF (The Intergovernmental Organization for International Carriage by Rail) which was set up on 1 May 1985. For many years efforts have been made to harmonize the provisions of ADR and RID with each other, and to align these regulations with the main provisions of the IMDG for sea transport, which are based on the UN Model Regulations. The task of updating and harmonizing the regulations is a continuing one. New developments in both products and transport may require amendments, some of which may be less easily applied to one transport mode than to another. There is growing international awareness of a need to avoid new differences arising in these requirements and to continue to seek means of removing those that remain.

2.3.4 Maritime transportation

Transporting DG by sea covers a great variety of different substances. The main commodity is crude oil and oil products, but also the amount of packaged DG is substantial. Oil and chemical ships are specially designed for transporting their environmentally hazardous cargo. Their hull is thicker and often double, or triple layered to prevent leakage in case of collisions.

It is estimated that more than 50% of packaged goods and bulk cargoes transported by sea today can be regarded as dangerous or hazardous from safety standpoint or harmful to the environment according to the criteria set by the IMO. The bulk cargoes, being referred to, include commodities such as solid or liquid chemicals and other materials, gases and products for and of the oil refinery industry, and wastes (UN Atlas of the Oceans 2006).

The legal requirements surrounding the transport of Dangerous Goods by sea are comprehensive and specific. They have to be, to effectively protect the lives of seafarers[10], the safety of vessels and the maritime environment[11]. The potential for disaster at sea is considerable; therefore the penalties for mistakes are also, up to two years imprisonment and/or an unlimited fine.

The IMDG code contains internationally agreed guidance on the safe transport of packed Dangerous Goods by sea, and most commonly relates to the carriage of Dangerous Goods in freight containers and tank containers. Primarily it is used by shipping operators but it is also relevant to those transporting Dangerous Goods on journeys involving a sea crossing. At sea the particular considerations include time to evacuate, availability of emergency services, proximity to land, sea conditions and associated vessel motion and so on. The carriage of oil and bulk gas is dealt with under specific cargo regulations. A sea journey is classed as involving domestic or international ferries and cargo ships, operating in either rivers, estuary waters or the open sea and therefore, the requirements of the IMDG Code apply. Packaged Dangerous Goods are Classified according to the reformatted IMDG Code 32nd amendment or 2004 edition which came in to force January 1st 2005.

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[10] Such as the SOLAS. Safety of Life at Sea is the most important treaty protecting the safety of merchant ships dating back to year 1914.

[11] Such as the MARPOL 73/78 , which is the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978

Container and ro-ro ships carry the largest amount of packaged Dangerous Goods nowadays and all the same IMDG regulations apply among these as in tankers, but the correct segregation of different substances play a much bigger role. A tool called Segregation Chart has been developed for this purpose, which is provided to assist occupiers of storage locations to better minimize the risk of storing incompatible goods. It recognizes that transport guidelines are not suitable for workplace situations where larger quantities of goods may be kept together in circumstances enabling better control measures. Radioactive materials (Class 7) and explosives (Class 1) should be deemed incompatible with all other Dangerous Goods.

A lot of commercial software has been developed to assist the stowage of mixed cargo ships. These systems automatically hold information of each substance and data about which materials should be segregated from each other. Below is a screenshot of one of these software. By inputting a required UN-number to the field, the system automatically shows which DG Classes should be separated from it and in which magnitude.

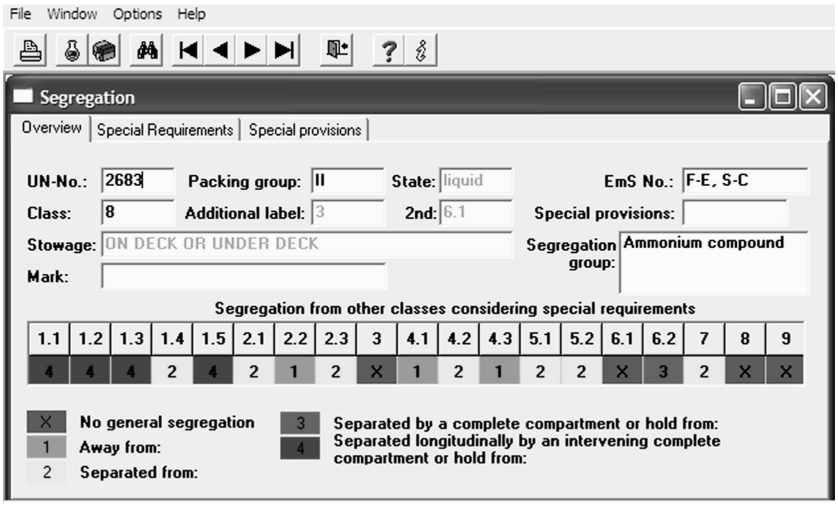


Figure 3 Caption of DG-segregation software (Storck Guide by K.O. Storck Verlag)

2.4 Port operations in general

A port is a facility for receiving ships and transferring cargo to and from them. They are usually situated at the edge of an ocean or sea, river, or lake. Rodrigue, Comtois & Slack (2006) define ports as a component of freight distribution as they offer a maritime or land interface for export and import activities. They are points of convergence of inland and coastal transportation systems, defining a port's hinterland. This function may be direct, as freight reaches a port directly through road transportation, or indirect as freight reaches a port though a freight distribution center or through traffic being consolidated at a regional port and shipped by coastal transportation. Likewise, ports are points of distribution to inland and coastal transportation systems, defining a port's foreland. At the local level, every port provides services to ships with berths, docks, navigation channels and sometimes repairs, and services to merchandises with cranes, warehouses and access to inland distribution systems.

The four major categories in sea freight are crude petroleum, dry bulk (i.e. iron ore, chemicals and grain), containers and conventional freight. The first two are usually handled in specialized ports or terminals because they demand specified cargo handling equipment based on the physical demands. Loading and unloading of crude oil requires large tanks near the berth so that the long pipelines are avoided and therefore oil-terminals are usually separated from other cargo terminals. Dry bulk cargo is often closely connected to the factory or mine where it is produced or processed. Dry Bulk is often quite low on its weight/value ratio and long land transport is avoided to keep the expenses in minimum. The most cost efficient way to transport dry bulk is directly from the producer to the upgrader or end user who is located by the sea or a river.

Ports in the Baltic Sea region can be city/state owned or private. Crude oil and specified dry bulk ports are usually privately owned especially when the cargo constitutes of one or few raw materials for specified factories or outbound cargo i.e. from mines. The movement of the cargo, i.e. loading and unloading vessels as well as lashing the cargo among with the ship’s crew, is often handled by the Stevedorers because they have the required equipment and vehicles for this purpose. The Stevedorers usually work for Port or Terminal Operators who provide the place for containers and other cargo before it is moved to land vehicles. The Operator is hired sometimes by Ship owners who usually tend to have an office or a representative in ports their ships regularly sail and if not they have to nominate a Ship Agents who acts as representative of the company in port. Ship brokers are the intermediary between a Charterer, who owns the cargo, and a Ship owner. Their work is to assist Charterers and Ship owners in negotiating the terms and conditions of the movement of cargo. Shippers prepare goods for shipment, by packaging, labeling, and arranging for transit, and coordinate the whole shipping process.

Bigger ports have specialized traders to buy and sell different commodities according to current demands of the market and earn their profit at the same time. Freight forwarders are operators who are familiar with official reporting such as custom clearance and help cargo owners to dispatch various shipments and find reasonable-priced cargo space for them. The official sides of the port are represented by port authority staff such as harbor master and port security officer which are closely linked for customs authorities, port police, port state control officers and border guards. The pilots and harbor pilots assist foreign ships to properly navigate on the port area and on the correct berth. Sometimes the routes can be narrow or there might be channels so it is impossible to unfamiliar master to navigate his ship safely on his own. Tugboat operators usually assist larger and unmaneuverable vessels to arrive or leave unharmed especially on windy conditions.

A modern port interconnects and offers a choice between various transport modes. Goods are transferred from sea to rail, road and inland navigation and vice versa. European ports can be very different, even if they are located in the same country. This diversity is reflected in geographical characteristics, size or the type of traffic handled. Europe has estuary ports, city ports and island ports, mega-size ports and small local ports, container ports, industrial ports, cruise and ferry ports, as well as fishing ports. But the diversity goes further than these visible characteristics. (The Role and Value of Seaports, 1-10).

This study discusses primarily on mixed cargo ports where container is the most common transport unit. Containers allow for efficient transport and distribution by eliminating the need for smaller packages to be loaded individually at each transportation point, and allowing the shipping unit to be sealed for its entire voyage. Standard containers can just as easily be loaded on a ship, train, truck, or plane, greatly simplifying intermodal transfers. The most common container sizes are 20, 40 and 45 feet. Liquid or gasified dangerous substances can be transported in a tank container which is metallic rounded tank which is encased by metal girders to protect it and to be able to attach it to other containers.

Figure 4 Tank container (Photo: UBH International)

2.4.1 Handling of Dangerous Goods in port areas

The term "handling of DG" can be described unofficially as the loading, unloading, packing or unpacking of Dangerous Goods in a means of containment or transport for the purposes of, in the course of or following transportation and includes storing them in the course of transportation (TDG Act 1992).

Perhaps the most important aspect of handling is the packing of Dangerous Goods into a means of containment; it is generally believed that if the packaging is suitable, the risk of a serious incident occurring is greatly reduced. To this end, representative committees from industry, government, environmental groups, and others develop standardized designs and methods of manufacturing packaging or means of containment for particular types of Dangerous Goods. A general requirement in the regulations stipulates that when no standard packaging is prescribed, the Dangerous Goods must be packaged in a way that ensures no discharge, emission or escape of the Dangerous Goods that could result in danger to life, health, property or the environment.

Clearly the biggest change in resent year in port operations is the International Ship and Port Facility Security (ISPS) Code which came into force on July 1, 2004. It was a result from the terrorism events on 11 September 2001 in United States. The International Maritime Organization agreed to develop security measures applicable to ships and port facilities. It is applicable to all vessels over 500 GT[12] operating on international trades, as well as the ports that service them. The Code provides for considerable flexibility to allow for required security measures to be adjusted meeting the assessed risks facing particular ships or port facilities. ISPS contains two different parts. Part A discusses mandatory provisions covering the appointment of security officers for shipping companies, individual ships and port facilities. It also includes security matters to be covered in security plans to be prepared in respect of ships and port facilities. Part B contains guidance and recommendations on preparing ship and port facility security plans. Only IMO member states who are Contracting Governments to SOLAS have a legal obligation to comply with the requirements of the ISPS Code and to submit information to IMO.

[12] GT (Gross Ton, or Gross Tonnage) refers to the volume of all ship's enclosed spaces (from keel to funnel) measured to the outside of the hull framing. It is always larger than gross register tonnage, though by how much depends on the vessel design.

The ISPS Code contains three security levels for ports, which are (FAQ on ISPS Code and maritime security):

- Security Level 1, normal; the level at which ships and port facilities normally operate.
- Security Level 2, heightened; the level applying for as long as there is a heightened risk of a security incident.
- Security Level 3, exceptional; the level applying for the period of time when there is a probable or imminent risk of a security incident.

Ship and port facility security is a risk management activity. As with all risk management efforts, the most effective course of action is to eliminate the source of the threat. Eliminating the source of the threat, which in this case is that that would commit acts of terrorism or otherwise threaten the security of ships or of the port facilities, is essentially a Government function. 100% security is an aim but cannot be guaranteed - hence the risk reduction approach to lessen possibilities to the lowest practicable (FAQ on ISPS Code and maritime security). In practice this means that the entire port area has to be monitored and secured much better than before. The code contains regulations about fencing the whole port area, building gates in entrances and exits, installing cameras and similar equipment. The roles of ship and port security officers become broader and the whole staff should be trained for meet these new and stricter requirements. In a wider perspective the ISPS code aims to change the attitudes, routines and customs of all shipping industry stakeholders. The threat of terrorism naturally effects to passenger traffic as well because the ports are forced to stricter security checks already in the port areas not to mention terminal buildings.

The guidelines for storing Dangerous Goods cargo are rather similar in Baltic Sea Area seaports and it stipulates that hazardous substances should be kept in the port facilities as short times as possible. This does not concern bulk cargo i.e. oil, but in the packaged goods are for example in The Port of Turku usually bounded out in 24 hours. The same relates to DG cargo loaded on ships and they should not be brought waiting too much earlier. The stevedoring requires special caution and if the labeling is insufficient or there are mistakes in the stowage plan the risk of a serious accidents become extremely high. For example some substances become hazardous if they are kept in a rain or the content of DG-container is trembled in loading or unloading the vessel.

A large amount of packed Dangerous Goods is transported in containers. The in or out bounding containers are freighted to port area by truck or by train, which are specially designed for easy attachment. If some of the containers are marked to contain Dangerous Goods in the documents it requires special attention when handling it in port areas. The DG-cargo must be separated from other substances which might pose a danger when reacting with each other and should also be deposited in a place as far from building or people as possible. Almost all ports in Baltic Sea Region do not allow more than 24 hour storage in the port area and for the most hazardous substances the follow-up transportation must be matched to the berthing of the vessel. The carrier or its agent must notify the port officials usually in 48 hours advanced for the incoming DG-cargo for have enough time to prepare the loading or unloading. Weather conditions usually play an important role of the stevedoring because some substances can become very unstable in case of saturation or freezing over or even if left long times in direct sunbathe or otherwise in hot and unventilated place.

Dangerous Cargo is handled in majority of the cases at the same fashion as normal cargo but always remaining extra caution. The most common cargo-handling equipments are cranes, forklifts, straddle carriers, terminal tractors for ro-ro cargo and roll trailers for moving cargo around port area and inside the ships. The units containing Dangerous Goods must be labeled properly for stevedorers to notify and handle them in a correct way.

Figure 5 Straddle carrier (Photo: Author)

Figure 6 Gantry crane in a large container terminal (Photo: Linda Long)

The ports have very detailed plans in case of an emergency or an accident with Dangerous Goods. The background of Port Security is governed by rules issued by the International Maritime Organization, and it's ISPS-Code. The local rules are formed about the characteristics of the port structure and the surrounding environment. The concept of Port Security contains also issues about counter terrorism and overall safety of the infrastructure and the people interacting with the harbor complex. Security issues are handled jointly by the Coast Guard, Customs, Border Guard, Port Officials, Police and the Fire Brigade.

2.4.2 Common Dangerous Substances in mixed cargo ports

The following Tables provide a rough overview about the typical Dangerous Goods transported in Finnish ports. The statistics are originally taken from DaGoB Publication Series 2:2006 Transport of Dangerous Goods in Finland and although this is not directly compatible of the figures in whole Baltic Sea Region it will give an indication of the subject. In year 2002 the most common Dangerous Goods transported in the Baltic Sea Region is evidently crude oil and oil products. The Baltic Maritime Outlook 2006 (46) reviews that the development of oil and oil products handled in the Baltic Sea ports from 1998 to 2004 showed a strong growth in shipments from the Gulf of Finland. Estonia, Latvia, Lithuania and Poland, are major transit countries for oil from Russia. In Finland the share of oil is 65.7% measured by tonnes. The following Classes are solid bulk (18.9%) and chemicals (12.5%). The amount of packaged DG is only 1.9% of the total, but it originates about the nature of goods and the large consumption of oil products and bulk-cargo (Suominen 2006, 44-48).

Table 3 Maritime transport in Finnish ports in year 1997 and 2002 (Suominen 2006, 48)

Transportation Class	Transportation volume	Share of total volume	Change in comparison to 1997	
	(1000 tons)	(%)	(1000 tons)	(%)
Bulk:				
Gases	377	1.0 %	38	11 %
Chemicals	4 906	12.5 %	1 795	56 %
Crude oil and oil products	25 758	65.7 %	2 998	13 %
Solid bulk	7 413	18.9 %	-139	-2 %
General cargo (IMDG)	726	1.9 %	274	61 %
Total	39 181	100.00 %	4 966	15 %

If we rule out the oil-harbors and specialized dry bulk cargo ports and focus in the mixed cargo ports, in which the packed DG-cargo forms the majority, the most common substances divided into UN-Classes are in Finland at year 2002:

- Class 3 – 34%
- Class 8 – 18%
- Class 9 – 15%
- Class 2 – 8%

Class 3 is named Flammable liquids which can ignite in air on contact with a source of ignition. The most common substances in this Class are paints, varnishes and lacquers.

Table 4 IMDG Cargo transportation in Finnish ports in 1997 and 2002 (Suominen 2006, 51)

Transportation Class (IMDG) In 2002	Import	Export	Total volume (import + export)	Share of IMDG transportations	Change in comparison to 1997
	(1000 tons)	(1000 tons)	(1000 tons)	(%)	(%)
1	8.9 (93%)	0.7 (7%)	9.6	1.3	+80
2	38.5 (64%)	21.3 (36%)	59.8	8.2	+73
3	132.6 (53%)	115.9 (47%)	248.5	34.2	+104
4.1, 4.2, 4.3	10.9 (61%)	6.9 (39%)	17.8	2.4	-17
5.1, 5.2	44.3 (41%)	55.7 (56%)	100.0	13.8	+28
6.1, 6.2	31.2 (64%)	17.3 (36%)	48.6	6.7	+13
7	0.05 (68%)	0.02 (32%)	0.07	0.01	-74
8	77.4 (59%)	54.5 (41%)	131.9	18.2	+46
9	39.1 (35%)	71.3 (65%)	110.4	15.2	+92
Total	383.0 (53%)	343.7 (47%)	726.7	100	+61

Containerization diminishes the risk of accidents and stevedorers exposure to hazardous material because the cargo can travel inside the container on its whole voyage from shipper to consignee and does not necessarily have to be unloaded in between. Workers engaged at the port or terminal for stuffing the cargo into the container are the last persons to have fair knowledge about the nature of the cargo and its disposition inside, until the container is opened at the consignees premises. Proper training, instructions for workers and labeling of the cargo is substantial to maintain safety in port area and in ships. A major DG incident could be triggered off by dropping the container during loading or discharging, collision during transportation, hit by another vehicles during storage or prolonged undetected leaking.

2.5 Dangerous Goods and the environment issues

The maritime traffic in the Baltic Sea region has growth steadily for the last ten years as a result of intensified co-operation in the Baltic Sea region and a prospering economy. Approximately 2,000 sizeable vessels are normally at sea at any time in the Baltic, including oil tankers and ships transporting dangerous and potentially polluting cargoes.

This also means that the probability of ship accidents causing marine pollution has increased, although maritime transportation is generally one of the most environmentally friendly ways of transporting goods (Shipping 2007). The relatively small size and slow exchange of water of the Baltic Sea makes it vulnerable for even smaller waste emissions or spillages. The most common ways for Dangerous Goods to end up in the sea area are:

- Accidents and Incidents
- Spillage
- Emissions from ships
- Ship generated waste

To protect the marine environment of the Baltic Sea Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden have established The Helsinki Commission (HELCOM) to work as governing body between the countries. HELCOM stands for the "Convention on the Protection of the Marine Environment of the Baltic Sea Area" (About HELCOM 2007).

One of HELCOM's duties is to annually collect data on ship accidents in the Baltic Sea. Reports provided by the Contracting States revealed that there were 117 ship *accidents* in the HELCOM area in 2006. This is 29 less than the year before. Collisions were the most common type of accidents in the Baltic reaching 46% of the reported cases and for a second year in a row exceeding the number of groundings (total 39%). The share of the both types of accidents has increased as much as 10 % for collisions and 2 % for groundings compared to 2005. According to the report three ships also sank as a result of collision (Dangerous Goods Related Incidents… 2007, 4-5).

The Baltic Sea countries are working together to ensure swift response to the pollution incidents in the Baltic. Over 30 sea-going response vessels are available in the region and a lot of attention is being paid to establish adequate emergency capacity as well as to meet the challenges of addressing the *oil spills* in ice. A marine oil spill can be defined as the unintentional release of liquid petroleum into the ocean or coastal waters as a result of human activity. Oil can refer to many different materials, including crude oil, gasoline or diesel fuel or by-products, ships' bunkers or oil mixed in waste. Spills take months or even years to clean up from the water and coasts.

Maritime transport represents a major source of uncontrolled air pollution. Large ships are responsible for a noteworthy share of global *emissions* of nitrogen oxides, particulate matter, sulfur, air toxics, greenhouse gases, and ozone-depleting substances. These toxins are harming the environment through acidification in addition to human health, particularly around coast regions and seaports. The problem is rising since ships are getting bigger and the number is increasing, while the residual heavy fuel oil they use is degrading in quality. The increasing shipping activities add the air pollution significantly in the BSR as well. According to the report on ship emissions in 2000 by the EU Commission emissions of nitrogen oxides from international shipping are expected to increase by a two-third even after the implementation of Annex VI of MARPOL 73/78 concerning air pollution by ships. It is estimated that the nitrogen oxides emissions from international shipping around Europe will by 2020 exceed the emissions from all land-based sources in the 25 EU member states combined (Emissions from ships 2007, Analysis of Policy Measures 2007, 4-8).

The ship generated waste should be properly treated in ports and not to be discharged into open waters. Unfortunately some vessels due to tight schedule or to achieve cost savings still dump their wastes into the sea. In accordance with Marpol 73/78 and EU-directive 2000/59/EG, ports are obliged to ensure port facilities for the reception of residues of oil and noxious liquid substances and of garbage, adequate to meet the needs of ships, using them, without causing undue delay to these ships. In addition, regulations concerning the discharge of sewage into the sea and the prohibition of burning the ship-generated wastes in the territorial seas of the Baltic Sea States have been adopted by the Contracting Parties to the Helsinki Convention. There is also a general ban on dumping and incineration of other wastes, not incidental to or derived from the normal operation of ships, in the entire Baltic Sea area. However, several hundreds of illegal discharges are observed during aerial surveillance flights by the Baltic Sea States and the total amount of pollution cases is considered to be even higher than estimated (Special measures for a special sea 2007).

3 ANALYZING AND COMPARING IT SYSTEMS

3.1 IT Systems in general

Information system means an interconnected set of information resources under the same direct management control that shares common functionality. A system normally includes hardware, software, information, data, applications, communications, and the most important: people.

Laudon & Laudon (2002, 7-11) divides the functions of an Information System to three basic activities: input, processing and output. They produce the information what the organization needs. Feedback is output returned to appropriate people or activities in the organization to evaluate and refine the input. Environmental actors such as customers, suppliers, competitors, stockholders and regulatory agencies interact with the organization and its information systems.

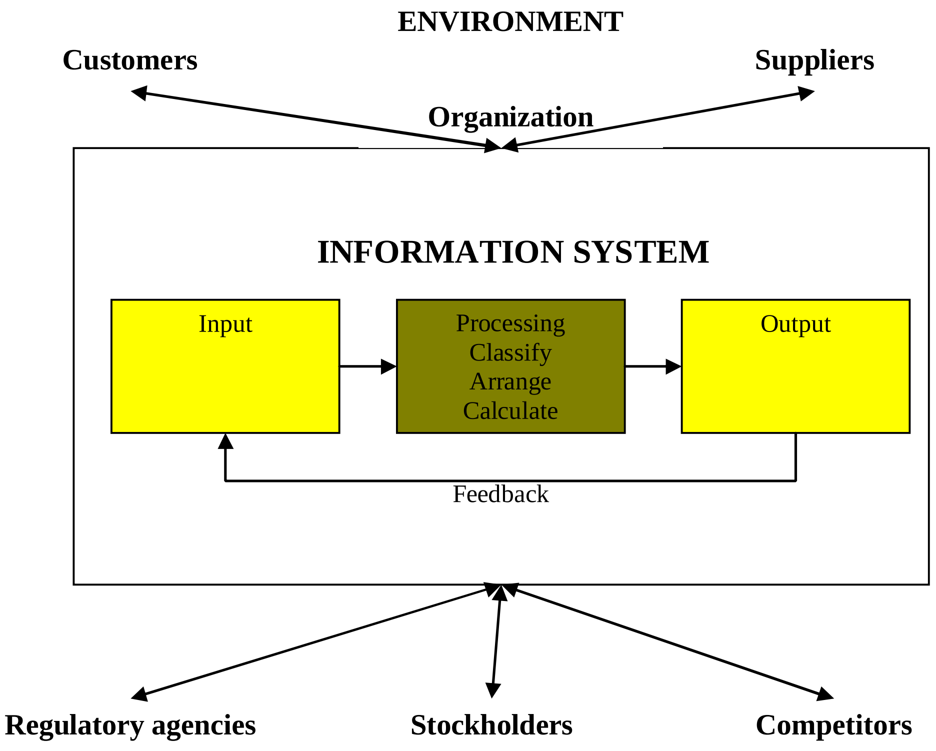


Figure 7 Functions of an information system (Laudon & Laudon 2002, 9)

Information systems contain information about significant people, places and things within the organization or in the environment surrounding it. By Information we mean data that have been shaped into a form that is meaningful and useful to human beings. Data in contrast are streams of raw facts representing events occurring in organizations or the physical environment before they have been organized and arranged into a form that people can understand and use.

The basic concepts in information system all are needed to produce the information in a form that can be analyzed or to help decision-making and can be listed as follows. (Laudon & Laudon 2002, 9-16):

- Input
- Processing
- Output
- Data
- Database
- Schema

Input is the information produced by the user with the purpose of controlling the computer program. The user interface determines what kinds of input the program accepts i.e. control strings or text typed with keyboard and mouse clicks. The data can be inputted by the organization and its staff or third party actor or it can be automatically collected from various sources of information.

Data Processing can apply to any process that converts data from one format to another i.e. in our perspective; data processing becomes the process of converting information into data and also the converting of data back into information in a form that is more meaningful to humans. Another concept for this model is Data Conversion which differs in a way that conversion does not require a question or queries to be answered. For example, information in the form of a string of characters forming a sentence in English is converted or encoded from a keyboard's key-presses as represented by hardware-oriented integer codes into ASCII form, after which it may be more easily processed by a computer as a meaningful character in a natural language and finally converted or decoded to be displayed as characters, represented by a font on the computer display. Bourque and Clark (1992, 1) define Data Processing by converting verbal or written information into machine-readable data. Under this definition, data processing includes data coding, entering coded data into a computer, verifying data, and conducting range and consistency checks on data files.

Output is information produced by the computer program and perceived by the end-user. The software’s user interface defines the kinds of output the program produces, which is naturally linked to the form of acceptable inputs. The desired output is usually quite well formable to adapt the need of the user and the same stored data can be processed to various different forms.

The processed data can be saved to the information system for storage or to use it in a various ways. The storage is better known as a database and it can be seen one of the key elements of every modern IT-system. In a more specific way database is a collection of records or information which is stored in a computer in a structured way, so that computer software can progress it to answer queries. The demand for accurate and pre-defined structure of data has let during software development that there is currently in use many different programming languages and data-base structures. The used software must be compatible to the structure used in the database to collect data from it. This leads to problems of integrating various systems in various organizations together when databases and software are not executed in similar programming languages.

Schema means the structural description of the type of facts held in that database. In more detail it describes the objects that are represented in the database, and the relationships among them. The Schema can be organized in number of different ways of modeling the database structure, also known as database models or data models. Common database models include (Date 2003, 8-21):

- Hierarchical model
- Network model
- Relational model
- Object-Relational model
- Object model

The model in most common use today is the relational model, which basically represents all information in the form of multiple related Tables each consisting of rows and columns for example Microsoft Access, SQL or even Microsoft Excel. This model represents relationships by the use of values common to more than one Table. Other models such as the hierarchical model and the network model use a more explicit representation of relationships. The advantages of database are according to Laudon & Laudon (2002, 209-210) that the data is stored in one centralized place and therefore minimizing redundant data. Rather than storing data in separate files for each application, data are stored physically to appear to users as being in only one location. A single database services multiple applications. The term database refers to the collection of related records, and the software should be referred to as the Database Management System or DBMS. Many database administrators and programmers use the term database to cover both meanings anyhow.

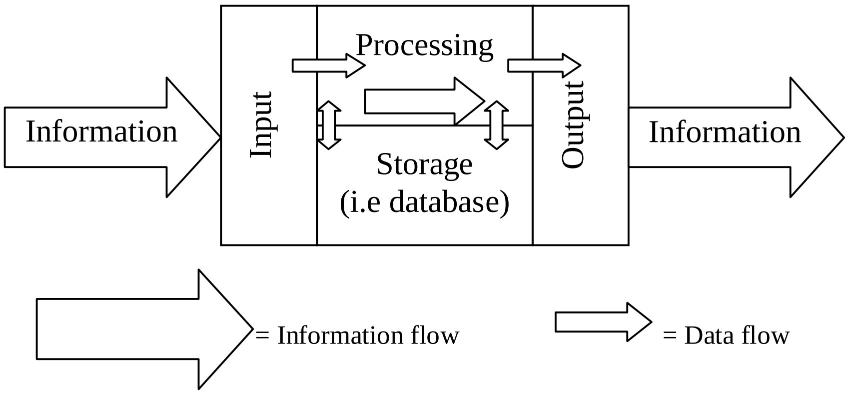


Figure 8 The role of Database in an information system (Adapted from Laudon & Laudon 2002 and Date 2003)

For modeling the structure in database there are various possible techniques. Most database systems are built around one particular data model, although it is increasingly common for products to offer support for more than one model. Although a Data Model can be considered just a way of structuring data, but it also defines a set of operations that can be performed on the current data. For example the Relational Model defines operations such as select, project, and join. These operations may not be explicit in a particular query language, but they provide the foundation on which a specified query language is built.

In this study we concentrate on computer based information systems and more precise in logistics and in port operations. It is quite clear that to be able to manage the growing cargo flows efficiently one must have suitable software to assist on the processes. The number of systems, database models and the depth of integration are quite substantial in the field of logistics. Many different software have similar characteristics but the means of execution might - and often does - differ. The problematic on system integration lies usually of the fractured development of IT Systems over time. Each organization in different countries have produced their systems one-by-one to meet their own needs and most of the time integration possibilities have been on the background or even forgotten.

3.2 IT Systems in logistics

The logistics theory considers the information flow equally important to the material flow which refers to the fact that there is without expectation always some data related to the transporting cargo. Often the product is useless without the written “paper work” i.e. customs declaration or instruction manuals. In this study the data flow stands for information exchange transferred preferably in electronic form. Unfortunately in present-days some documents are still sent by normal post. Below illustration reveals the role information flow in the logistics chain.

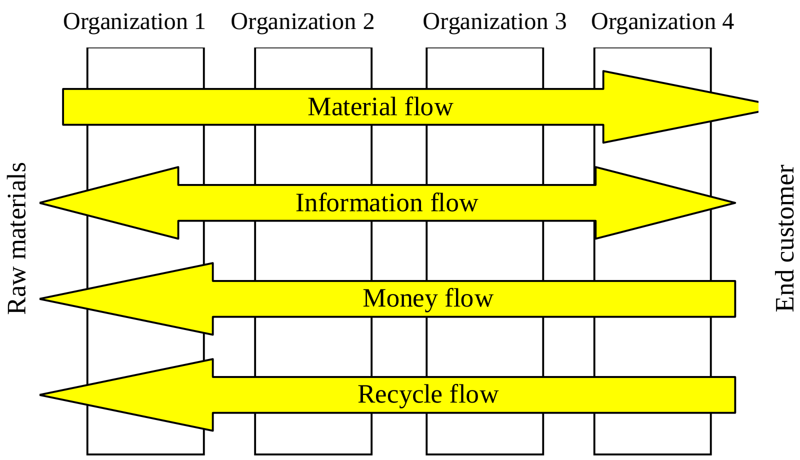


Figure 9 The role of information flow in logistics (adapted from Karrus 2005)

In the following paragraphs are described some of the most common ICT application models in logistics. The most applications used can be labeled in:

- Warehouse management system (WMS)
- Transportation management systems (TMS)
- Enterprise Resource Planning (ERP)
- Track and Trace

Warehouse management systems (WMS) are providing real time views on material flows within the warehouse, i.e. tracking and keeping note of the movement and storage of material within a warehouse facilitating the optimal use of space, labor, and equipments (ARC News 2004). From the managers point-of-view this means that a WMS enables to optimize transactions to and from warehouse operators, recognize problem areas and major shifts in activity levels and patters, while making it possible continuously determine performance indicators, such as productivity, shipping and inventory accuracy, warehouse order cycle time, and storage density (Lee 2002). Typically WMS systems are well connected to material handling automation and transportation systems. Some WMS systems also include a route planning functionality that makes them related with the TMS systems (Helo & Szekely 2005, 8). Initially a system to control movement and storage of materials within a warehouse, the role of

WMS is expanding to including light manufacturing, transportation management, order management, and complete accounting systems.

Transportation management systems (TMS) are software applications that facilitate the procurement of transportation services, the short-term planning and optimization of transportation activities, and the execution of transportation plans with continuous analysis and collaboration (Rider 2003, 62). Typical features in these systems are route planning, transportation control and advanced reporting tools. These software packages can also automate the work of traffic controllers and provide a systematic way to generate documents and packing labels.

Enterprise Resource Planning (ERP) is a business management system or a software made up from a collection of applications, usually called modules, that integrates all facets – marketing, distribution, finance, human resources, sales, manufacturing, logistics, etc. – of the company into a common database. The basic structure of most ERP's reminds the others. The names of software modules may vary, but they all have similar functionality. Each part of the software is connected to each other and every piece of information should be stored in only one place. Duplicate records are avoided by linking the information in the single database. In many cases these information systems are required to support multiply currencies and languages, specific industries, and an ability to customize without programming as well (O'Leary 2002, 28, according to Helo & Szekely 2005, 10). Currently, the leading vendors of ERP software applications include SAP, Baan, Oracle Applications, Infor Global Solutions, The Sage Group, Lawson Software, Microsoft Dynamics (Formerly Microsoft Business Division)

The modularity structure allows customer to purchase only the suitable modules for their needs and leave the rest. Modules can easily be added on or removed from the system afterwards. The most common modules in modern ERP-systems, which formerly were mainly stand-alone applications, are i.e. (Helo & Szekely 2005, 10-22):

- Manufacturing
- Supply Chain
- Financials
- Forecasts
- Customer Relationship Management (CRM)
- Human Resources
- purchasing management
- budget and loans

And for logistics point of view the most useful sub-modules are i.e.:

- Planning and control of the supply chain
- Work planning in warehouse or transport
- Product flow planning
- Information flow management
- Warehouse Management

The main benefit for well-functioning ERP-system is the avoidance of overlapping work. The inputs are made only once to the system and into the database and then it is re-usable for all terminals of the system. In example the data of incoming container is fed to system already when the order is made it can be used and supplemented of the whole supply chain by various functions in the port area.

For customers point of view Track and Trace is a very useful service originally provided by large international logistics integrators such as UPS, DHL and TNT. It enables customer to track his shipments in real time on the internet or mobile devices. The cargo is identified by a packaging number which is typed on the tracking website. The system locates the shipment and it whereabouts and views it on the same site. Some services also provide an estimated delivery date and time which helps customer to plan his own engagements based on this information. Nowadays almost all international and national shipments are traceable. Usually the movements are recorded in each terminal based on barcodes or RFID-chips (Radio Frequency Identification) but the most advantaged services able tracking also en route based for example Global Positioning System, where location of the truck, train, or ship is positioned by satellites.

3.3 IT Systems in shipping

Modern seaports use various IT Systems to manage the day-to-day data-flow in the organization. It is quite common that old stand-alone applications are replaced by port-wide ERP-systems, but the field is still quite fractured and each task can still be taken care of individual software.

In the below illustration is described one possible use of an ERP-system in container shipping agency. It is not an organization wide ERP-systems since some crucial modules for normal business operations are left out.

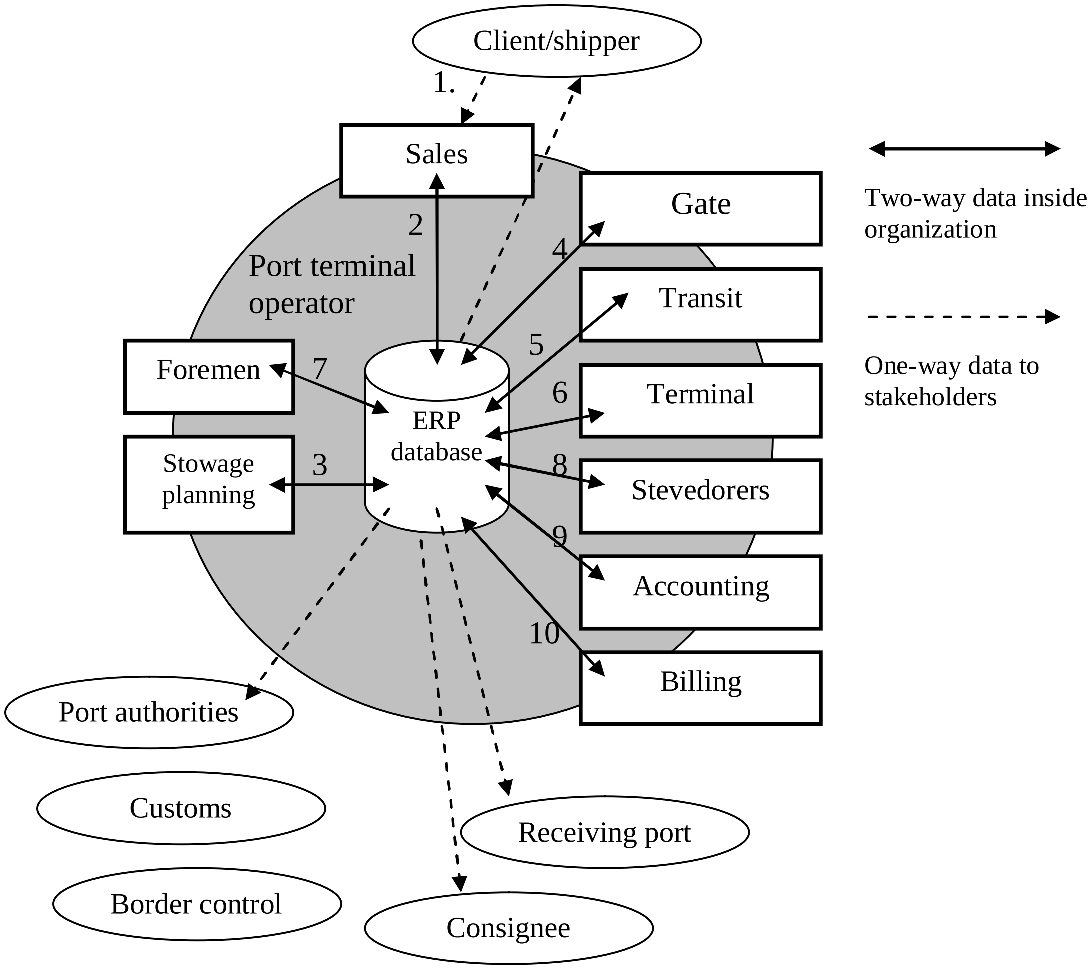


Figure 10 An imaginary ERP-system of an container operator

1. The client makes an order for transporting the container
2. The sales division makes an input of the information about the container
3. Stowage[13] planning starts making preparations of locating the container
4. The container arrives to port area and the gate checks permission from the ERP
5. The in-port-transit people get information about the shipment and discharge the container from the truck and park the container on its place
6. Terminal workers discharge or load the container if needed
7. Foremen make plans about the loading the ship where the container is planned to ship out
8. Stevedorers get the stowage plan about the correct positioning of the container
9. When the container is loaded and the project finished the costs are charged from the shipper
10. The accounting department can do proper entries on the bookkeeping according to its phases in the organization

[13] The loading of a vessel by handling and placing goods within the container (Welby & McGregor 2004)

During the project it is possible to send reports to outside stakeholders such as Customs, Border Control, Port Officials, shipper, receiving port and the consignee. In an ideal system these reports are fully automated.

SafeSeaNet (SSN) is a European Platform for Maritime Data Exchange between Member States' maritime authorities. It is an Internet solution based on the concept of a distributed database (SAFESEANET: Safe Sea Network). It was developed as a result of a number of accidents (mainly the loss of the tanker ERIKA off the French coast in 1999). The European Union identified a need to improve safety for vessels carrying hazardous goods. According to EC directives 2000:59 and 2002:59, all vessels exceeding 300 GT must report a call to a port or anchoring area, hazardous goods cargoes, and vessel generated waste at least 24 hours prior to arrival. For this purpose, the EU has established a central information system, SafeSeaNet, to which each member country is to transfer information from national systems. It became operational in October 2004 (Electronic Reporting to the Swedish maritime Administration 2004, 1). The SafeSeaNet is introduced in more detail Appendix 5.

One good example of a nationwide shipping IT system is the PortNet - The Finnish Maritime Administration Traffic Data System which can be seen as an ERP for various actors related to shipping such as Maritime Administration, Customs, Border Guard, Forwarders, Shipping Companies, agents, ports etc. The PortNet is described in more detail in Appendix 6.

3.3.1 IT Systems in ports and port areas

Containerization, which took place in the 1960s and 1970s speeded up by globalization and increasing commodity flows, laid a foundation to adapt IT Systems in logistics. IT Systems were already established in commerce and were developing very quickly into other areas as well. The development bred ports and terminals which were only concentrated on container traffic, which were ideal for the development of inventory and logistics control type computer systems. Those systems have been continually updated as the container trade became more sophisticated and as the capability of computer systems advanced. Thus container shipping was one of the early industries to become heavily reliant on operational IT Systems and software (Garstone 1995, 30).

A modern cargo or passenger port can be imagined as a small conglomerate. One port can have several terminals in a large geographical area and different functions varying from accounting and finance to personnel management to various logistical functions. It is common that pretty much each of these functions have some kind of software to control the operations. The linkages and abilities to share information between different systems is the most challenging issue to execute the whole gamut of port operations. Fast and efficient planning, stowage and tracking of cargo are necessity to cope with the enormous cargo flows in a port of today.

The advantages of efficient IT Systems does not limit only to controlling the paper notification flow better, but in large mixed-cargo ports the cargo handling vehicles and cranes equipped with inter-connected cargo software can significantly diminish ships' time at berth, service time of cranes and straddle carriers or forklifts and congestion caused by container movers in the stacking area. The information contained in the stowage plan can be in electronic form and then integrated into the port's operational computer system. Anyone concerned with the ship's operation in the port usually have access to the system and view current status of loading, unloading and storage of the cargo. The system keeps a real time image of the vessel and its state, often through Electronic Data Interchange (EDI).

In the simulations made by Kia, Shayan & Ghotb (2000) are estimated that in major container ports in Australia could provide approximately 140M€ savings per year, by using electronic devices in cargo handling vehicles and equipment. In more detail the best benefits arise from reduction of the waiting time of straddle carriers, which is predominantly due to the elimination of search time for the right container slots, which sometimes are occupied by other containers in the terminal. The berth crew and foremen have mobile terminals on their own in which the up-to-date information of the cargo is transmitted to vehicles, cargo terminal and all other parties involved on the process. The other advantage of the electronic devices in handling containers is that they do not use the same container isles simultaneously since the movements of other straddles in the isles are shown on the cabin monitors. This is also applied to the berth area where several straddles arrive at the same time to pick up one unloaded container or the presence of several containers on the quay area caused longer crane waiting time and longer ship time at berth. In overall perspective this enables more efficient use of vehicles and due time, less straddle carriers are needed. The recognition of the cargo unit can be accomplished by RFID or microwave-tags, but if the cargo area is well organized and fully computerized the IT Systems should remember the correct place of each individual cargo unit all the time. The following Figure is modernized from the Kia et. al 2000 diagram and loosely illustrates the links between the devices used in modern port IT-infrastructure. The thin line represents data or information flow between the different actors. The central computer integrates all components together and also acts as a database for the whole information flow.

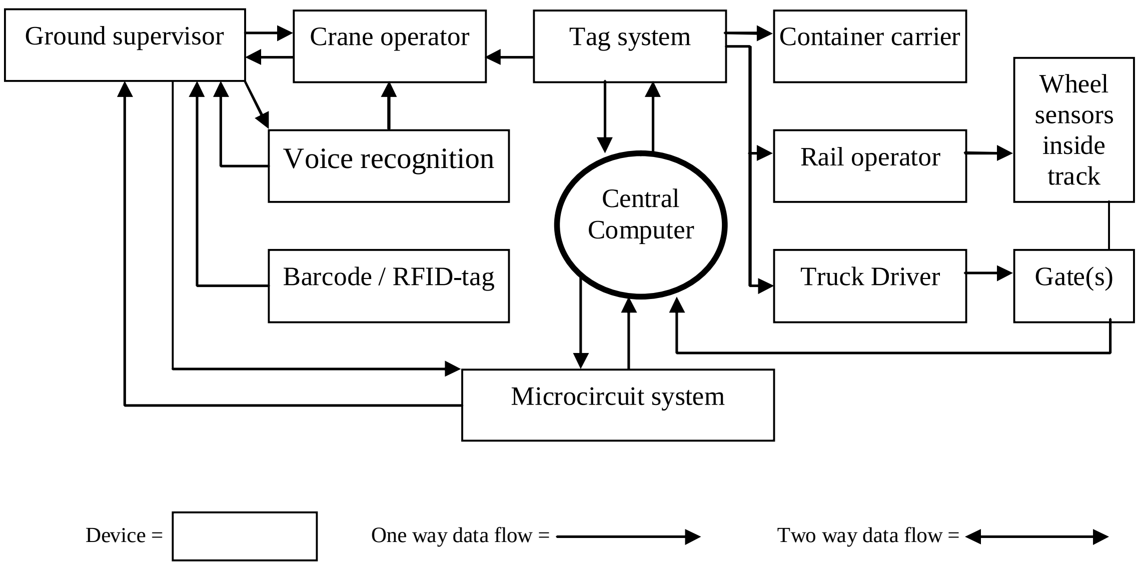


Figure 11 The use of movable electronic devices for cargo handling in ports.

Other benefits in practice provided by above mentioned system compared to fixed systems are following (Kia et. al 2000, 333-343):

- Shorter lead times on discharging and loading
- Faster turnaround of cargo through increased productivity
- Better monitoring of the storage and storage areas and efficient planning
- Accurate and correct information and reporting
- High level of reliability of the provided information to other stakeholders in the transport chain

By improving the electronic stowage plans even further, regular liner traffic ports can alter their own systems so that a plan made in loading port can be also used in all the discharging ports. The task is relatively easy if the cargo is handled by multinational companies operating in all target ports as they already might use the same IT-system anyhow. If the software is not compatible the parties could also use middleware system to relatively easy transform the incoming data to a correct form to meet the receivers systems and vice versa. The stowage planning can also be made on a WWW-platform when all parties involved can view the information by their normal web browsers. In reality this is not yet very widely used technique because of the possible security threats of the data. The main media to distribute cargo information nowadays and stowage plans is still fax, letter or e-mail. A shared stowage plan and cargo notifications database would bring considerable benefits in Baltic Sea Area, according to its nature of a relatively small sea area. Feeder ships can call several ports on their journey and it is essential to make the stowage plan in a way that all loading ports can add their cargo to the vessel efficiently and with the minimum movement of the other transport units already on board. Additionally, the ports where cargo is to be unloaded are required to be able to access their containers easily and without having to move other cargo in the process. A shared IT-system enables this kind on an efficient way to handle cargo in smaller area of relatively short sea voyages such as the Baltic Sea Region.

There are many actors in the shipping industry whose size wary from small local actors operating in one port to huge multinational corporations operating in almost every field of logistics and all major ports. Without a question these different actors have different capitals to invest on IT Systems and software. Therefore smaller companies might be in danger to fall out of business when the requirement of IT-system usage becomes daily necessity. It is already notified that for example the set-up cost of EDI-capabilities can create problems for smaller organizations operating in logistics. It is often the larger companies who impose EDI on their suppliers, such as forwarding agents, who are then forced down the EDI route in order to retain the business. If the company manages to participate in the joint systems, it allows the benefits of economies of scale which they would otherwise find difficult to achieve (Garstone 1995, 33).

3.3.2 IT Systems in monitoring of Dangerous Goods in port areas

The monitoring systems for handing the DG-cargo flows inside port area, usually consists two components. The first one is the channel where the information of incoming DG is provided and the second one relates to the storage and positioning of hazardous substances in the port premises. Danger controlling and risk analysis are important components of the latter as well.

The DG-cargo documentation is provided to port and other officials pretty much the same fashion as the normal shipping documents. The nature of Dangerous Goods naturally require more accurate documents beforehand and attached to shipment and almost without any exception they must be provided 24 or 48 hours in advance. This helps the port to adapt to the special obligations of current substance if there is needed to i.e. clear some areas to fulfill the open air –requirements. Most ports provide special sheets in which the incoming cargo has to be reported (see. Appendix 3 – Swedish Maritime Administration DG reporting form) and these forms has to be sent in required timeframe usually by fax, post or e-mail, but in some ports the notice can be given by EDI-transfer or by using web-based form. There are not usually problems if the port of departure is used of working with the stakeholders of the destination port i.e. in regular liner traffic cases. But when the port of calls[14] are infrequent it might pose a problem

[14] Port of Call = Place where a vessel actually drops anchor or moors during a certain voyage.

providing the required notifications on time, especially in short sailing distances. For example the sail time from Tallinn to Helsinki is way shorter than 24 hours so sometimes it is impossible to give DG-notifications on time. Also if the shippers' agent in the departure port are unfamiliar working with its colleague on the other end it might take excess time to deliver all the documents. Often the port officials are dependable of the local ship agent on supplying the information and then i.e. cases of sickness the documents can be forgotten to be delivered on time. It was quite clear that such small sea area as Baltic Sea where the traffic is intense and susceptible to pollution there is demand for unified ship and cargo database in which the information is up-to-date and simultaneously achievable to all parties involved.

3.4 Information System evaluation

The evaluation of information systems is a rather tricky task. There are several of models and theories on how to measure IT Systems and how to compare them with each other. The goodness of a certain system or software is usually a subjective concept. Each actor value different factors and usually on their own perspective and only few can illustrate the big picture. The viewpoint is different between users and technical maintenance and between clients and the organization management. Leonard & Mercer (2000, 7) summarizes that Information Systems theory in a general level concentrates on getting the right information at the right time and in the right format to the right user. The development of information systems, then, requires focus on organizational objectives, designs and dynamics as much as it requires focus on the procurement of the most appropriate hardware and software.

The evaluation and selection of a system or software can become an emotive issue in some organizations. People whose work are to find software or are involved in the software selection often base their decision on the fact that they like "the look" of a particular IT application. Whilst the range of features available in modern business software applications can be overwhelming, this approach can be perceived wrong. The decision on the selection of organization's software applications can seriously affect the efficiency the organization can act. One good evaluation tool is a matrix in which the appreciated issues are listed in one axel and target systems on another. It also allows you to provide a weighting factor for the standard criteria and also for the features which are important for the current organization. A weighting factor is used to ensure that the criteria that are important to the organization are correctly scored according to their weight of importance. The important criteria for evaluating the software based to the person's status on the organization are as follows:

Table 5 The evaluation criteria of used IT system

The user point of view:
- The look and feel of the application
- Length of download times
- Simple login process
- Overall ease of use
- Filtering and searching friendliness
- Archiving requirements

When the administrators value:
- Operating System infrastructure
- Database format (SQL, Oracle, etc.)
- Data import or export requirements
- Ease of configuration
- The number of concurrent users and the database ability to handle it
- Archiving requirements
- Graphical, hierarchical data structure
- Ease of implementation
- Additional database software required
- Access to data from various areas

The management, which usually is not the user, value:
- The cost of the equipment and software
- The cost of the administration workers
- The gained savings based on the reduced work hours
- The cost of implementation, updating and helpdesk-services
- Future costs of upcoming updates and new versions
- Possibilities to print out reports and statistics
- Reliability

Important issues of the other stakeholders/clients of the organization:
- Compatibility of organization's own systems
- Possibilities on system integration
- The preservation of the exported data
- Possibility to view information on web-based interface

Overall the evaluation and the definition of a "good" IT System is troublesome issue and should always execute on a fashion that suits the current organization. One finding of this research is that many port IT Systems are purchased or developed solely on the specifications defined by the management and the users or technical-maintenance has had very little saying on the matter.

In this research we evaluate the IT Systems to monitor the movements of Dangerous Goods inside a commercial port area. The geographical coverage is the Baltic Sea Region and to be more precise six of its major ports in six countries. In the background the leading focus is the integration capabilities of these systems, with each other or via middleware such as the SafeSeaNet. The next Sub-chapters firstly introduce the model which is used to evaluate and compare the target IT Systems, secondly the differences from modularity to full ERP-system is discussed and finally the focuses are in the integration issues based on the prevailing practices. The practices of executing a certain tasks in different ports are laid in a matrix which will clarify and ease to get an overview of the entire field.

3.4.1 Evaluating the port DG Software

The evaluation model used in this study focuses on two important issues. The first one is to describe how a certain common task is executed on the software level and the second one focuses to system integration or so called Inter-organizational System (IOS). The technical system description is introduced during the whole evaluation process as a tool for understanding the used resolution. The examination starts at the software level in DG-department of the studied port and extends covering the relation to all other used IT Systems in the whole port-organization. The following phases review the DG-systems position and IOS-capabilities to other city/country/BSR -level actors. The most important stakeholders are officials operating in the same port and country and other ports in the Baltic Sea Region.

The user-interface and database issues are the basic components in which every Computer Based IT System is composed of. The interface can be imagined as a window where the user can view or make inputs on the stored database. The system characteristics or “the modules” are different type of tools to edit the data, such as port-of-call –lists, cargo enquiry, calculating costs and timetables. In an ideal situation all the data is stored only in one centralized database but usually different functions have databases of their own.

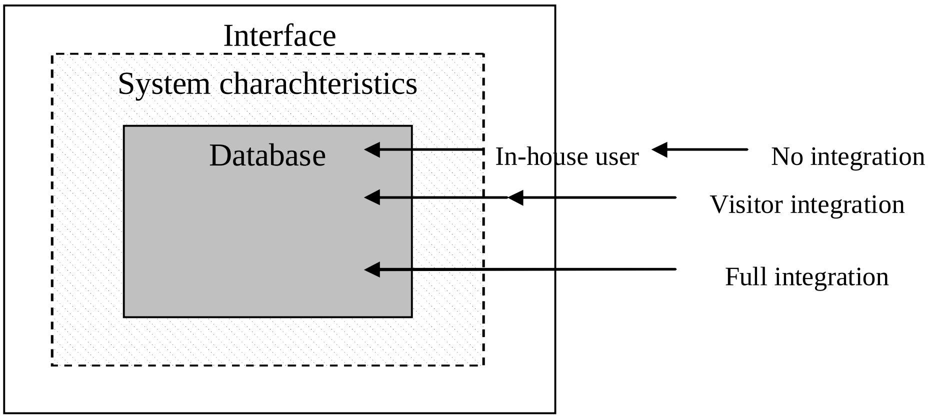


Figure 12 The model of database integration ability

The level of inter-organizational data exchange is divided in to three levels. The first one is *no integration* when the foreign organization does not have the ability to input or view data from the system. This is the case in most organization and the inputs have to be made by *in-house user* based on the information provided by phone or e-mail etc. The *visitor* level is most often used i.e. web-based forms, when the visitor makes inputs on pre-defined fields, such as cargo notifications etc. The information flow can go both directions in example if the user is making inquiries of incoming vessels and their timetables. The below screenshot is from a web-site form in which anyone can make an advance notice from the transportation of dangerous substances to port area. This notice must be made 24 hours before the cargo unit is transported to the port area.

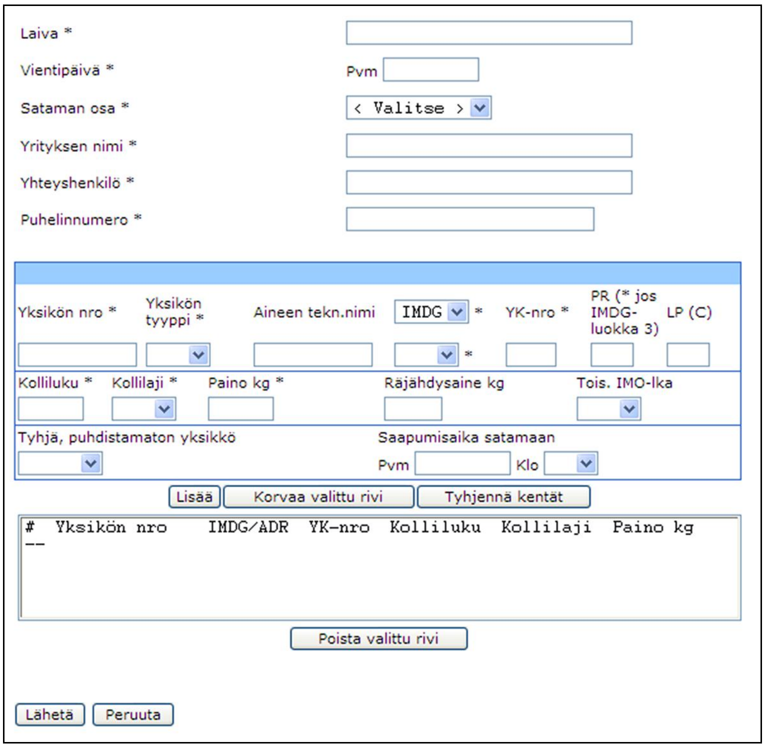


Figure 13 Screenshot of IMDG notification web-form (Port Of Helsinki website)[15]

The *in-house* users have different privileges as well. People working in different departments usually have the ability to manage the data essential to their own function only, i.e. accounting department can not change the ships crew list and so on. The *full integration* is rarely used in between organizations which have totally different ownership-basis. The full integration is mostly executed between software and database, very rarely between two or more databases. This derives in most cases the different programming-architectures, because fluent integration requires extremely accurate in compatibility.

3.4.2 Evaluating the modularity of Port DG Software

As said before ERP-systems are constructed by a database and modules linked to it. These modules can be perceived as stand-alone software such as warehouse management or accounting but the key-factor lies in the fact that they all are connected to the same database. In some literature *modularity* can be describe the opposite of

[15] The form fields include for example *ships name, informants contact details, unit-number, substance name, un-number, Class, packing group, packing details* and open field for *additional information.*

ERP-modules, meaning IT-system which consists on several different software which are not linked with each other or some database. In this research the opposite models are called *modularity* and *stand-alone platforms*. In the following Figure is shown the linkage between common port modules and the ERP-database. These modules can act only as a terminal or they can have a database on their own. The stand-alone application can work similar way as the modules, but it does not have connection to the base.

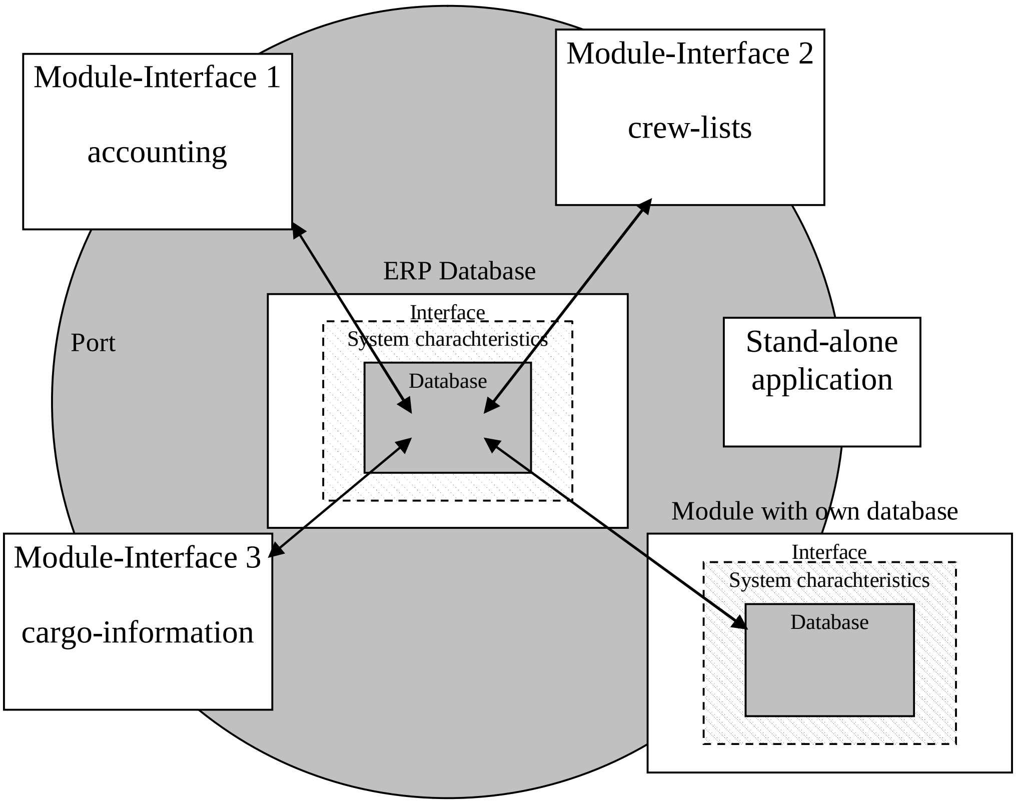


Figure 14 Common port-applications relation to ERP-database

3.5 Evaluating the integration of DG IT System in target ports

So far we have stayed inside the port organization, but modern shipping is multi-player game and the collaboration with different stakeholders is an every-day activity. To be able to cope with all the information related to cargo flow it is essential to have suitable software for it. The data movement inside one organization is usually handled quite well, but the inter-organizational side is still at its infants. Although it is clear that if i.e. data of Dangerous Cargo is inputted into a database only once and then it would be available to all parties involved simultaneously, would make significant cost savings.

Figure 15 widens the operational field of a port to surrounding infrastructure on city and country level to whole Baltic Sea Region. The circles represent each geographical area which is basically the ports sphere of influence.

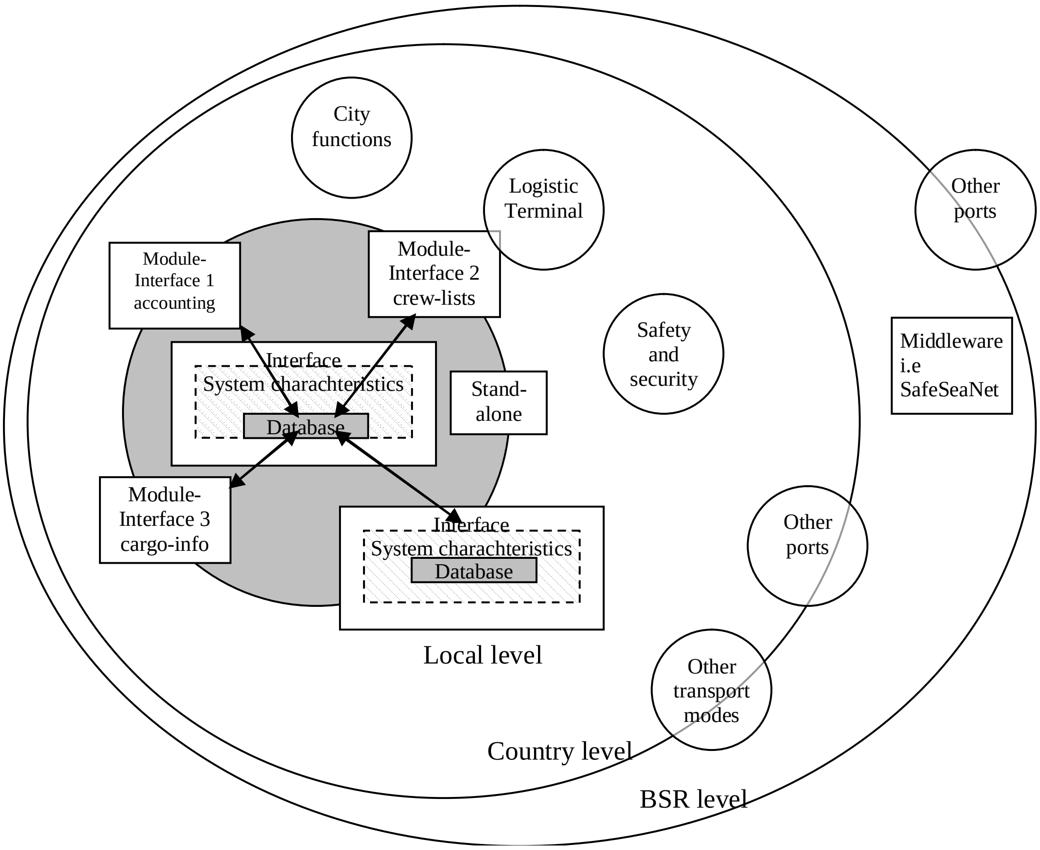


Figure 15 The evaluation model of Port IT Systems

The first sphere is the *local level* what includes local actors such as police and fire brigade and local logistics companies and terminals. If the port is city-owned the other municipal functions are also included. Second sphere represents the *country level* and for example national rail- and road integrators as well as other ports appear in this stage. In this research the third sphere consists of the Baltic Sea Region countries but can as well include the whole world as the departure port of the cargo. On Chapters 5 and 6 each studied port is positioned on the Chart to illustrate the linkages between these actors. Between all actors there is also a possibility to use a middleware, whose function is to act as translator between two incompatible systems. The middleware's role can be an ERP-system as well when it stores essential information and shares it between different ports. The middleware in this study is the SafeSeaNet (see. Appendix 5)

4 METHODOLOGY ON THE STUDY

Besides literature research this study is conducted by qualitative interviews to the users and developers of the ICT Systems in target ports. Qualitative research is comprehensive data-collection by its nature, where material is gathered in real-life situations. Using persons as material gathering instruments, inductive analysis and qualitative methods of data collection are typical for qualitative research. The focus group is selected expediently not randomly. It is very common that the research plan is shaped along the proceeding of the study. The cases are dealt as unique and the results are analyzed based on the findings (Hirsjärvi, Remes, Sajavaara 1997, 165; Koskinen, Alasuutari & Peltonen 2005, 31–33). The qualitative research interview seeks to describe and the meanings of central themes in the life world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say (Kvale 1996, 59-61).

The method of the empirical part is thematized interview, which is clearly the most used qualitative data gathering method in social sciences as well in business economics. In this method the subject matter is pre-defined but the questions are not precise. The interviewee ensures that all the required areas are covered, but the order and scale can alter in each separate interview (Eskola & Suoranta 1998, 87). If the thematized interview is used properly it is a very efficient research method. The efficiency is based on the fact that the researcher can steer the interview without the need of full control. Well planned and executed interview is also a motivating experience, in which is relatively easy to find people to take part in (Koskinen et al. 2005, 105).

4.1 Case selection

The selected target ports are Tallinn, Hamburg, Riga, Klaipeda, Stockholm and Helsinki. The first four are DaGoB-partner ports and all represent the biggest ports in each country. The connection to partner-ports already existed through the project which made the first contact much easier. It was also crucial to have enough target-ports in this study to be able to achieve a wide coverage of the ICT Systems in Baltic Sea areas. Only Russia, Poland and Denmark are excluded so we get adequate picture of the current overall status. Naturally the extent and depth of the studied phenomena ruled out the possibility to study all Baltic Sea Area ports and therefore for example a quantitative survey was ruled out.

4.2 Conducting the study

The following paragraphs review the methods that this Dangerous Goods Port IT System research was conducted. The basic methodology can be described as a combination of interview-observation-literary research by visiting each target ports. The meetings occurred from November to December in 2006 and the complete list of the interviewed people, timetables and locations can be found in Appendix 4. The research of the background theory started already in summer 2006 and kept going on during the whole process, although the majority of the in information was gathered in autumn 2006 to early winter 2007. Parts of the text were already written simultaneously with the research and the slots combined to the final layout during January 2007. After February 2007 the writing process continued only by adding smaller slots to text or by completing them. The illustration below reveals the phases of this study and their positions on the timeline.

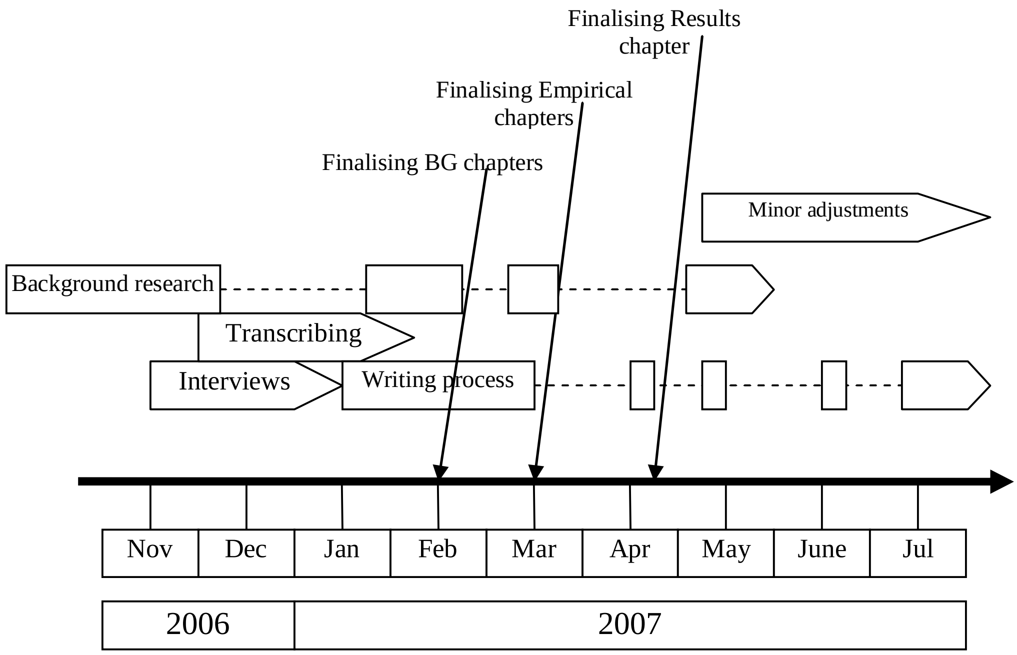


Figure 16 The timeline of the study

4.2.1 Data collection

One part of the data collection process was to interview people using the port IT Systems and was executed with two different questionnaires. The first one was designed to system administrators and it has detailed parts for infrastructure, which are excluded from the user-side questionnaire. The user-side is broader and more detailed. These are only the framework of the interviews and the discussions were conducted based on these outlines.

The Administrator-side questionnaire dealt firstly about the background issues of the IT System; when was it created, current version as well as security and encryption matters. The database issues were discussed in general level paying attention to hosting and the pace of updates and physical location of the servers. For technical side the brand of database and used programming language for the interface were discussed. One part of the study was to find out the current status and future plans to use the current software with mobile devices in the field and therefore the questionnaire included some parts for remote working possibilities. The user-side questionnaire dealt more of the every-day actual operations in port area such as the data-flow of incoming, stored and out-going cargo, the easiness of making search and reports from the system and naturally the user-friendliness issues. This part also included a review of the different user-groups and different access-levels to the system, not forget the cornerstone of the study: linkage to other IT Systems in port organization and other stakeholders.

These both questionnaires covered well the field of the studied phenomena and most important, the three key issues were discovered: technical execution of the system, handling cargo flow and data inside port area and possibilities to interorganizational system combinations.

The basis of this research was, besides the structured interview, to observe the software in action and it was studied by system showcases. In practice this means that the interface was viewed in real-life situations presented by the administrator staff and other workers in the organization. The observation is an essential method to evaluate the usability of studied software since it enables better understanding of the features discussed with the interviewees. The usability is an important part of well designed software and therefore it must be included in the evaluation process. Usability means the efficiency, comfort, safety and satisfaction with which a wide range of users can perform their tasks with a product at hand. It is much more than a measure of how easily a thing can be used, and it includes all aspects of the product and its use, involving the hardware and software interfaces, the documentation, the packaging and even the services associated with the product. The term “user-friendliness” can often be seen as a synonym of usability.

Usability is not something that can be merely added on during the final stages of product development or production. Rather, it usually must be considered from the very first stages of product planning and design and through final delivery and servicing. This is analogous to the concept of total quality control, which likewise must be taken into consideration from the very first stages of product planning, materials procurement, etc., in contrast to the common notion that quality control merely consists of testing completed products. It is also analogous to other aspects of product design, including security in computer software (Usability definition by… 2006).

Sometimes the end-users evaluate the used DG-software based merely on the usability and are not able to see whole system on a wider perspective. In this study the opinions of the end-users did not affect much on the final results since the usability is only one part of the “goodness” of the IT System.

4.2.2 Data analysis

As the data for this study was gathered in various ways the analysis process was not an easy matter. What it comes to the interview part the administrator side and the user side commonly has very dissimilar thoughts about them. The creators very seldom use the software in its real life operational environment and can be blind for the possible illogicalities and other deficiencies in the usage. The users on the other hand can be unaware of all the provided functions or the individual’s computer skills can be rather low which can worsen their opinion about the system. This led to a situation of that the “goodness” of the studied port IT System could not be determined solely based on the users’ opinion and an impartial evaluation of the user interface was obligatory. Almost all of the 10 interviews were recorded in electronic form in which they can easily be modified or listened by any computer. Not any of the interviews were transcribed because the extensive notes taken during the discussion and because this is not an interview research but more an observe-to-learn study. Transcribing means converting the interview from tape to written format word by word. Transcribing tapes can be very expensive as well as time-consuming and it is profitable only when it is seen as extremely fundamental for the research (Grönfors 1982, 156).

The interviews were conducted according to the rough guideline questionnaire presented in Appendix 1 and discussing of one topic at a time and in same order with every interviewee. This method ensured required coverage from each port and produced comparable research results. From the notes written from each question and comparing them to visual observation was formed the overall picture of the IT System. The report was written immediately after the visit in each port to ensure fresh memory of the results. Later on some additional question to interviewees were made to fill all necessary results.

4.2.3 Evaluation

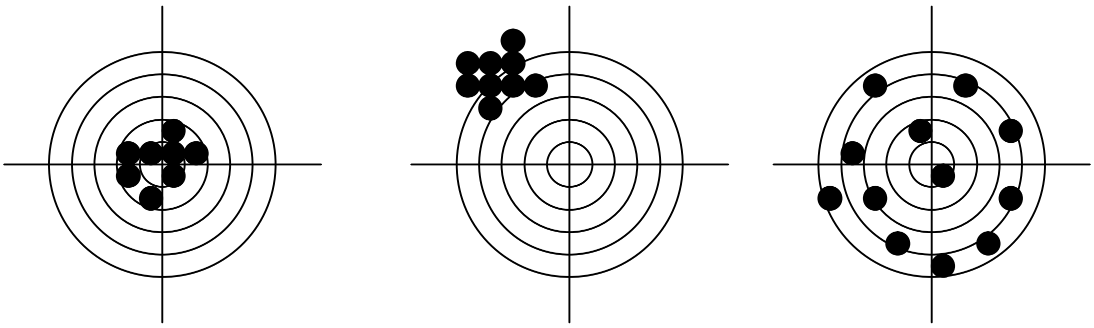
When the data is gathered by interviews the opinion of the interviewed person is quite strong. The risk in this type of study is that the administrators tend to reveal only the good sides of the system and leave the deficiencies unmentioned. For getting more accurate information about the matter the user-side interviews worked as a proper source. The users do not get any advantage for boasting their system and therefore their opinion can be consider more reliable for some matters i.e. functionality issues. As Kettunen (2005, 44) well said, the complexities and limitations of the human mind relate to the fact that the statements the subjects make may not be able to be taken at face value. The subjects may consciously seek to mislead or deceive the researcher, perhaps reporting events in a manner that is the most flattering or acceptable to them. All the six port studied were rather similar what it comes to objectivity. The administrators showed the features in best possible way for themselves, but the observer was still let to view and ask more details of the systems in an open interaction. As the data gathering was largely based on the observations and not only on the interviews, the researcher would have been rather hard to mislead.

4.3 Reliability and validity of the study

Validity and reliability are issues that cannot be avoided or compromised in either the conduct or reporting of the field research. Failure to acknowledge these issues in the conduct of the study prejudices the attainment of the researcher’s faith in the results. Further on, the researcher’s own prejudices shape the findings of the study and diminish the acceptability of the results. (McKinnon 1988, 35).

In general, validity is defined as the appropriateness and relevance of used methods, approaches, research techniques, language, type of writing etc considering the research object and considering the research question. In other words, the validity of a study can be seen as the extent of how the used methods in the study measure what they are supposed to measure. Validity is concerned with the fact whether the researcher is studying the phenomenon she or he purports to be studying. This means that the design and/or conduct of the research might lead to a situation where the researcher is unintentionally studying something either more or less than the claimed phenomenon (McKinnon 1988, 36). In this study the study of the target phenomena was not based on extensive theoretical background, because the port IT Systems have not been studied much beforehand and the current information systems management theory is not very adaptable to logistics of Dangerous Goods. To achieve good validity it was naturally necessary to study the basics of IT research but the most important backbone of this report was the authors own working experience along many logistics and shipping software.

The question concerning reliability is whether the researcher is obtaining data on which she or he can rely. Reliability is tightly connected to the process of the execution of the study. When evaluating the reliability of the study, one must ask whether some other researcher would have resulted in similar results. The researcher must try to avoid accidental circumstances that might result from the respondent's lack of concern or care which lead to prejudice the credibility of those responses. (McKinnon 1988, 36.)



High validity and reliability	**Low validity and high reliability**	**Low validity and low reliability**
(generalibility possible)	(generalibility not possible)	(generalibility not possible)

Figure 17 Target model for validity and reliability of a study (Adapted from Newcomb 2003)

The difficulty and complexity of reliability and validity can be better understood through the target model, where the center is optimal and the dots are results of studies. If the dots or marks are all concentrated in the center, all studies measured what they were supposed to measure and did it consistently. This optimal situation concurs when high validity and high reliability exists. When dots are in a group but not in the center, low validity and high reliability exists, i.e. the study measures consistently but not what it is supposed to measure. When the dots are scattered all over the target, there is low validity and reliability. A situation where there is high validity and low reliability is due to its contradiction impossible. (Newcomb 2003.)

Although threats that might affect the validity and reliability of a study are typically discussed on an ad-hoc basis, some general threats can be found. McKinnon (1998, 36-39) argues that several characteristics of interviewing might affect the validity and reliability of the study and might further lead to distorted results. These threats are observer-caused effects, observer bias, data access limitations, and complexities and limitations of the human mind.

4.3.1 Observer-caused effects

Observer-caused effects are concerned with the presence of the researcher in the setting of the study. The physical presence of the interviewer might result in a change in an interviewee's natural behavior. A change in behavior occurs for instance in situations where the researcher is measuring employees' performance. (McKinnon 1998, 36-39.) In this study the observer-caused effects were not as drastic as in McKinnon's example, but similar effects could be argued. Similar effects as the observer-caused effects were detected but they were rather issues of the complexities and limitations of the human mind so they will be discussed later under that topic. In this study the presence of the observer tend to pose the interviewees to boast about their systems and reveal only the good functions and leave out he bad ones. This problem was best avoided by discussing specific about the down-sides too and even dedicating couple questions to it as well.

4.3.2 Observer bias

Observer bias is an issue where an observer's own beliefs and assumptions distort the information. An observer's presumptions over the researched phenomena shape the way the research is conducted and analyzed. With observer bias, it is what the observers see and hear that is of concern and it results in selective perception and interpretation. (McKinnon 1998, 36-39.) In this case the observer, in another words I, had no presumptions over the phenomena studied. All the information over the topic was received through theory and, as generally in studies concerning business there are no strict guidelines, the theory led to no affecting presumptions.

4.3.3 Data access limitations

Data access limitations consider the fact that the researcher has insufficient possibilities to collect all the related data to the phenomena at hand. The limitations might result from the lack of time or the lack of cooperation by the host. Firstly the lack of time refers to the issue that the researcher is unable to know what happened before the research took place and what will happen after that. Secondly the lack of cooperation refers to the unwillingness of the target of the study to cooperate. That can occur when the research hosts impose restrictions on mobility and access to certain documents, event or people. (McKinnon 1998, 36-39.) Since this Port IT Study was qualitative at its nature the need for accurate numerical data was not required. By discussing with the various people working with the Systems gave sufficient overview of the studied phenomena.

4.3.4 The complexities and limitations of the human mind

Finally the complexities and limitations of the human mind relate to the fact that the statements subjects make may not be able to be taken at face value. This means that the subject might consciously seek to mislead or deceive the researcher or even when they try to be as honest and as accurate as possible, the subjects are only humans, which means that they pay a different amount of attention to different things, they forget things, they have their own biases etc. The most important thing for a researcher is to acknowledge the existence of these four threats in order to increase the overall validity and reliability of the study. (McKinnon 1998, 36-39.)

It is obvious that the higher the validity and reliability of the study, the higher the possibility for generalibility of the results is. With a low validity and reliability of the results the results cannot and should not be generalized. Lukka and Kasanen (1993, 380) state that credibility is the key criterion for the goodness of the study which is the issue whether the reader of the study becomes assured of the validity of its results or not. The generalibility and credibility of a study interact, although the mode of this interaction seems to vary over the research approaches. Lukka and Kasanen also argue that there are differing views of business administration research as far as the role of generalizing is concerned. One view, and the mainstream, is that generalizing is important in business administration research, while generalization is even explicitly rejected in other research approaches. Several limitations of generalizing can be found but there are also several ways in which the researcher can increase the generalibility. The key question is whether the researcher is able to tie his or her analysis to business administration theories and to other prior research and especially to the relevant real-world context of the studied phenomena. There is no question that generalizing in studies such as business administration is a complex and intricate issue but is it even necessary. Lukka and Kasanen (1993, 381) pose the question of necessity of the quest of generalizing in business administration research. Because generalizing might carry significant costs and truly general results, valid over time and place which are hard to find and when encountered they seem to lack practical relevance. The quest for generalizing has a tendency to lead to a lack of relevance and applicability of a study. Despite the existing controversy, it is not a continuum with generalibility in one end and relevance as well as applicability in the other. With the right research approach which is valid and reliable for the studied phenomena, general as well as applicable results can be attained.

Although there are several opinions of the fact that business administration studies, especially case studies, can not be generalized, in this study the issue is more connected with the topic, that is, the regarding the topic of the study generalizing is nearly impossible. Business relationships, especially in the field of logistics, have to be evaluated on an ad-hoc basis. Each organization is different and generally deeper generalizations over the relationships of two organizations may not apply to others.

Since this study does not attempt to generalize studied issues or focus objects but to compare them to each other. Although same functions can - and are - executed in different ways in different ports the demands of global maritime legislation unifies the daily routines. This helped the comparing process as the researcher could only compare how a certain task was committed rather than compare accurate technical functions of each of the software.

4.4 Research approach and categorazitation

Business research can be categorized by the following framework developed by by Neilimo and Näsi (1980). It was later updated by Lukka (1991) as well as Kasanen, Lukka & Siitonen (1993). The model is divided to two dimensions: Theoretical-empirical and descriptive-normative. Lukka (2003, 93-95) lays the foundation of the model to the following five categories:

- Theoretical research means reasoning and knowledge can be observed without experimenting.
- Empirical research means that data is collected, either on the field or in a laboratory.
- Descriptive research aims to describe “what is” and “how is” and the emphasis in this kind of research is on describing, explaining and forecasting.
- Normative research is target oriented and it aims to recommend ways of acting in practical situations.
- Constructive approach is both normative and empirical by nature and constructive research always entails an attempt to explicitly test the practical usability of the constructed solution.

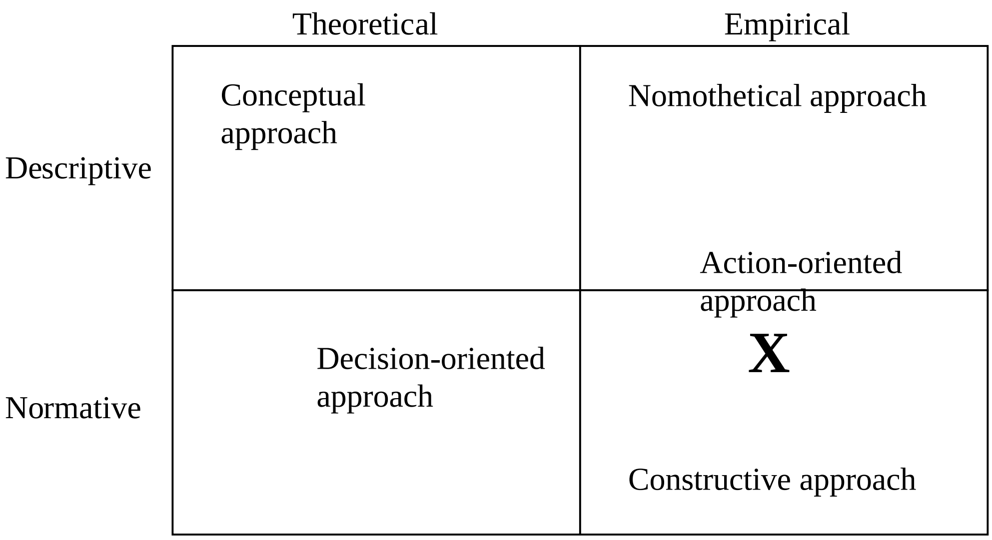


Figure 18 Categories of business research methodologies

This study can be perceived to Action-oriented approach although the empirical part is strictly Nomothetical (Neilimo & Näsi, 1980). At the end and of the study a fictional “optimum” port IT System is introduced which transfer the categorization to more normative category. Before that the studied port IT Systems are presented in a Descriptive manner. The researcher acted as an outside observer, which is in harmony with the Nomothetical approach, opposed to the Action-oriented approach, where the researcher is an actor in the studied environment. The position is marked with the large “X” on the Chart.

5 DANGEROUS GOODS IT SYSTEMS IN BALTIC SEA REGION PORTS

5.1 Studying IT Systems in selected ports

The focus ports are described by dividing the paragraphs into five Sections, in which the latter three represent the actual empirical part. It is essential to recognize the grouping because it forms the basis for discussion, conclusion and summary chapters. The framework is as follows (summarized from Sections 3.4 and 3.5):

- The first part consists the **basic information** of the target system.
- The second part is an **overview of the port** and it includes e.g. name, location and size.
- The third part describes the systems' **technical issues** in interface – database relation.
- The fourth part discusses the **ERP-qualities and provided modules** such as notifications and reporting/statistics tools.
- The fifth paragraph is about the **depth of system integration** and capabilities for inter-organizational data exchange such as SafeSeaNet. This part also discusses user-level and access.

The illustration below describes how the last three empirical paragraphs are placed in the evaluation model. The 'technical issues' cover the actual IT-system or software currently in use in port. 'ERP-qualities and provided modules' contain findings of other sub-modules or applications that the whole IT-system has (innermost circle). 'Depth of system integration' discusses the next three spheres essential to inter-organizational data-exchange in port organizations.

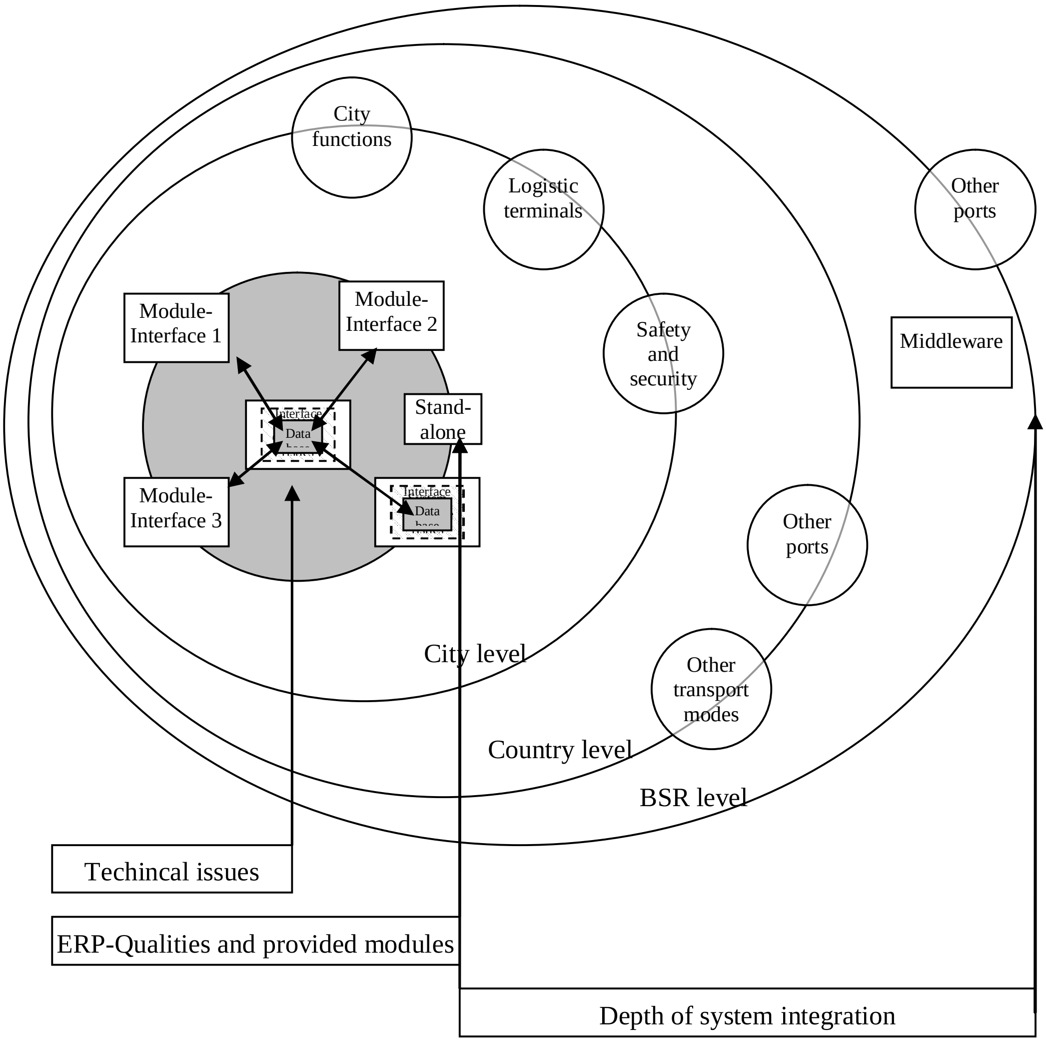


Figure 19 The reflection of empirical data to the evaluation model (combined illustration from Figures 8, 12, 14, 15)

5.2 Short description of target ports

The studied ports represent the biggest ports in their countries and the foundation dates back to middle-ages. This paragraph gives an overall description of the essential data about the size of the ports included with short introduction text. Most of the figures are from the year 2005 and if not, it is mentioned in the text.

Table 6 Statistics of the target ports (data collected from port Websites and brochures).

	Founded (year)	Port area (hectares)	Cargo turnover (Mtons)	Containers (1000 TEUs)	Passengers (millions)
Tallinn	N/A	600	39.5	126	7.0
Hamburg	1189	7,400	125.7	8,861	N/A
Riga	1201	1,962	18.1	127	0.2
Klaipeda	1252	415	21.7	231	0.2
Stockholm	N/A	16,400**	4.7	36	9.7
Helsinki	1550	N/A	11.6*	416	8.7*

* = 2004

** = direct and indirect employees

Port of Tallinn consists of five different ports, which are located on the northern coast of Estonia. The eldest is the Old City Harbor, followed by Paljassaare Harbor, Paldiski South Harbour and Muuga Harbor. Saaremaa Harbor is the most recent port. The total port territory in four harbors is over 600 ha., and it includes 73 quays in 24 terminals. The Port of Tallinn currently employs more than 600 people. In the year 2005, the cargo volume that passed through the ports of AS Tallinn reached 39.5 million tons. The majority of the cargo consists of liquid cargo (66%), dry bulk (20%) and rolling stock (8%). The greatest part of the cargo is transit (85%), and the share of export is only 8% and import only 7%. The Port of Tallinn has regular liner traffic for six container routes, and ten routes for ro-ro-vessels.

The Port of Hamburg was founded in 1189 by Frederick I for its strategic location on the river Elbe. It has risen to be one of the top 10 of the biggest container ports in the world reaching 8.8 million TEU seaborne container turnover. The hard-surface terminal area covers 7400 ha. and consists of four container terminals, five multi-purpose terminals, and four bulk terminals. Container traffic forms 96 percent of the total cargo-flow and, therefore, the share of other cargo types is quite minimal. The largest of the container terminals is Buchardkai with a capacity of 2,8 million TEU, followed by Terminal Hamburg, 2,6 MTEU, Altenwerder, 2,4 MTEU, and Tollerort, 0,9 MTEU (Statistics about the Port of Hamburg, 2007). About 12 million tons of unpacked chemical liquids are handled annually, as well as general cargo covering all categories of Dangerous Goods that are transported in more than 300,000 single lots in strict compliance with the IMDG Code. In Hamburg, the Central Office for Port Safety and Dangerous Goods - a Section of the River Police Hamburg - is responsible for ensuring port and transport safety standards, including the issuing of exemptions and permits (Handling and Storage of Chemical Products in the Port of Hamburg, 2007).

The Freeport of Riga is located on the outfall of River Daugava covering 15 kilometers in length and a total land territory of 1 962 ha. The numerous berths served in the year 2006 total 3648 vessels, whose main types of cargo were containers, various metals, timber, coal, mineral fertilizers, chemical cargoes, oil, and food products. Up to 80% of the 25.4 million tons of cargo turnover is transito forwarded to or received from the CIS-countries.

The Klaipeda State Seaport Authority is the most northern all-year ice-free port on the eastern coast of the Baltic Sea. As Lithuania's only seaport, it has ferry terminal connections to Sweden, Denmark, and Germany. The port can be seen as the most important transportation hub in Lithuania, connecting sea, land and railway routes from East to West. Klaipėda is a general cargo, deep-water port covering 415 ha. land territory with 19 big stevedoring companies, ship-repair and ship-building yards. The annual port cargo handling capacity is up to 40 Mt. The port operates 24 hours a day, seven days a week, all-year round. The foundation of the Port dates back to the year 1252, when Curonian bishop and vice-regent of Livonian Order signed the agreement that ensured constructing the Klaipeda castle. Vessels from Lübeck and Bremen used to moor in the small port neighboring the castle, the port being currently the Klaipeda Harbor (Klaipėda 2007, Presentation of the Port of Klaipeda 2007).

The Stockholm Ports group provides quay-berths, facilities, and services primarily for combi-ferries, ro-ros, cruise ships, and container vessels. The group includes harbors in Kapellskär, in Stockholm, and in Nynäshamn, whose operations employ some 16400 permanent staff both directly and indirectly. In the year 2005, Ports of Stockholm handled a bit under 10 MTons of various goods, which is about six percent of the total amount in Sweden. The largest ports in the country are Gothenburg (36 MTons), Brofjorden Preemraff (19 MTons) and Trelleborg (10 MTons). From these statistics it can be concluded that the Port of Stockholm is a passenger harbor. In the year 2002 over 7.1 million passengers passed through Stockholm’s harbor with frequent and regular connections across the Baltic. Modern freight and passenger ferries sail between Sweden and Finland, and a rather large quantity of ro-ro freight is transported on trucks or trailers aboard these ferries. The rail ship traffic between Sweden and Finland enables fluent transportation without the need to load or unload the railway wagons in the port area. The Free Port of Stockholm (Frihamnen) is a complete freight terminal with sea, land and rail links. The port has the largest container terminal on the Swedish east coast and the terminal is connected to the rest of the world by feeder services. Bulk freight is handled at several quays in Stockholm. The organization contains also the Loudden oil port which is the central oil depot for the Stockholm region (Strümpel 2007, 1; Utrikes och inrikes trafik med fartyg 2005 (2005)).

The Port of Helsinki is the second largest port in the Nordic countries and the main port for international trade in Finland. The Port of Helsinki is Finland's most important port for unitized cargo traffic. It has direct, scheduled connections by sea to the ports of the Baltic Sea and the North Sea, as well as to most other European ports. Over 9 million passengers and over 10 million tons of cargo pass through the Port each year. Container traffic going through Helsinki amounts to 40% of the total Finnish container traffic. The Port operates in three harbors which are South-Harbor, Söörnäinen-Harbor and Western-Harbor. The latter is the central hub of container and ro-ro traffic in Finland. Söörnäinen is mainly used for general cargo and importing cars and other vehicles. The future of goods traffic in the Port of Helsinki lies in Vuosaari. Traffic will be transferred to that location in 2008. When completed, Vuosaari will be the central port for unitized cargo traffic in Finland. It is a full-service harbor centre providing the most advanced value added services in logistics and traffic (the brochure of Port of Helsinki).

5.3 Technical characteristics of the studied IT Systems

The technical details of the studied systems are gathered in to the Table number seven. This helps to compare systems side to side although the characterization does not go extremely deep on the programming issues. Part of the same data can be reviewed on each of the port introductions.

Table 7 Technical details of the studied IT Systems

Name of the port	Tallinn	Hamburg	Riga	Klaipeda	Stockholm	Helsinki
Name of the system	Dangerous goods by oracle	GEGIS (Gefahrgut-Informationssystem), translated to Dangerous Goods Information System. Created by Dakosy AG.	Velkonis. Created by a Latvian-based software company HMS.	Laivo (Ship in English).	PortIT. Created by InPort Intelligent Port Systems A/S & AB	MasterIMO
Implementation year	2000	Pilot 1999, actual implementation 2000.	1995.			1989
Current version	Version 1	Version 1; minor updates several times every year.	2.22.		Version 6	No versions. Latest update is ADR-compatibility
Security	Database inside the building, no web interface, client server system, username & password authentication	Entry restricted for certain computers in the port area, which form the user-network.	Proved to be very secure	Digital security certificate in the log-in process	Three user levels, changing password for 30 days interval	User-level grouping and IBM-I series implemented security protocol
Encryption	The signal is encrypted when using the system wirelessly through WLAN. Not a possibility to use software via internet or via mobile devices.	No encryption. The EDI-transfers are possible to encrypt.	128bit encryption			No encryption
Hosting	N/A	Hosted in the Dakosy office.	Hosted in-house by two physical databases. Technical System development outsourced to HMS	Hosted inside the Port of Klaipeda office	Two separated servers with in-house maintenance	Hosted by Finnlines plc

5.3.1 The Port of Tallinn

The IT field of Port of Tallinn is very fragmented. The port has many good modern I Solutions for each essential area that the ports are dealing with. Some of the programs are more advanced than the others, and generally they are quite user-friendly. Port of Tallinn keeps the movements of ships, cargo and passengers under surveillance by using altogether nine different ICT Software. The rather large number of separate software increases manual labor when transferring data from system to system since the current software are not able to do it automatically. The other software besides the cargo systems are for example:

- One system used on the arrival of the ship.
- One system to deal with the notices of the arrival.
- One system to decide which berths are used.
- One system to handle the passenger information.
- Two systems to compute the different charges and payments.
- Several number of systems that are used in the field of ship and port call registers.

The *Dangerous Goods* Software has a text-based[16] interface which is relatively easy to use. The IT-department is responsible for developing the software based on the guidelines given by the users in the port organization. The system is basically the same it was in the year 2000, because there has not arisen any need for development. The software is built on top of an Oracle database, which is hosted inside the port organization. Dangerous Goods does not have a web interface, but works simply as a client – server –system, and the user is recognized by username & password authentication. The given inputs are stored directly to the database and no double-checks are made. Approximately 40 of Port of Tallinn employees have access to the system, which covers vastly different actors such as Harbor Master, Commercial department, analysts, IT Department, financial department, etc. Mobile access to the software can be executed via encrypted links to port WLAN stations. The cargo information is inputted from the paper notifications provided by the ship's agent. Arriving cargo's DG-manifest is usually supplied by the ship via its agent, and documents concerning outgoing cargo are given by the owner or sender of the shipment. The system does not provide tools for surveilling the stored DG-cargo in the port area,

[16] A text-based application is one whose primary input and output are based on text rather than graphics. This does not mean that text-based applications do not have graphics, just that the graphics are secondary to the text.

and the officials do not pay attention to the storage since it belongs to the duties of the stevedoring company.

The used architecture in Port of Tallinn represents pure stand-alone system. It is a combination of several independent software performing the various duties of a certain department in the organization. The port officials, though, do not recognize the vast need for an ERP-system and are quite pleased with the current situation. The IT department has the capabilities to develop the system, but it requires a request from the user-side. The most commonly used features besides inputting cargo data are the different searching and statistics functions. It is possible to make a search based on a ship's name, arrival date, departure date, UN Code, Class, and name of the port. The user can also adjust the search by selecting either incoming, outgoing or transit cargo. The reports are restricted only in relation to DG cargo, and if a comparison for normal cargo is required, one must print out the data from different systems and evaluate all the available data side by side. The timeframe dates back to the creation of the software. Therefore, data before year 2000 is not stored in the database.

Dangerous Goods is an individual system and does not have any kind of connection to other systems inside or outside the port area. Middleware-translator has not been in consideration and a totally new combined system is a more possible solution in the future if the integration requirements increase.

5.3.2 The Port of Hamburg

The DG-officials in the Port of Hamburg use the GEGIS Dangerous Goods information system which has been especially developed for the transport safety of Dangerous Goods. In Hamburg, GEGIS has been implemented with a registration requirement for all movements of Dangerous Goods in the port. The GEGIS system's main benefits are the seamless monitoring and documentation of all movements of hazardous cargo to, inside, and from the port area. Other advantages are internationally usable Internet applications, which relieve the users from their offices, and comprehensive databases containing all the legislation data, segregation and handling requirements, as well as a log of all the movements since the system implementation. The software is built by pure java, and it requires a functional internet connection to operate properly. There is no web browser -interface. Wireless or mobile use is possible via WLAN stations from accepted laptops, but Dakosy AG has a future plan to make a pure wireless application which is enabled by UTMS technology (Gefahrgut-Informationssystem (GEGIS) / Transport Emergency Card (Tremcard) Service, 2007).

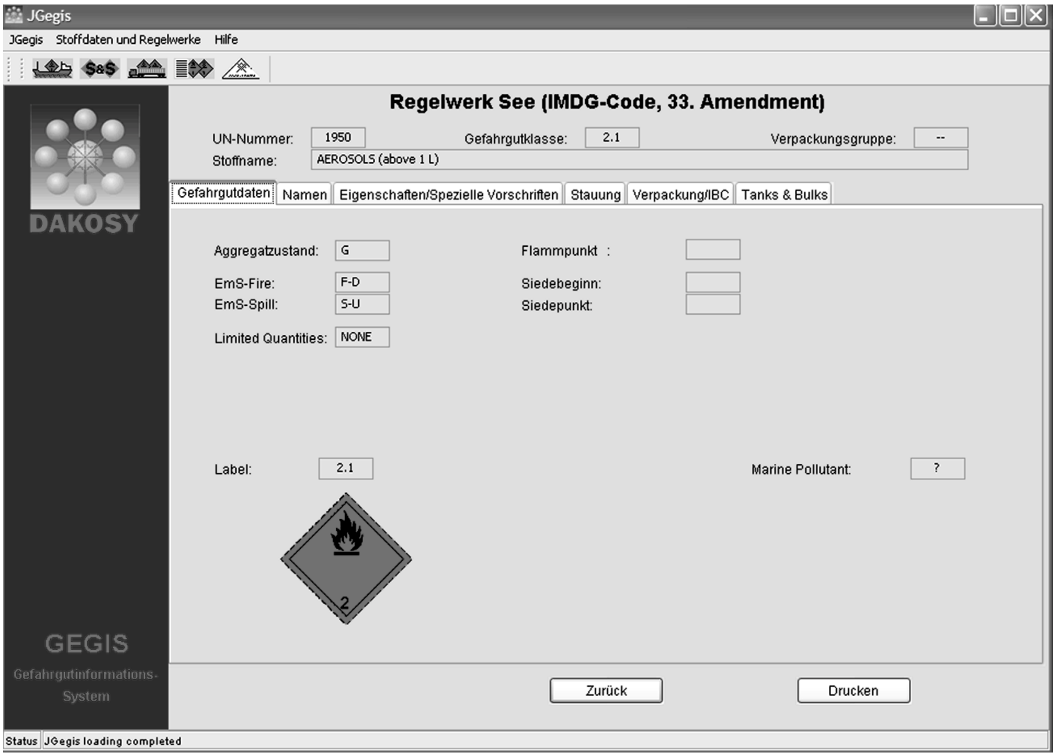


Figure 20 GEGIS Dangerous substance view (Screenshot of the software)

The mainframe database (SQL / IBM I-Series) of GEGIS is located in the office building. It is equipped with a secondary server which makes real-time back-ups of the stored data. The database is updated every two or three months to meet the changing regulations of the IMDG code and other legislation involved in the field of Dangerous Goods management.

The liner agent or ship owner must enter the DG-notifications 12 hours prior arrival or departure through his GEGIS interface. The stored data is simultaneously available via Dakosy integrated network for the authorities such as the Waterways Police, Fire Department, and the other stakeholders such as the quay operator, forwarder, etc. The database contains versatile data from the movements of the DG-cargo and can be exploited in many various ways, for example for reporting and statistics. Other useful modules are effective stowage and segregation application for assisting the container loading.

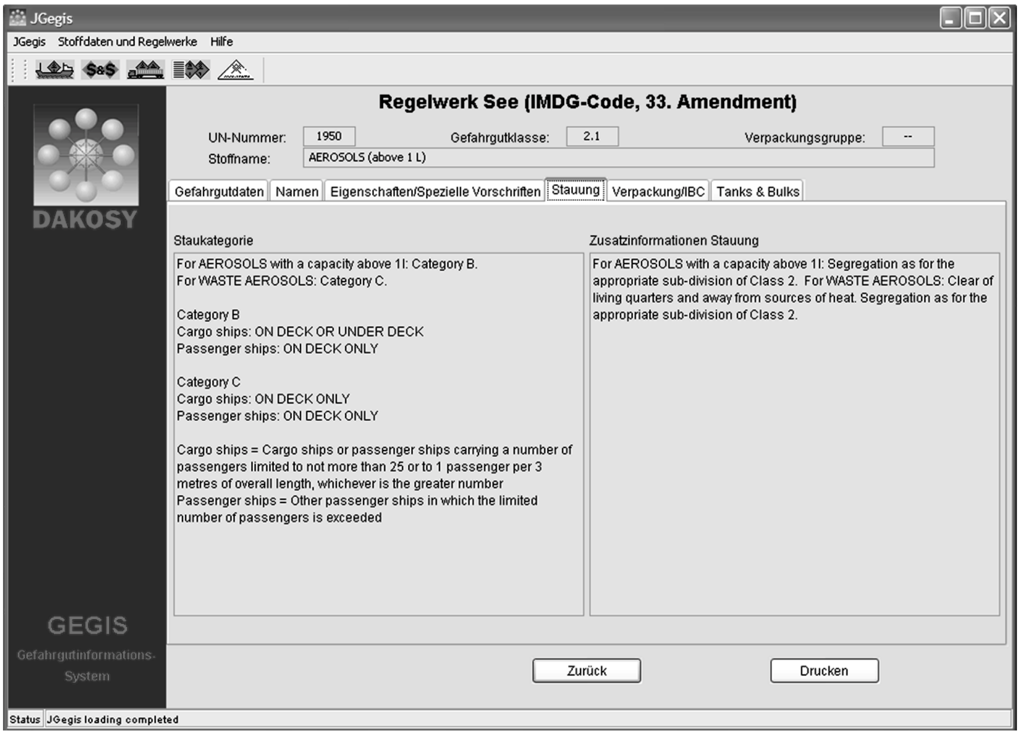


Figure 21 Stowage and segregation instructions on GEGIS interface (Screenshot of the software)

With the graphic support, the user can check which dangerous substances may be placed together and/or determine whether the segregation requirements even apply. The stowage and segregation regulations can also be viewed and used separately (see Figure 21). The database contains comprehensive up-to-date regulatory requirements for all transport modes such as sea, road, rail, and barge with all essential information like Classification, labeling, substance characteristics and packaging policies. A realistic risk analysis, estimated of hazards and accidental, is combined with data on first aid measures as well as thorough information and help for damage control.

The Dakosy AG gives permission for selected users in each of the co-operation organizations to achieve a better control of all the outside users. This is a better solution rather than just to give common passwords for a larger group of people which can create a large quantity of misuse in some cases. One of the biggest private companies operating in the Port of Hamburg is shipping company Maersk Line. It uses the GEGIS system for reporting incoming and outgoing cargo and currently has four people working in the office with GEGIS user profiles. The Hamburg office of Maersk transfers the required cargo data from their own system to GEGIS with an EDI-transfer and therefore overlapping inputs can be avoided. The usage privileges of Maersk Line are restricted only to inputting and viewing of the DG-notification slot, and they do not have rights to use, for example, the reporting and statistics modules. The Waterways Police of Hamburg, on another hand, have fever limitations with the software as they work as the main supervising officials in the port area. The road officials have access to GEGIS as well to have preliminary information of the arriving cargo from the port.

The Hamburg Port Railway uses HABIS information system for a central management tool for smooth operation, maintaining, and expansion of the infrastructure of rail services. HABIS features interfaces with railway companies, freight forwarders, terminals, shippers, customers, and other parties in the transport sector. The networking model allows information to be exchanged without delay. HABIS connects the IT Systems of the Deutsche Bahn AG (German Railways) with other IT Systems in shipping and transport industry, and facilitates an IT-supported operation of the Port Railway System (HABIS 2007, Biggest transhipment location for rail container traffic, 2007). HABIS and GEGIS are linked together allowing efficient, accurate, and up-to-date DG data exchange in multimodal transportations.

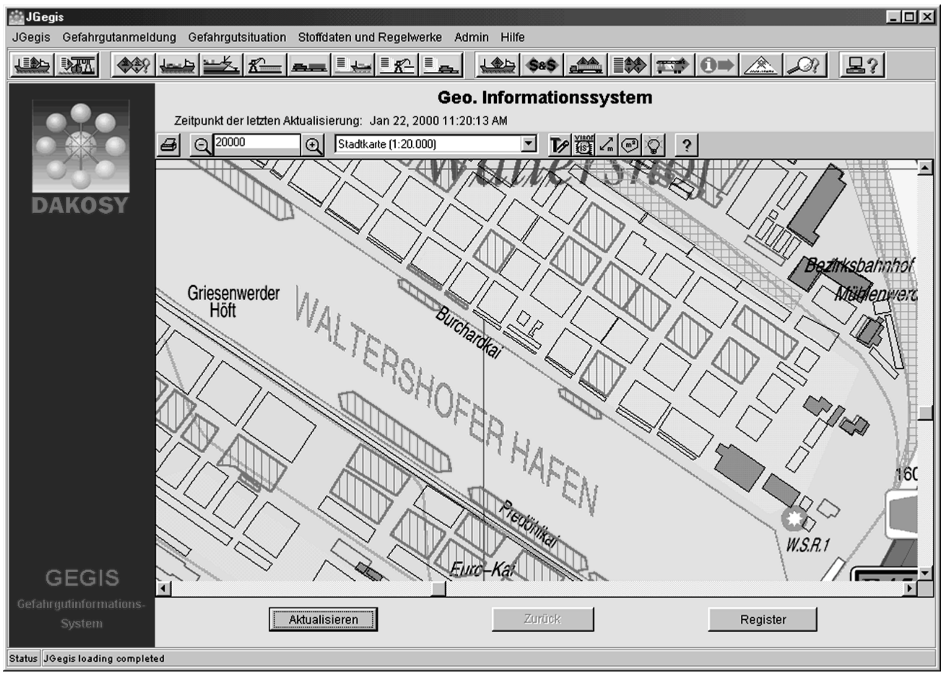
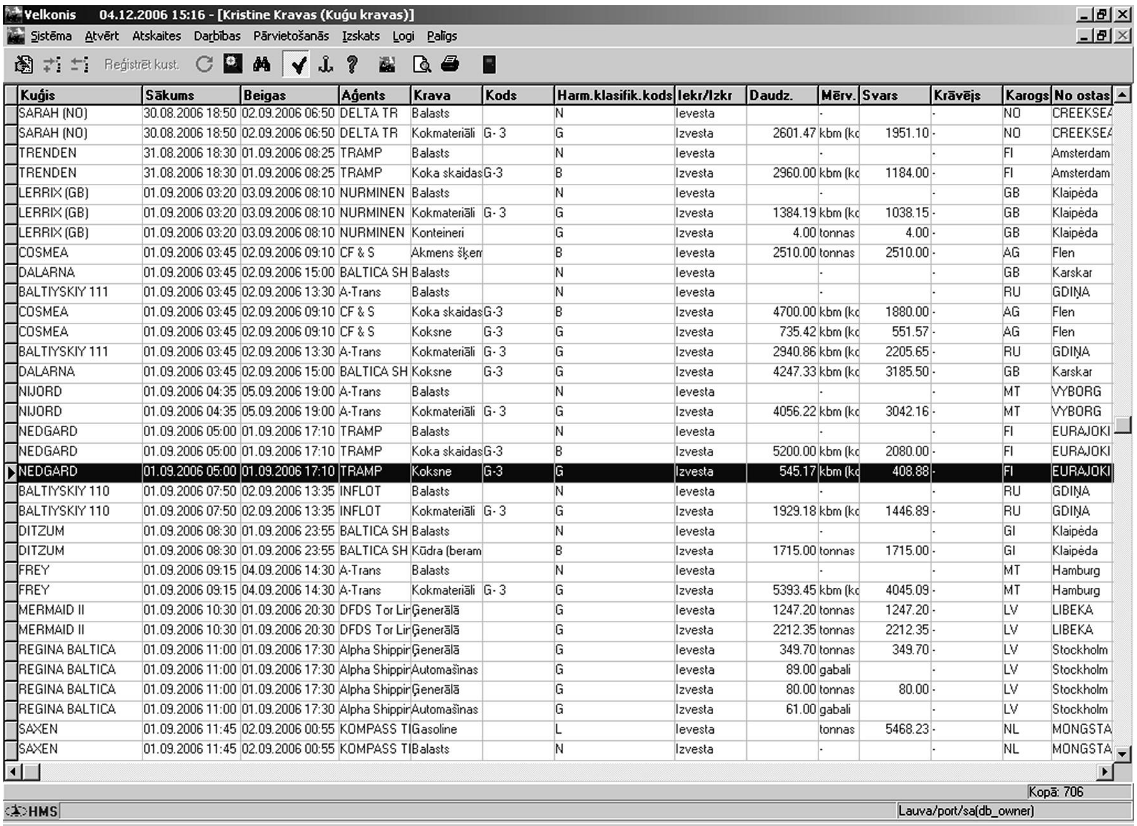


Figure 22 Location of DG containers in the port area (Screenshot of the software)

GEGIS displays the location of each cargo unit in the terminal. In the above screenshot (Figure 22) the checked boxes represents containers with dangerous substances. This helps officials to visually get an overview of the current situation and search proper locations for incoming DG-containers.

5.3.3 Freeport of Riga

The Freeport of Riga uses a highly evolved IT System called *Velkonis* which represents deeply integrated ERP-software. Velkonis was created by a Latvian software company HMS. The first version was implemented as early as in the year 1995. It is updated in the average every two months depending on the changes in shipping legislation and regulation. Current version 2.22 is secured by 128 bit SSL-protocol, and it is hosted by port authority IT Department. The Microsoft SQL database is divided into two physical locations and is back upped every 15 minutes. *Velkonis* has a web based interface and can therefore be used anywhere with an internet connection or a mobile via GPRS-connection. The Port organization has 13 different access levels to represent the user-rights of all the stakeholders, who represent the stevedoring companies, agents, customs, police, state environmental agency, Port Administration and The Latvian Maritime Administrator. The data of each port-of-call is stored in the database from the year 1995 and can be downloaded and re-used based on many different search criteria such as dates, type of the cargo, vessels' name, nationality, and so on. The results can be viewed on spreadsheet or directly from the software's own interface.



Kuģis	Sākums	Beigas	Aģents	Krava	Kods	Harm.klasifik.kods	Iekr/Izkr	Daudz.	Mērv.	Svars	Krāvējs	Karogs	No ostas
SARAH (NO)	30.08.2006 18:50	02.09.2006 06:50	DELTA TR	Balasts		N	Ievesta		-		-	NO	CREEKSEA
SARAH (NO)	30.08.2006 18:50	02.09.2006 06:50	DELTA TR	Kokmateriāli	G- 3	G	Izvesta	2601.47	kbm (kc	1951.10	-	NO	CREEKSEA
TRENDEN	31.08.2006 18:30	01.09.2006 08:25	TRAMP	Balasts		N	Ievesta		-		-	FI	Amsterdam
TRENDEN	31.08.2006 18:30	01.09.2006 08:25	TRAMP	Koka skaidas	G-3	B	Izvesta	2960.00	kbm (kc	1184.00	-	FI	Amsterdam
LERRIX (GB)	01.09.2006 03:20	03.09.2006 08:10	NURMINEN	Balasts		N	Ievesta		-		-	GB	Klaipėda
LERRIX (GB)	01.09.2006 03:20	03.09.2006 08:10	NURMINEN	Kokmateriāli	G- 3	G	Izvesta	1384.19	kbm (kc	1038.15	-	GB	Klaipėda
LERRIX (GB)	01.09.2006 03:20	03.09.2006 08:10	NURMINEN	Konteineri		G	Izvesta	4.00	tonnas	4.00	-	GB	Klaipėda
COSMEA	01.09.2006 03:45	02.09.2006 09:10	CF & S	Akmens šķem		B	Ievesta	2510.00	tonnas	2510.00	-	AG	Flen
DALARNA	01.09.2006 03:45	02.09.2006 15:00	BALTICA SH	Balasts		N	Ievesta		-		-	GB	Karskar
BALTIYSKIY 111	01.09.2006 03:45	02.09.2006 13:30	A-Trans	Balasts		N	Ievesta		-		-	RU	GDIŅA
COSMEA	01.09.2006 03:45	02.09.2006 09:10	CF & S	Koka skaidas	G-3	B	Izvesta	4700.00	kbm (kc	1880.00	-	AG	Flen
COSMEA	01.09.2006 03:45	02.09.2006 09:10	CF & S	Koksne	G-3	G	Izvesta	735.42	kbm (kc	551.57	-	AG	Flen
BALTIYSKIY 111	01.09.2006 03:45	02.09.2006 13:30	A-Trans	Kokmateriāli	G- 3	G	Izvesta	2940.86	kbm (kc	2205.65	-	RU	GDIŅA
DALARNA	01.09.2006 03:45	02.09.2006 15:00	BALTICA SH	Koksne	G-3	G	Izvesta	4247.33	kbm (kc	3185.50	-	GB	Karskar
NIJORD	01.09.2006 04:35	05.09.2006 19:00	A-Trans	Balasts		N	Ievesta		-		-	MT	VYBORG
NIJORD	01.09.2006 04:35	05.09.2006 19:00	A-Trans	Kokmateriāli	G- 3	G	Izvesta	4056.22	kbm (kc	3042.16	-	MT	VYBORG
NEDGARD	01.09.2006 05:00	01.09.2006 17:10	TRAMP	Balasts		N	Ievesta		-		-	FI	EURAJOKI
NEDGARD	01.09.2006 05:00	01.09.2006 17:10	TRAMP	Koka skaidas	G-3	B	Izvesta	5200.00	kbm (kc	2080.00	-	FI	EURAJOKI
NEDGARD	01.09.2006 05:00	01.09.2006 17:10	TRAMP	Koksne	G-3	G	Izvesta	545.17	kbm (kc	408.88	-	FI	EURAJOKI
BALTIYSKIY 110	01.09.2006 07:50	02.09.2006 13:35	INFLOT	Balasts		N	Ievesta		-		-	RU	GDIŅA
BALTIYSKIY 110	01.09.2006 07:50	02.09.2006 13:35	INFLOT	Kokmateriāli	G- 3	G	Izvesta	1929.18	kbm (kc	1446.89	-	RU	GDIŅA
DITZUM	01.09.2006 08:30	01.09.2006 23:55	BALTICA SH	Balasts		N	Ievesta		-		-	GI	Klaipėda
DITZUM	01.09.2006 08:30	01.09.2006 23:55	BALTICA SH	Kūdra (beram		B	Izvesta	1715.00	tonnas	1715.00	-	GI	Klaipėda
FREY	01.09.2006 09:15	04.09.2006 14:30	A-Trans	Balasts		N	Ievesta		-		-	MT	Hamburg
FREY	01.09.2006 09:15	04.09.2006 14:30	A-Trans	Kokmateriāli	G- 3	G	Izvesta	5393.45	kbm (kc	4045.09	-	MT	Hamburg
MERMAID II	01.09.2006 10:30	01.09.2006 20:30	DFDS Tor Lir	Ģenerālā		G	Ievesta	1247.20	tonnas	1247.20	-	LV	LIBEKA
MERMAID II	01.09.2006 10:30	01.09.2006 20:30	DFDS Tor Lir	Ģenerālā		G	Izvesta	2212.35	tonnas	2212.35	-	LV	LIBEKA
REGINA BALTICA	01.09.2006 11:00	01.09.2006 17:30	Alpha Shippir	Ģenerālā		G	Ievesta	349.70	tonnas	349.70	-	LV	Stockholm
REGINA BALTICA	01.09.2006 11:00	01.09.2006 17:30	Alpha Shippir	Automašīnas		G	Ievesta	89.00	gabali		-	LV	Stockholm
REGINA BALTICA	01.09.2006 11:00	01.09.2006 17:30	Alpha Shippir	Ģenerālā		G	Izvesta	80.00	tonnas	80.00	-	LV	Stockholm
REGINA BALTICA	01.09.2006 11:00	01.09.2006 17:30	Alpha Shippir	Automašīnas		G	Izvesta	61.00	gabali		-	LV	Stockholm
SAXEN	01.09.2006 11:45	02.09.2006 00:55	KOMPASS TI	Gasoline		L	Ievesta		tonnas	5468.23	-	NL	MONGSTA
SAXEN	01.09.2006 11:45	02.09.2006 00:55	KOMPASS TI	Balasts		N	Izvesta		-		-	NL	MONGSTA

Figure 23 A screenshot of Velkonis Cargo data spreadsheet displays berthed vessels in Freeport of Riga

An upcoming feature for *Velkonis* is a GPS mapping system which will show the current location of each vessel in the port area. It will also assist the planning of the loading and unloading process.

The system consists of approximately 50 interconnected modules that cover almost all common functions inside the port. The inputs are stored from all of the modules to the same database and the data can be used instantly throughout the organization. Incoming vessels are reported by the agents via web based form 48 hours prior arrival if it is transporting Dangerous Cargo. Enquiries during storage time can be made by printing out Tables of the cargo divided by Class.

The integration works well between different actors in the Freeport of Riga. The Latvian Maritime administration has access to *Velkonis*, and they use it daily to calculate all different kinds of shipping and navigational fees. The Port's accounting department can compute overall port-of-call costs and charge the shipping agency directly by e-invoice or automated paper invoice. Other users of the system are naturally shipping companies, special DG-division of the Police Department, bunkering companies and several state-level organizations. The system is developed for open multi-user software and it is not trying to be closed and accessible for the port staff only. *Velkonis* does not have any connection to other transportation mode systems such as trucking or railway operators.

5.3.4 Klaipeda State Seaport Authority

The IT Field of Klaipeda Seaport is in a transition. Currently there is being used a system called Laivo for managing the DG-cargo flows in the port area, but plans for an ERP system covering the whole port is in development. In this Chapter both solutions are discussed side by side as there is no point of reviewing only the withdrawing system. The upcoming CACIS-system (Cargoes and Commodities Information System) is already in use for some modules, but the final implementation is scheduled for the end of the year 2007.

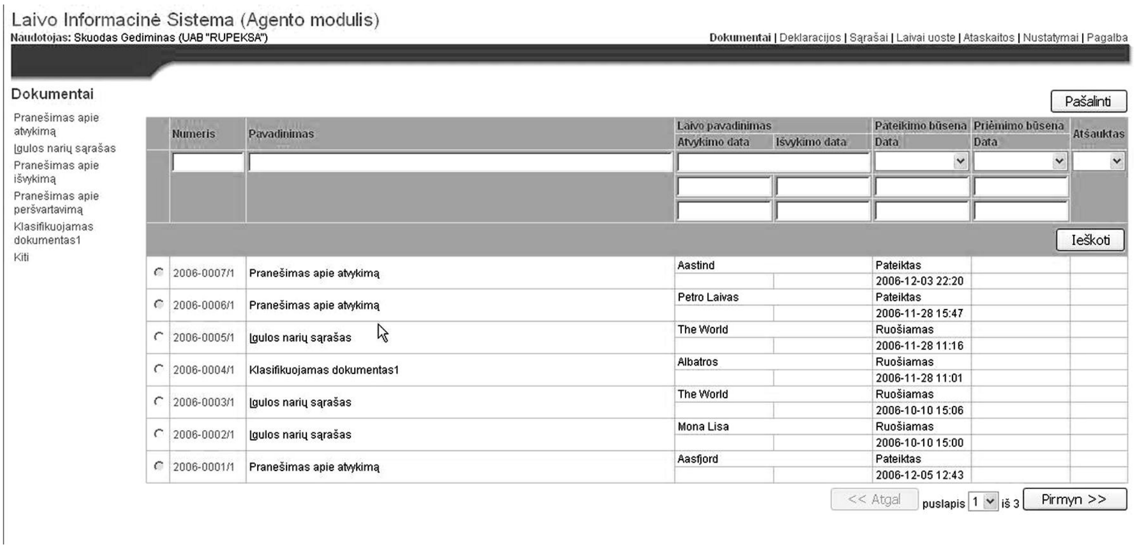


Figure 24 A Screenshot of Laivo port IT-system (Courtesy of Mr. Zygus)

Laivo is a straight forward application to serve the needs of port-of-call and cargo notifications made by shipping agents and for storing the data of vessels movements in port. The interface is graphical and it operates mainly with several form-fields. A WWW-interface is provided for externals users such as agents. The Cargo Information System part has been found to lack user-friendliness, but improvements are being made all the time. The Oracle server is hosted inside the Port of Klaipeda office, and it has a digital security certificate for encrypting and protecting the data. The log-in processes for outside users require usernames and passwords which are continuously varying from the list of 24 different ones. Future plans include the use of a digital signature for ensuring the identity of the user. The inputted data in the first stage appears in temporary Tables, which have to be revised and corrected by an officer. As soon as the required paper documents are delivered from the agent, the data can be published and viewed by all users. The delay between inputting and publishing can be something from a few minutes to several days depending on the nature of the documents.

The upcoming CACIS system aims to accelerate customs declaration of sea-going cargo and therefore relieve performance of risk analysis and unify electronic communication for stevedore companies. The increasing data exchange between logistic partners and Customs such as import/export/transit, temporary storage, and other customs formalities, is considered do diminish the manual labor and provide essential information to all stakeholders simultaneously. One of the basic functions is an interface for data communication with ports of cargo dispatch and destination. Main general objective of the system is to speed up the cargo operations at the seaport area, aiming to increase the overall competitive ability of the Klaipeda State Seaport. On a more specific level, the objective is to design, develop, and implement an Information System for data exchange and workflow processes between the logistic partners involved in all port activities. The new system includes the following characteristics and modules:

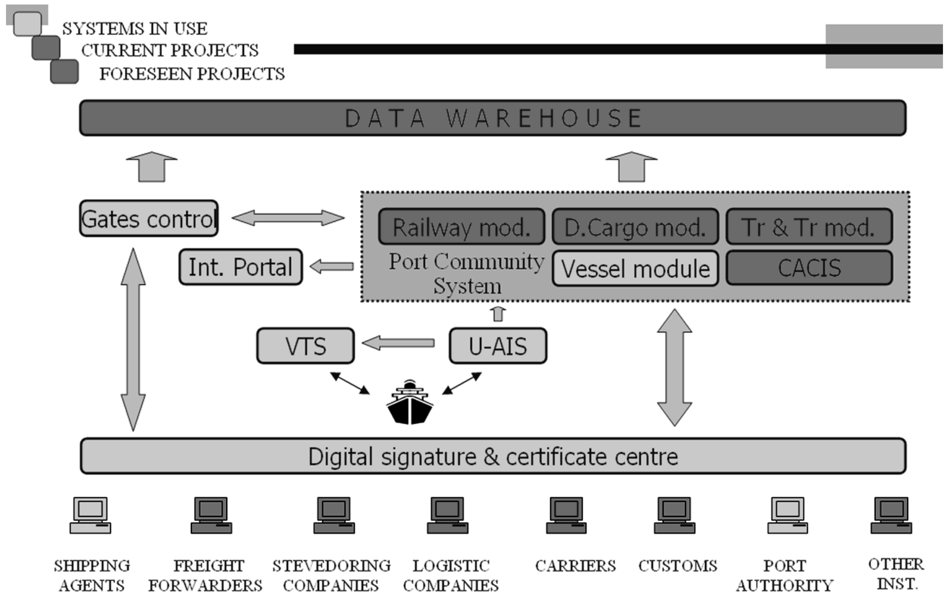


Figure 25 CACIS and its relation to the port Information System (Courtesy of Mr. Zygus)

Gates control, Int. portal, VTS, U-AIS and the Vessel module in the port community center are already in use. At the moment there is no operational system specified to monitor dangerous cargo, but the CACIS will have an individual module for it. Other new innovation in the system is a GIS-based positioning to track the vessels' movements it the port area (Žygus 2006).

The current system Laivo does not have features to make pre-defined reports or statistics. Basically, the data is stored in the database in a certain form and the user can download it for example as an excel sheet to formulate statistics to his own likings. As soon as the CACIS is online, the Port officials are planning to implement a report/statistics program to it. There has not emerged any needs for mobile use of Laivo, and special handheld devices have been considered too small and difficult to use. For CACIS the Port has taken into consideration some specially designed WWW-pages for mobile phone use, which demand smaller screen resolution and petite file-sizes.

The CACIS makes a large contribution to the system integration issues compared to Laivo. Currently, Laivo operates inside the port organization with only a few outside users. What differs from the other Baltic Sea ports is that the Port Of Klaipeda has already implemented SafeSeaNet notifications where XML-form data is transferred to both directions. The operational part includes vessel and port-of-call information provided by the agent. CACIS is suppose to have outside linkages, for example Customs IS, Port IS (Vessel module, Gates Control IS), Lithuanian Railways

(CARGO), and other ports of cargo dispatch and destination. The user levels wary from restricted viewing to full control depending on the status of the associate which include the following groups:

- Cargo Forwarders
- Shipping Agents
- Stevedore companies
- Customs offices and Customs Department
- Lithuanian Railway Company
- State Food and Veterinary Service
- State Plant Protection Service
- Klaipeda Public Health Centre
- State Border Guard Service
- Klaipeda State Seaport Authority

After completion, CACIS will be a very powerful and deeply integrated port ERP-system.

5.3.5 Stockholm Ports

The main tool for the port information handling at Stockholm Port is the PortIT System. PortIT is a system developed jointly by a majority of Swedish harbors, and it provides means for electronic interchange of information between all operations in the port. The data interchange covers also the linkage between the port and its clients and service providers (Workpackage 7: Technical Case Study No. 4: Transport Logistics via Feeder Shipping, 2000). The system developer is a Danish/Swedish based company InPort Intelligent Port Systems A/S & AB. Version no. 5 of the software can be seen the first variety of the present software functionalities and it is followed by a version no.6 which is currently in operational use. PortIT is built on IBM iServer 800 and it has two separate databases in different locations to ensure back-upping in case of emergencies.

Inputted data is stored directly to database and the data can be viewed and used simultaneously by the users. The user groups consists of he staff of the port organization and shipping agents, and for security reasons all their passwords change every 30 days to prevent malpractices. Container operators have access to PortIT web-based intranet in which they can make queries about all units that belong to their line or depot. The restricted users can browse the history of the units' movements during port visit and search upcoming or previous bookings. Carrier-level users and other customers can access a slim version of the intranet to get information if the unit is ready to collect.

The graphical interface of PortIT displays the ship or the transportation unit containing Dangerous Goods. The software automatically searches essential information of the current substance such as storage regulations, stickers and accident procedures. The main container shipping company in Port of Stockholm is Teamlines, which provide the cargo information data by EDI-messages to PortIT. The following screenshot is from a cargo list from m/v Lappland. The red square in the middle notifies that the shipment contains Hazardous Cargo. The user can scroll down and search for more information on each container needed.

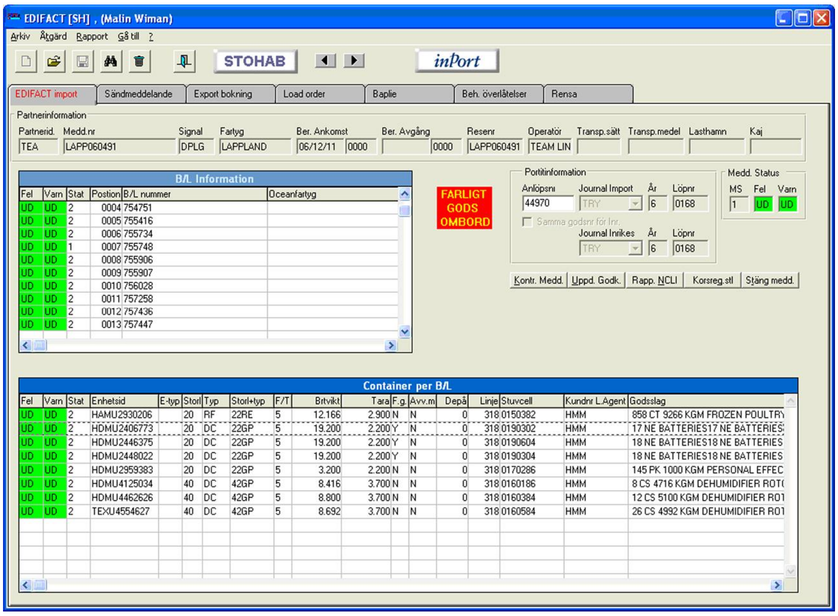


Figure 26 PortIT displays when the shipment contains DG-cargo (Courtesy of Ms. Wiman)

With the help of the PortIT system, the port officials can view and control the stored cargo in port area. The Charts show normal cargo and DG-cargo separately, but it does not provide tools for land segregation. The relatively small amount of DG-containers makes it possible to position these kinds of substances in sufficient distances from each other in any case. One of the modules named Kartago map-system enables the viewing of the current location of each container. It also allows the user to examine the container's contents and handling instructions. The software cannot review the cargo's ownership details, but the information can be easily checked from the gate by the transportation unit's ID-number.

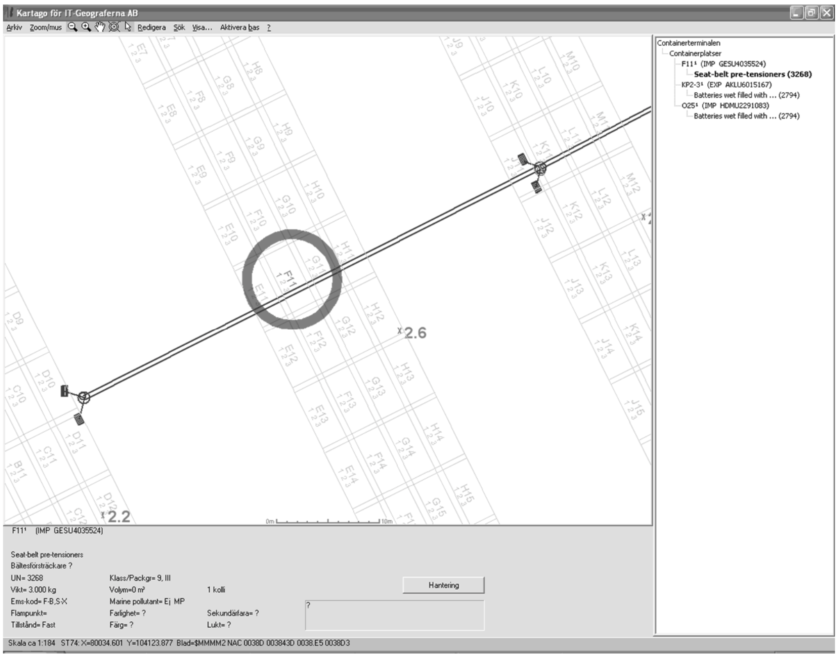


Figure 27 PortIT displays the location of DG-container (Courtesy of Ms. Wiman)

The system has modules for reporting and statistics which can date back to at least two years. The statistics software is actually a different application, but is able to make queries from PortIT databases. The search criteria can be e.g. incoming, outgoing or stored cargo inside a given timeframe and divided by transport unit or by UN-number in case of Dangerous goods. Containers which are not shipped by Teamlines and other general cargo notifications are still made to traffic control by hand via fax or e-mail 24 hours in advance. The Swedish Maritime Administration is responsible for compiling DG-cargo information from ports and shipping companies and it has developed an information-processing system for the task called Fartygs Rapporterings Systemet – FRS (Vessel Reporting System). The information regarding each vessel has to be reported to FRS and it works as middleware for translating data to SafeSeaNet. At the moment PortIT is incapable of receiving incoming Hazardous Cargo data from FRS, but it will be possible in the near future.

The user levels of PortIT are divided into three categories: The first and most powerful is naturally the *administrator*, followed by the *operator*, covering mostly the staff of Port organization. The third group is called *carriers* who have basically only entitlement to input cargo data such as notifications and cargo manifests. Each of the three ports in the organization is using the PortIT system, but they are not currently linked directly together except via FRS, which provides information to various actors such as the Swedish Coast Guard, the Swedish Customs, and many ports. The main goal for FRS is that all information regarding a port call will eventually be transferred to a single centre. The PortIT is linked closely to The Swedish Rescue Service's Information Bank (RIB) which contains various risk-analysis tools as well as general information of all Dangerous Substances. By this solution the PortIT system does not need to have up-to-date information about different substances since they can be downloaded from the RIB.

5.3.6 The Port Of Helsinki

Selecting the right IT System in Port of Helsinki was a difficult task, since Finland has a highly evolved nationwide maritime and port IT System called PortNet. The PortNet system is presently managed by the Finnish Maritime Administration, but is owned by the PortNet community. The core content of the PortNet system is operative timetable information and cargo information regarding ship traffic. Although the Port of Helsinki uses PortNet on daily basis it was excluded since it can not provide tools for organizing Dangerous Goods handling inside the port premises.

IT-infrastructure in the Port of Helsinki differs from other ports in this study, because one stevedoring company is responsible for the majority of cargo handling port operations. This company is a subsidiary of Finnlines Plc. called Finnsteve Ltd. Finnsteve has developed and used a port IT System of their own for many years and the Port of Helsinki has bought the same software for their use. The system uses the same database and selected modules for both parties when there is no need to data exchange. This collaboration dates back as far as the year 1989, and the software is more or less the same as it was then. The software is actually an IMO-application called Masterimo and its text base interface is very straight-forward and easy to use. The software uses IBM I-series relational database and is linked to Finnlines' ERP, but works as a stand-alone version as well. The back-upping is executed in daily routines partially with replication scripts.

Finnlines Plc. is the major transporter in the Port of Helsinki. Since the ship and cargo database is shared with the port organization, there is no extra work needed for the notifications. The inputted data is received by EDI-transfers from the Finnlines Plc. agencies from the departure port or from the home port booking department. For non-Finnlines cargo the port has an internet form whose inputs are stored directly to the database. In January 2007 the form was operational only in Finnish. Forms filled with languages other than Finnish must still be sent by fax. When the shipment contains Dangerous Substances, the notifications must be provided 24 hours in advance. This poses a slight problem, since Helsinki has frequent regular liner traffic to Tallinn with the sea voyage considerably shorter than the 24 hour margin.

MasterIMO has many different user levels because the variety of users differs greatly. Naturally, both organizations have distributed and divided the access-levels to their own staff, but for example the security department of Port of Helsinki has 23 officers with full rights. The software operates purely as a port operations tool and does not have linkages to SafeSeaNet. The cargo information including DG-notifications can be transferred by EDI to Finnish Maritime Administration’s PortNet system. This protocol diminishes manual labor required for inputting data from one system to another and enables SSN transfer through PortNet.

5.4 Port specialization and IT Systems

From the IT System point of view, the difference between specialized and mixed-cargo ports is the amount of stakeholders whom the information is to be shared. Communication with only few cooperation partners eases the process of combining different IT Systems together since number of actors is considerably smaller. According to Baltic Maritime Outlook 2006 (93-95) the development of port specialization is still underway in the Baltic Sea Region. Competition between BSR ports and terminal operators increases the importance of effective handling routines, IT Systems and specialization in certain commodities. Strategic co-operation or uniting into port groups has also brought competitive advantages for small regional ports, making them stronger within specialized ports.

Many specialized ports are often quite small, not necessary by transport volumes, but by staff or revenue since they might operate with only one or few commodity i.e. bulk or ro-ro. When the port has only few major clients it may still manage the data-flow between systems manually. The input work is not time-consuming as one large bulk-cargo is usually only handled as one shipment compared for example container vessels that might have several thousand shipments. This leads to a situation when a small or specialized port do not necessarily need to put much effort on IT System development and still keep up with the competition. Although effective and fast data-flow management can improve the competitiveness of the port since potential customers achieve more information about the handling process of the cargo at port.

6 COMPARING THE DIFFERENT IT SYSTEMS

The previous Chapter introduced all target IT Systems and the following part compares them to evaluation model presented in Figure 15. It is essential to follow also the guidelines given in Chapter 5.1, since the IT Systems will be reflected via the theoretical framework to the following comparison matrixes. The first sub-paragraph discusses and presents the qualities or features which appeared in the studied IT Systems. A short review is given of each of them to help to understand what their function actually is. The second sub-paragraph presents three matrixes derived from paragraph 5.1 guidelines. Each feature in each port is executed in this fashion. The third Section presents the fictional "best practice" IT System, again following the guidelines in Chapter 5.1.

6.1 Introduction and directory of functions

Port IT Systems execute various different tasks in normal daily port routines. Some of them are still taken care of by hand, and some can be electronically aided. The following timeline represents the most common tasks which the shipping of Dangerous Goods poses in a port organization.

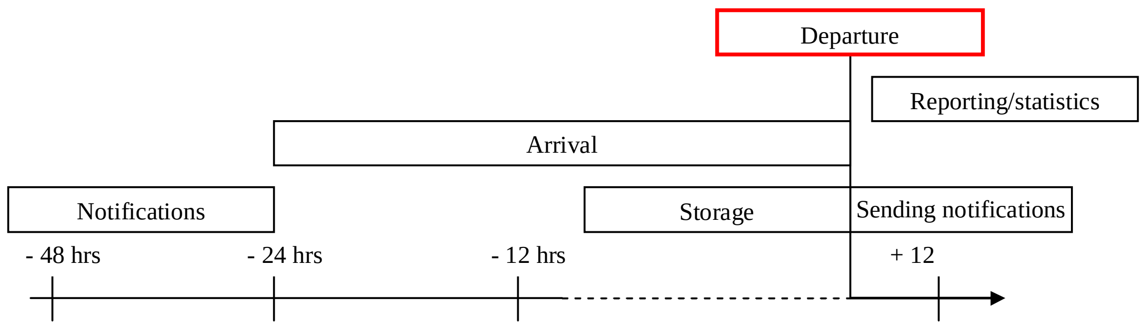


Figure 28 Timeline of actions required in shipping DG-cargo

This Figure represents carrying Dangerous Cargo in mixed cargo ports. Oil and chemical bulk harbors are a different case, because the substances are usually also stored near the berths. The following actions cover only Hazardous Substances. When this is not the case, it will be noted.

Table 8 Common Port IT System functions in common Port of call

Notifications
Notifications are announcements usually provided by the ships agent to port organization or other officials about the in- or outgoing cargo. They contain information about the vessel, its timetable, crew, and passengers, and most importantly, the cargo. In most cases when the ship is transporting DG-material, the notification must be made 48 or 24 hours in advance. The most common way to give inter-organizational notifications is via fax or e-mail, but some ports provide an opportunity to make the notifications in a web-based form which saves the data directly to the system. In Helsinki, the situation is optimized as the Port and the major stevedoring company are using the same software.
Arrival
Usually the outgoing cargo has some preliminary booking already made in the port IT-system, and on arrival the booking becomes concrete. The arrival time is essential in case of DG-cargo, since the storage time is aimed to be kept as short as possible. Some IT Systems (such as GEGIS) automatically aid the cargo positioning and then early information of incoming cargo assists the project.
Storage
It is a custom that Dangerous Goods are not usually stored for very long times in the port area, for they can pose a serious danger in case of an accident. The maximum storage time depends on the substance, but in mixed cargo ports it is not usually more than 24 hours. If the port has special warehouses or other storage areas designed to fulfill the cargo area requirements, the storage is possible for longer times. Good IT Systems visually show (see Figure 27) the actual position of each cargo unit in the port and display instructions of the containing substance and protocol for accident situations.
Departure
When the vessel is leaving the port it is essential to transfer cargo information to the next port or consignee. Inter-organizational IT Systems are capable by EDI-transfer to send essential information directly without the need of sending papers by fax or e-mail. Naturally, some documents travel onboard or are sent to the consignee. This is the case when the original papers have to be presented, such as some custom notifications.
Reporting/statistics
It is always time-consuming if the reporting and statistics tools are not integrated into the main system. It helps to query and edit data directly from the original database, and therefore the information is correct and on-time. The relational model database though makes it easy to make summations in a spreadsheet software such as excel, but the data might be out-of-date and rarely automatically updated when the master data changes. In most cases the searchable data is connected to the age of the current system. The documents prior to the creation of the software are not re-inputted in the system, at least not in the target ports of this study. Then, in case one wants to make statistics that are older than the software, one must collect the data from paper archives. Various actors search information for various purposes, and optimal search-function provides many different search criteria. Naturally, a well-designed database helps and accelerates the searches. Most common query attributes are: • The name of the substance (UN-number, packing group, shipping name etc.) • Arrival or departure date and time • Name of the vessel • Port of loading or discharge • Owner of the cargo • Transportation unit

In reality the operations performed varies between ports and countries, but the issues detailed in the Table 8 represent the most common duties at least in the Baltic Sea Region.

6.2 Comparison of the IT Systems in use

The following paragraph represents the findings of this survey on a three feature/port matrix. The matrixes are selected by the same Classification that was used in the port review Chapter (see Chapter 5):

- **Technical issues**
- **The ERP-qualities and provided modules**
- **Depth of system integration**

The horizontal axel represents each function, and each cell displays how the function is executed in the port, shown on the vertical axel.

6.2.1 The Matrix of Technical Issues

The functions of this matrix are all technical related such as the structure and brand of the database, as well as the interface matters. What was notable that the solutions for both user and guest interface are very diverse. The implementations varied from Java-platform to "old-fashioned" text-based interface. Text-based applications run faster and offer more flexibility for interoperation of programs than graphic based software. Text-based applications run faster because the machine does not expend resources on processing the graphics, which generally requires more system resources than text does. Text-based software often provides the user more control on the system by taking all the details of the instruction as the parameters or redirecting the outputs. Text-based though has limitation on its input and output. The output is generated in such a way is not very attractive and can be difficult to follow compare to the output involving graphics. It is also quite complicated to directly combine web-applications to text-based applications but it can be eased if the database is properly formed.

The good-side of Java-programmed software are that they are platform independent. It means that programs written in the Java language can be run similarly on any supported hardware/operating-system platform. Downside is that the java-support must be installed to the user computer before the software can be used. Web-based interface on the other hand does not require any software installations more than a web browser. In this solution all the scripts are ran in the organizations servers and the user's computer is not encumbered.

What it comes to database issues was quite clear that the bigger suppliers rule the markets. Oracle, IBM and Microsoft are the main manufacturers of server applications which was clearly detectable on the target IT Systems. The replication and security issues represented the standard level of every modern organization. In reality this meant that the whole base was replicated at least once a day. Backup is different from replication, since it saves a copy of data unchanged for a long period of time. Replicas on the other hand are frequently updated and quickly lose any historical state. In a port environment where the data flow is nearly continuous the on-time replication is more advisable as then the data-loss is impossible.

The mobile use of each system was still in its infants. All target software were usable at on a laptop with wireless internet access, but only Klaipeda was planning to launch tailored pages for mobile use in the future. Mobile Web access today suffers from interoperability and usability problems. This is partly due to the small physical size of the screens of mobile devices and partly due to the incompatibility of many mobile devices with computer operating systems. None of the target ports had any handheld devices designed to the IT System as they were found too small and inconvenient to use on the field.

Table 8 The Matrix of Technical Characteristics of target Port IT Systems

	User interface	Guest interface	Database brand	DB Security	DB backupping	Wireless use	Mobile use	Mobile devices
Tallinn	Text	None	Oracle	In-house DB, username / password authentication	N/A	WLAN	None	None
Hamburg	Java-Software	Same software with limited applications	IBM I-Series / SQL	In-House DB, restricted computers are accesible to system	Secondary Server for real-time back-ups	WLAN	None, UMTS mobile phones in the future	None
Riga	Web-browser / graphic	Same interface with limited accessibility	Microsoft SQL	128 bit SSL / 13 access levels	Two separate servers, back-ups every 15 minutes	WLAN / GPRS	Standard mobile phones with GPRS and web-browsing capabilities	None
Klaipeda	Graphical	Web interface for agents	Oracle	Digital certificate / changing passwords / in-house maintenance	N/A	Guest web-interface by WLAN / GPRS	Standard mobile phones with GPRS and web-browsing capabilities for guest interface	None
Stockholm	Graphical	Web interface for agents + restricted access for Carrier-level users	IBM iServer 800	30 day interval changing passwords	Two separate servers	Web-interface by WLAN / GPRS	Standard mobile phones with GPRS and web-browsing capabilities for web interface	None
Helsinki	Text	None	IBM I-Series	N/A	Daily replication	WLAN	None	None

6.2.2 The ERP-qualities and provided modules matrix

This matrix goes through the various applications each system contains and the model that is implemented and accomplished. In the horizontal axis are listed the tasks performed in daily port operations (see Table 8) and how they are executed in the target IT Systems. The Chart is mere a revision of the functions reviewed in Chapter 5 and works best for comparing the systems with each other.

Few of the studied six software still require the cargo notifications made by hand, this demands usually a lot of manual labor and slow down the cargo lead-time. If the port organization has a one strong partner among shipping companies or port operations the data transfer can be made by EDI-transmit. This choice requires relatively massive alteration in each party's software, but can create significant time savings over time.

All studied systems included some sort of searching tools which is an essential instrument as the cargo volumes are as high as they in a modern mixed-cargo port. Search engines help to minimize the time required to find information from the database. Optimal searching function is designed to help find information stored on a computer system in various criteria and entries. It should at least contain criterion based on the

- DG-substance (UN-number, Class, Packing Group, Name)
- Timeframe
- Vessel
- Port area where the cargo is/has been stored
- Previous port
- Next port
- Port of departure
- Ownership of the cargo
- Shipping company, forwarder, agent, port operator
- Separated searches from the Non-dangerous Cargo

Search engines can be relatively easy to install in the IT Systems afterwards as long as the databases are properly structured and indexed. Indexing is recommended if the data mass is large in order to support for fast lookup. The goal of creating an index is to optimize the performance and speed of finding relevant documents for a search query. Without an index, the search engine would scan every document in the database, which would take a considerable amount of time and computing power.

Port authorities use statistics to understand collected data and make informed decisions throughout it. The port can review how much and what kind of cargo has passed through it premises in the given timeframe and i.e. modify the port infrastructure if the cargo turnover is changing. Statistic tools are in many senses similar as the search tools. The data is queried in same fashion but producing a report can be automated. In most cases nearly all studied system created the regular statistic automatically. Besides the routine reports in good systems the user should be enabled to make statistics with all the same criteria as the search engine has and print it to pre-defined statistical report.

In a situation when the DG software is a part of a larger port IT System it does not usually contain detailed information about the substance. The data can be downloaded from third party software as it is the case in the Port of Stockholm. The importance of the information concerning the transported substance is much more crucial when operating among DG than in normal cargo. For example accurate and on-time information can help to segregate stored DG-cargo and provide emergency instructions in spillage accidents. The GEGIS system used in the Port of Hamburg is a model example of an well-functioning segregation tool for both land storage and loading the vessels. The land segregation is not, on the other hand, necessary if the port can provide enough storage spaces and the DG-cargo can be located with sufficient space anyhow.

Records from the ownership about the cargo were not seen important by the interviewees in this study. The port authority commonly is not interested about the possession of in- and outgoing shipments as it in many cases the information can be inquired from the port operator or forwarder. The consignments are perceived usually only units going from place A to B and the owner is irrelevant.

The mapping utilities reveal the location of each cargo unit in the port area in graphical interface. The position can be obtained from a satellite (i.e. with GPS-signal) but this usually demands that the unit is equipped with an RFID-tag or similar identifier. The usage of RFID-systems are bounded by the lack of unified standard between the tag and the reader. There is no global public body that governs the frequencies used for RFID. In principle, every country can set its own rules for this. As the port has many shipping companies operating in the port area (and cargo from numerous of shippers and senders) it is quite likely that the IT System used by the authorities can not communicate with all of the different RFID-senders. Secondary solution in placing the cargo units on the electronic map is that trucks and lifting vehicles moving cargo mark the actual position of the unit directly to the database. For example container number “SUDU 303007 6” is stored in the slot 245 in isle 6. When the container moves on of its location the corresponding inputs must to be made again to the IT System. The down side of this solution is that the data can not be completely trustworthy as the fork-lift driver can forget to make the inputs, make a mistype or the cargo unit can be stolen. In other words the container is not actually in the place what the system reveals.

Table 10 The matrix of ERP qualities and provided modules

	Notifications	**Searching**	**Reporting / Statistics**	**DG-substance info**	**Segregation**	**Accidents**	**Ownership**	**Mapping**
Tallinn	Manual inputs from paper notifications	Various criteria and tools.	Various criteria and tools. Only DG-cargo.	N/A	No. Segregation is the duty of the stevedoring company	None	None	None
Hamburg	Direct inputting via software interface	Various criteria and tools.	Various criteria and tools.	All required information.	Provides segregation and stowage instructions.	Accident instructions and linkage to rescue service providers.	Yes	Yes
Riga	Direct via web-interface	Various criteria and tools. Comparison to normal cargo.	Table view with selectable criteria.	N/A	N/A	No special instructions but rescue service providers have	N/A	Available soon
Klaipeda	Web-interface requires control checking before publishing.	Various criteria, no special tools.	Has to be transfer data to outside spreadsheet application.	None	None	None	None	None
Stockholm	Manual inputs from paper notifications. Teamlines has direct access by EDI.	Various criteria and tools. Container operators and carrier-level users have restricted access to intranet	Various criteria and tools.	All required information.	No land segregation.	Accident instructions without link to rescue service providers.	None	Yes
Helsinki	Manual input. Finnlines cargo by EDI.	Various criteria.	Various criteria.	Basic information.	Basic information, but not an actual tool.	None	Yes	No

6.2.3 Depth of system integration

The depth of system integration is illustrated on bars which represent the level of electronic data exchange according to the evaluation model in Section 3.5. For each port, the possible data is divided into three sections based on three important information slots: timetable, cargo-data, and accident situations.

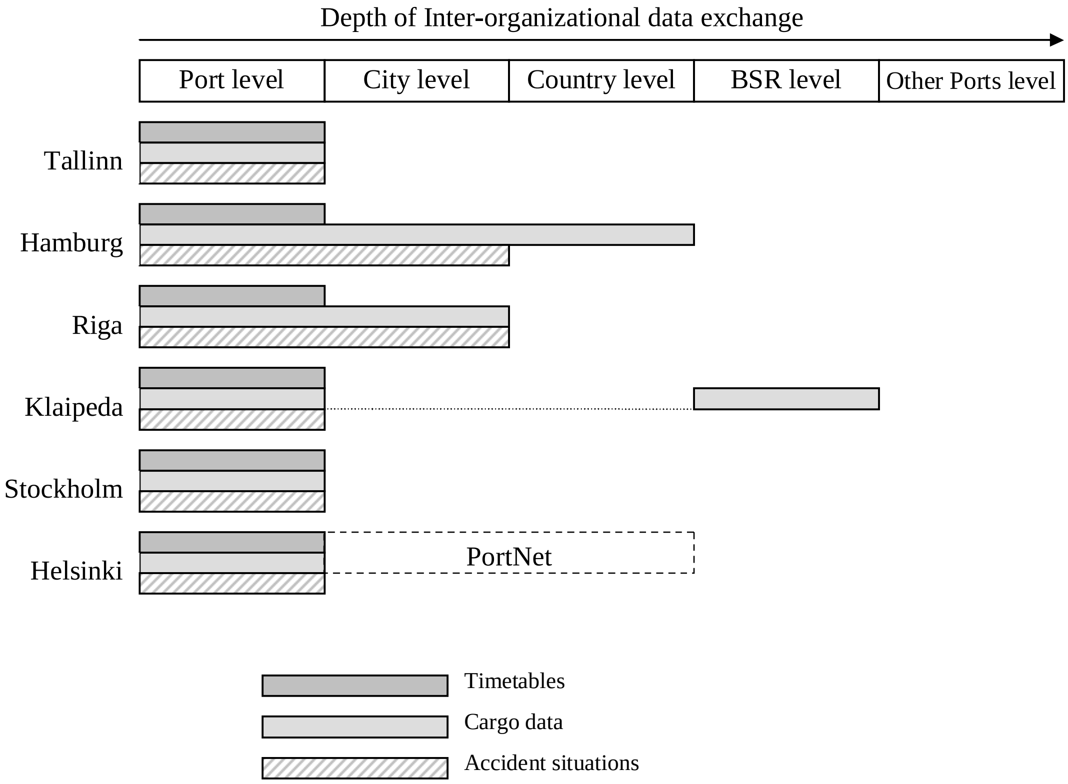


Figure 29 Depth of inter-organizational data exchange in target Ports

The Chart reviews that studied ports do not have a very deeply integrated system. The electronic data is stored on a specific form inside the port, but it is very rarely transferable to other organizations. Hamburg and Riga make an exception to others as they give access to other city-level actors to their system, which is a great help in accident situations. In Riga, the granted access for Maritime Administration and Customs also speeds up the calculation process of shipping related fees and the making of risk analysis. Klaipeda is currently the only BSR port with operational SafeSeaNet linkage. In all major Finnish ports the majority of cargo and timetable information is shared with PortNet and its role is illustrated in the chart though it was not the case IT System for the Port of Helsinki. The role of PortNet is so important in the Finnish maritime transportation that it must be mentioned in this framework.

6.3 Optimal IT System for DG-Cargo handling in ports

An inter-organizational or otherwise open system brings in a long run cost and time savings in a port environment. In the current situation, where there is a huge amount of actors working in Shipping Logistics, and a growing cargo flow, it becomes essential to efficiently share the required information. The information flow is an important part of the field of logistics. Slow and inaccurate information can pose unnecessary delays in the transport chain.

The following fictional port IT System is a combination of all the good elements found in the ports under study. It is introduced parallel to the same structure as the case ports in Chapter 4.

Software with web-based interface is clearly the most convenient way to operate as it enables usage in every location with an internet connection and does not require any installations. When the user is not bound to his or her office, the data is accessible outside office hours, in the evenings or even weekends. Simultaneously, internet access makes all GPRS cell phones mobile devices for using the system on the field, for example in the port area or inside the vessels. The database type is not an essential issue, but in a WWW-environment, SQL is shown to be the most effective, and MySQL provides an open source alternative for the purpose. The commonly used model with two separate servers in different locations is a secure solution. With real time back-upping scripts the data-loss is efficiently ruled out.

The web-application is capable of providing useful modules for the notification aspect as internet form is easily connected to relation model database. In this solution there are no in-house delays, because the client makes the inputs straight into the server (naturally, they can be proofread before publishing), and, the fever players in the middle, the fever mistypes. For viewing the stored information, the web interface is easily customized for displaying chosen data for each user or user group. In more detail, this means tailored user-rights for each party depending on their status in the port community e.g. shipping companies would have access to cargo and timetable data for their vessels, and so on.

If one wants to have a unified efficient port ERP-system, it is quite obvious that the representatives from closely related organizations have to be given access to at least inputting required data directly to system. The following illustration describes the current status (timeline I) in many ports regarding the information flow from the departure port (a) via the current port (b) to the next port-of-call (c). The lower timeline (timeline II) represents the optimum system, where the first port can input data straight to middle port database and the next port has access to view it. Please notice also the missing delay slots as the inputs are simultaneously usable for all without the need for someone manually store the data for the next system.

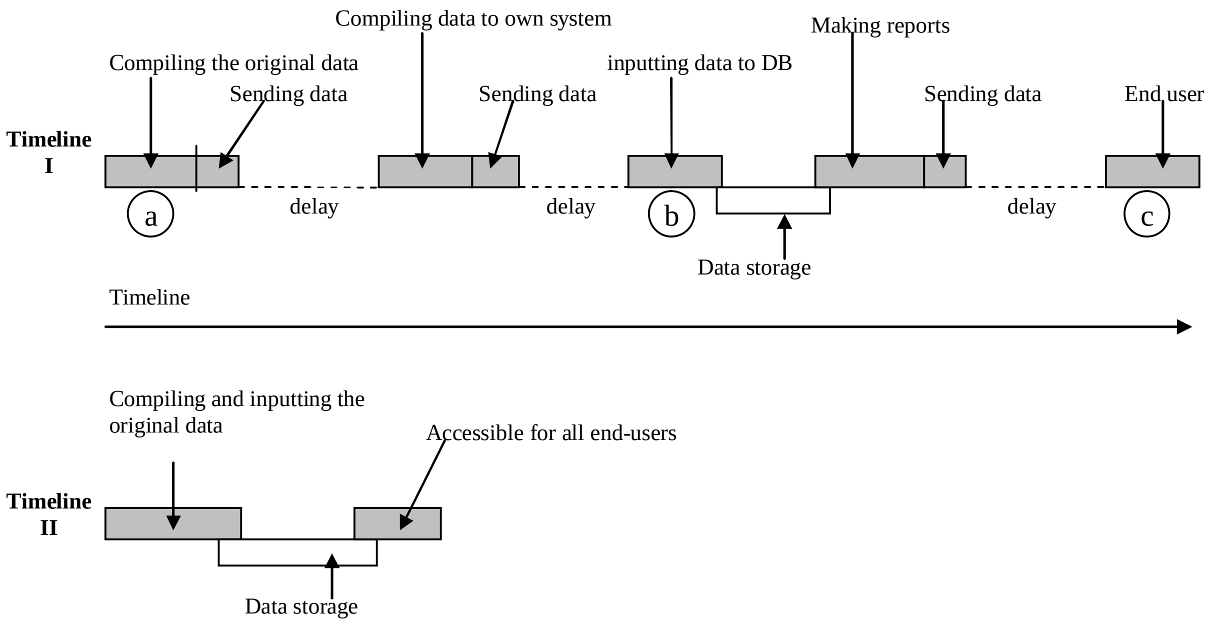


Figure 30 Information flow timeline for three port-of-calls of a vessel with and without centralized Data storage

“All users” does not naturally mean that the information would be accessible for whomever. With well-defined user-groups with varying user-right the administration can control who can input and who can view, which is not too difficult to plan and execute. The requirements for each group depend on the structure of the port community. Still, some basic guidelines can be considered, according to which official parties such as the Police, Customs, and Border Control have the most rights, and commercial actors will have access to only those modules which they will need. The integration to other related systems with fluent real-time data exchange is an important part of the data-exchange development. Problems arise from incompatible system structure such as different programming languages and database models. When the current software is widespread inside the organization, and there is no desire to create a totally new IT System, then a translator middleware is worth of consideration. The SafeSeaNet integration is not too difficult to execute as it operates purely on translator server for different ports and collects only basic information about vessels and their timetables. The following Table works as a “checklist” for all recommended solutions when developing port IT Systems.

Table 11 Checklist for essential solutions and approaches for an “ideal” port IT Systems

		Recommended solution	**Gained benefit**
Techical specifications			
	Interface	www-based	accessibility, mobility, platform independence
	Database	SQL	most common, relationality supports handled type of data, open source solutions available
	Data publihing delays	Simultaneous appearance	reduceses time-delays posed by non-office hour data-flow
	Database security	128 bit encryption	un-breakable and easy to install encryption protocoll
	Database backupping	2 separate replication databases	in problem situation no data is lost
User rights			
	User groups	3-5 groups	
	User rights	1 administration	
		2 in-house users	
		3 guest, officials	
		4 guest, closely linked companies	inputting data directly to database eliminates the need for retyping on faxes etc.
		5 visitor	all intrested actors can have information i.e. timetables etc.
System integration			
	Own organization	Fluen data-excahnge or full ERP	on-time information, reduces manual labour
	Other organizations	Open data-exchange with other liner-traffic ports	on-time information, reduces manual labour
		Open data-exchange with companies operating in the Port area	on-time information, reduces manual labour
		SafeSeaNet integration	Mandatory in few years

The three selected viewpoints (Technical issues, ERP-qualities and provided modules and Depth of system integration) executed in the target ports are compiled in the following Chart. First two are evaluated in grading system from one to three and zero representing none-existence. The latter block is assessed from one to five.

Table 12 Target Ports evaluated based on the three selected viewpoints

		Tallinn	Hamburg	Riga	Klaipeda	Stockholm	Helsinki
Technical issues							
A	Interface	0	1	2	1	1	0
B	Database security	1	3	3	N/A	1	1
C	Database backupping	N/A	3	2	N/A	3	1
D	Wireless use	1	1	2	2	2	1
E	Mobile use	0	0	1	1	1	0
The ERP-qualities and provided modules							
F	Notifications	0	2	2	2	1	1
G	Searching	2	2	2	1	3	2
H	Reporting / statistics	2	2	2	1	2	2
I	DG info	N/A	3	N/A	0	3	1
J	Segregation	0	2	N/A	0	1	0
K	Accidents	0	3	0	0	2	0
Depth of system integration							
L	Timetables	1	1	1	1	1	1
M	Cargo data	1	3	2	1*	1	1
N	Accident situations	1	2	2	1	1	1

The numbers indicate the increasing goodness of the solution

* = Klaipeda State Seaport authority has a SSN-linkage, but does not share data in other levels

Legend

N/A	Not Available			
A	0=text	1=graphic	2=platform dependable	3=web
B	0=none	1=only passwords	2=encrypted	3=password+encrypted
C	0=no backups	1= once a day	2=several times a day	3=replicated
D	0=none	1=WLAN	2=WLAN+GPRS	3=separate wireless interface
E	0=none	1=mobile phones	2=separate mobile interface	3=specific devices
F	0=manual	1=manual+EDI	2=web interface	3=automated
G	0=none	1=separate tool	2=integrated	3=integrated+guest access
H	0=none	1=separate tool	2=integrated	3=integrated+guest access
I	0=none	1=basic information	2=from separate database	3=all information
J	0=none	1=land/ship segregation	2=land+ship segregation	3=automated
K	0=no instructions	1=some instructions	2=many instructions	3=linked to rescue service
L	0=no integration	1=port level	2=Local level	3=Country level
M	0=no integration	1=port level	2=Local level	3=Country level
N	0=no integration	1=port level	2=Local level	3=Country level

The Table 12 demonstrates more clearly the dissimilarities of port DG IT Systems in the Baltic Sea Region. Hamburg and Riga have invested heavily on IT Systems in past years and their solutions represent a port-wide ERP at its best, when on the other hand the remaining four ports rely more on stand-alone applications. What was notable that Helsinki, Tallinn and Stockholm were quite pleased from the current status and only Klaipeda had larger development plans to the existing system. What is the role of mandatory SafeSeaNet notification remains to be seen. It is possible manually transfer the data between the current IT System and SafeSeaNet, but it requires much manual work. The SSN integration offers a good excuse to modify the port DG software more flexible to interact with other ports and when the used system must be developed anyhow it can be a good idea to develop it further more.

7 CONCLUSIONS

Over 300,000,000 tons of Dangerous Goods are transported in the Baltic Sea Region annually. In spite of formal implementation there are still substantial differences in operational practices between stakeholders and authorities involved in the Dangerous Goods (DG) transport. The need to improve the exchange of information between DG authorities and commercial actors, and to coordinate DG processes in the whole BSR is imminent.

Efficient IT Systems in ports diminish lead times and improve the control of inbound, stored and outbound cargo. Well designed software and systems reduce manual labor and provides essential information for all involved parties. The starting point for this study is that very little information about the port IT Systems already in use in Baltic Sea area is available. Some ports, especially in liner traffic, are known to co-operate with each other, but IT Systems are mainly country-specific and/or developed inside each port. From these hypothesizes a survey was made to examine six major BSR ports IT-systems and to find out about their characteristics and capabilities to share efficiently information between relevant actors.

One key finding was that the field of port IT Systems in major Baltic Sea Area ports is very fractured and dissimilar with each other. Most of the used software has been developed to fulfill the needs of each port. Some particular functions as well as the development has occurred over a long period of time. This incurs to a state in which many different functions or departments in the port have developed their own systems without co-operation with each other. The basic structure of a port is, that in a relatively small area there works various operators, both officials and commercial firms. On one hand, this kind of an environment can be seen as a potential breeding ground for deep integration. However, in reality everyone works on their own circle using their own IT Systems. From a corporate point of view this is understandable, since the various parties do not like to allow competitors to access their systems. On the other hand, the supervisory Port organization could easily ease their own workload by allowing other stakeholders to store data directly to their databases. The logistics theory considers the information flow equally important to the material flow. Therefore, it is unfortunate that shipping related organizations do not pay enough attention to it. Especially when transporting Dangerous Goods, the correct and sufficient information is crucial to ensure proper handling and to avoid accidents and other misuses.

Because the systems can be regarded as totally incompatible, the Ports can easily be afraid of the amount of work that the consolidation process might take, which restrains the eagerness to develop and integrate the various systems. In unofficial conversations with the decision level people was found that one major delay for connecting systems with each other was fear for revealing too much statistical data for other ports. The ports compete with each other for cargo and therefore combining IT Systems or otherwise making easier the data flow can be seen as process that improves the competitiveness of the other port as well.

The achievable cost savings, enabled by implementation of new IT System in general, depend in the long run always on the situation and accumulate slowly over a long period of time. Naturally, the high costs in the planning and implementation phase of a new IT-system might obscure the fact of economizing: it is cheaper to do nothing than buy new software and earn back the costs, for example, in ten years. One visible major factor for delaying the development progress is that the system developers are not usually involved in the handling of the logistics process. At the same time, the heavy-users are not professionals in system development. This issue can be easily solved by increasing the discussion between each party, but in a very fractured organization the users and developers do not in some cases even know each other.

The most obvious benefits for inter-organizational data exchange in this industry are the avoidance of delay and mistyped information. It is quite clear that when cargo related data including lots of numerical information is inputted many times in different systems, the possibility of error increases substantially. If and when the Port is using only one shared IT System, the cargo flow information becomes more open and the data more transparent. This improves the overall competitiveness of the whole Port when each stakeholder does not have to do manual labor to alter and/or input data again to their own systems (see Figure 30). The efficiently shared information can also improve the efficiency of the whole port, which can make it more eligible for shippers deciding which port to use to transport their cargo. Furthermore, the model of one single shared database enables accurate and correct cargo flow statistics, because the possibility of the data to change along the way is diminished.

What was notable in a nationwide examination was that only Finland has a shared IT System, called PortNet working between all the ports. PortNet is an information system aimed towards providing a national single window facility for collecting all authority notices required for ships arriving to a Finnish port or departing from a Finnish port. PortNet also distributes the information to all parties concerned, within the limits of their privileges to that information (Bäckström 2006, 1-4). PortNet is a state-of-the-art IT System capable of saving considerably amount of overlapping data entry work and provide on-time information for all required stakeholders.

All the studied ports are at least on some level developing their current systems. However, the ports tend to wait for SSN before making any major changes to their current systems. Consequently, the process of combining systems between ports has not developed as fast as it could have, which is partly consequence of the fact that The EU directive which requires the use of SSN is not mandatory yet. On the other hand it is predicted that SafeSeaNet will be fully operational at the beginning of 2008 and complete implementation of the SSN software will occur in 2011. The most modern port IT Systems already take SafeSeaNet into account, either by forming the information to suitable XML-formed data, or even exchanging data with current SSN-database. The SafeSeaNet also resolves the city- and country level data exchange problems since it can be used as information exchange server for intra-national communication as well. At the moment PortNet is the only nationwide solution in BSR that executes the data-exchange duty between authorities, ports and private companies. The upcoming PortNet2 will take the development even further as it has fully automated real time SSN interaction of Port of Calls, vessel information and timetables. The records of concurred movements of the vessel and its timetable are downloaded from all the VTS-centers so the data is very reliable and assists the port operation planning considerably. The interaction with SSN is a crucial issue to consider when developing port and maritime IT Systems since it will become mandatory in the near future. As a result of proactive IT development organizations do not need to make any larger changes when the actual implementation day arrives.

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APPENDIX 1 THE ADMINISTRATOR-SIDE QUESTIONNAIRE

Background issues:

- When the system is created?
- Is it part of some other system / linked to other systems / individual system
- Current version
- Security of the system
- Encryption issues

Hosting and maintenance:

- Hosted in the house or outsourced?
- Updates
    - How often do you have to make updates
- The physical location of the database
- Backupping

Database issues:

- MYSQL, SQL, ACCESS, Oracle, PostgreSQL…

Programming language issues:

- html, xhtml, dhtml, asp, php…

Wireless / remote use:

- Possibilities to use software wireless
- Data transfer solutions
- Future plans to develop the software in this area
- Used techniques

APPENDIX 2 THE USER-SIDE QUESTIONNAIRE

General issues:

- User interface
  - What does it look like?
  - Graphic- / textbased
  - User friendliness
  - Improvements (coming in the near future)
- Up-to-date
  - How often new versions appear
- Pace of updating
  - Is the information all the time up-to-date?
  - Are there any delays of the info / how long?
- Reports
  - Is it easy to print reports out?
  - What kind of reports are possible
    - Timeframe
    - Based on type of cargo (Dangerous Goods / normal cargo)
- Making searches
- Linking to other systems
  - Is it part of some other system
  - Maritime system
  - Highway system
  - Railway system
  - Other system used in the port area
  - Other authority systems
- Access
  - Who have access to the system?
  - Are there different user access levels?

The DG arrival in port area:

- How and where does the port get information about the incoming DG-cargo (in case of mixed cargo)
- Preliminary actions before the arrival (in case there is large quantities of DG-cargo)

The storage of DG cargo in port area:

- Is DG stored separated from normal cargo?
  - Different substances and how they react with each other
- Where are they stored (safety areas)?
- Surveillance during storage
  - Does the system enable surveillance during storage?
  - Does the system enable information about:
    - Who owns the cargo?
    - Where is the cargo going?
    - Who handles the cargo in port area?

The Handling of DG cargo in port area:

- Who can handle the cargo in port?
- Data from the movements:
  - Wireless systems
- Measures during handling

The DG departure from port area:

- Open discussion

Accident situations:

- Open discussion

APPENDIX 3 VESSEL REPORTING FORM (SWEDISH MARITIME ADMISTRATION)

SJÖFARTSVERKET

SWEDISH MARITIME ADMINISTRATION

FARTYGSANMÄLAN (FRS)

Vessel Reporting System (VRS)

Fartygets namn: *Ship name:*	Fartygets anropssignal: *Call sign:*	Fartygets IMO nummer: *Ships IMO number:*
Fartygstyp: *Ship type:*	Fartygets MMSI nummer: *Ships MMSI number:*	
ANKOMST TILL SVERIGE *ARRIVAL AT SWEDEN*		
Hamn eller ankarplatsområde: *Port of call or area for anchorage:*	Antal personer ombord: *Total number of persons on board:*	
ETA (ÅÅMMDD) (Tid): *(YYMMDD) (Time):*	ETD (ÅÅMMDD) (Tid): *(YYMMDD) Time:*	

LOTSUPPGIFTER

PILOTAGE INFORMATION

Lotspliktig fartyg ***Mandatory Pilotage***	Avser beställa lots: Ja/Yes ☐ Nej/No ☐ *Will request pilot:*	Farledstillståndnr.: *Pilot exemption no:*
Ej lotspliktig fartyg ***Non-mandatory Pilotage***	Avser beställa lots: Ja/Yes ☐ Nej/No ☐ *Will request pilot:*	
Aktuellt djupgående: *Actual draught:*	Kontaktperson för lotsuppgifter: *Contact person:*	
Föregående hamn eller ankarplatsområde: *Last port of call or area for anchorage:*	Nästa hamn eller ankarplatsområde: *Next port of call or area for anchorage:*	
Namn på anmälaren: *Name of the notifier:*	Telefonnummer: *Telephonenumber:*	
Anledning till faxrapportering istället för via FRS webb *The reason for sending facsimile to VTS Luleå, instead of using the FRS/VRS web:*		

Sänd detta dokument till VTS Luleå, Telefaxnr: 0920255306

Please send this document to VTS Luleå on telefaxnumber: +46920255306

Skriv ut **Töm formulär**

APPENDIX 4 LIST OF INTERVIEWEES

Klaipeda State Seaport Authority
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Stockholm Ports
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Port of Tallinn
Date: 22.11.2006
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Title: Head of IT-department
t.laanamae@ts.ee

The Finnish Maritime Administration
Date: 18.12.2006
Contact: Antti Arkima

Estonian Maritime Administration
Date: 22.11.2006
Contact: Jaak Arro
Title: Head of Dangerous Goods Section, Ship Supervision Department

Port of Helsinki
Date: 18.12.2006
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DAKOSY (Hamburg)
Datenkommunikationssystem AG
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Date: 31.11.2006
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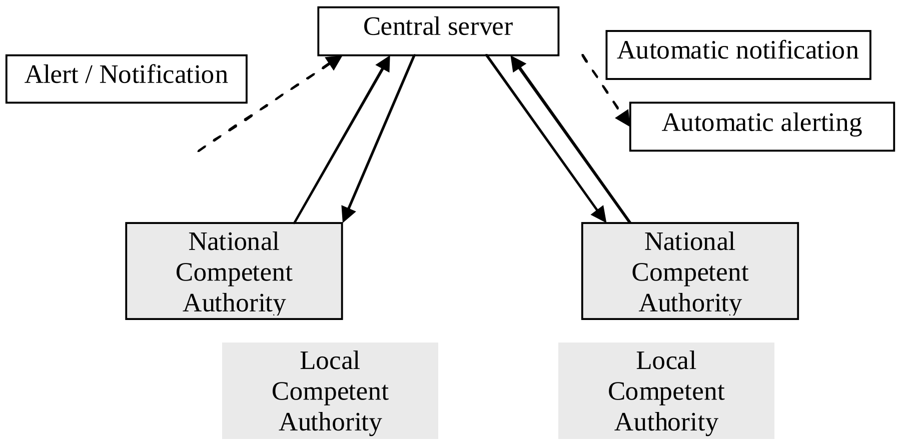
APPENDIX 5 A EUROPEAN PLATFORM FOR MARITIME DATA EXCHANGE: SAFESEANET

The following text is based on the Antti Arkima, interview 18.12.2006; Electronic Reporting to the Swedish maritime Administration 6/2004; SafeSeaNet Information bulletin nos.1,2,3,4 and SafeSeaNet User Manual Ver. 1.8.

The SafeSeaNet system has been designed and developed in response to the requirements of EU maritime safety legislation (Directive 2002/59) and is linked to port waste reception and Port State Control initiatives. The SSN Central Index acts as a secure “yellow pages” type index, which supports the exchange of data between users who are either identified as data providers or as data requesters. The Local Competent Authorities i.e. port, VTS, coastal station, MRCC, as data providers, should notify SSN, as a data requester, when information has been received on a particular ship. Messages are exchanged by XML format and secured by two-way SSL-protocol which provides secure communications over the Internet and other data transfers.

The data stored in the SSN-system contains information about ships and their movements, estimated times of arrival in ports and cargoes. The index-server works as transmitter of the detailed data between ports, which are sent by AIS-messages. The AIS messaging is an efficient tool to track the movements of the ships at sea.

Currently the system is operational in Norway, Lithuania and Netherlands, but all European Union member countries are more or less ready to take SSN in use when EU decides the final full implementation day, which is estimated to occur sometimes between years 2010 – 2011. In December 2006 only Norway is providing cargo information of the system and others send only AIS-messages. Current operational version is 1.8, but the test phase of 1.9 will begin soon. Basic concept of the SafeSeaNet system is illustrated in the below Figure.



The concept of the SafeSeaNet

The system is a network/Internet solution based on the concept of a distributed database. Once fed into the SafeSeaNet system, data does not have to be transferred, copied or duplicated.

The SafeSeaNet system keeps track of the data location, through a so-called Central Index which stores pointers (references) to the actual data location. Access is provided to the authorized persons via well-defined messages. Whenever access to the data is needed by one of the participants, this data can be requested through a well-defined message, and the SafeSeaNet system will locate it. The system will then retrieve the data from wherever it is stored and present it to the requester, again in a well-defined message.

The Members States are involved in the system through different authorities:

- National Competent Authority (NCA): Body designated by Member States responsible for the management of the system at national level. It co-ordinates all required action with the objective of complying with the specification described in the Interface Control Document.

The NCA is the only national authority in contact with the European Union Institutions for matters related to SafeSeaNet and as such it takes part in the management and development of the system at EU level by participating in periodical review. The NCA is also responsible for designating their associated Local Competent authorities and delivering and maintaining their access right to the SafeSeaNet network. The NCA may or may not be involved in handling and exchanging SafeSeaNet messages related to maritime safety and the traffic-monitoring directive.

- Local Competent Authority (LCA) are all the local stakeholders involved in the handling of maritime information. They are designated by their NCA for participation in the SSN network and include Port authorities, Coastal Stations, Vessel Traffic Service, shore-based installations responsible for mandatory reporting systems approved by the IMO, or bodies responsible for coordinating search and rescue operations.

The central server produces notifications and alerts on request or automatically. The alerts can be i.e. Ship reporting (shiprep), Pollution reporting (polrep) or even waste- or navigation route violations.

APPENDIX 6 PORTNET - THE FINNISH MARITIME ADMINISTRATION TRAFFIC DATA SYSTEM

The following text is based on the information packages made by Finnish Maritime administration mainly compiled by Mr. Rolf Bäckström.

PortNet is an information system aimed towards providing a national single window facility for collecting all authority notices required for ships arriving to a Finnish port or departing from a Finnish port. PortNet also distributes the information to all parties concerned, within the limits of their privileges to that information.

The PortNet system is presently managed by the Finnish Maritime Administration, but is owned by the PortNet community. The core content of the PortNet system is operative timetable information and cargo information regarding ship traffic. All other information and services are derivatives of or attributes to this base information.

The availability is at present 24h/7d, but the support level is at present only 8h/7d. This is going to change within a few years. In spite of this, the user availability achieved has been quite high. PortNet can be found at the web portal of PortNet, www.portnet.fi. A number of different applications including PortNet can be accessed through this portal. To use these applications requires registration, but full access privileges are not issued to anybody but authorities. Timetables, however, may be accessed without any registration through the Inter-modal Portal, found in the application list of the PortNet portal. Also the all important Customs reference number is shown. It is issued individually for every port call and has to be used in all dealings with the Custom's throughout that particular port call.

Information stored in PortNet is used by all authorities mentioned in the law about maritime security: Maritime Administration, Frontier Guard, Custom's, Marine defense forces and the ports. The information is also used by the Ministry of Agriculture, as an information source for inspections of imported food stuff and vegetables.

All those who give information into PortNet may freely look at their own information in PortNet and print out reports accordingly.

All notices may be input using the web-interface of PortNet. An increasing amount of notices are sent using XML or Edifact file transfer. Future developments strongly sup-port the use of XML file transfers. File transfer documents are usually confirmed by the user to be correct using the web interface. Notices into PortNet are input by ship representatives, ship owners, goods handlers and ports.

All the messages listed above are of course a part of the PortNet services structure, but there is more. The timetable facility has to be seen as a set of different times, from different sources: e.g. advance ETA/ETD, updated ETA/ETD (several sources) and finally ATA/ATD (formal). The providers of that information are the ship agents, the ship captains, the pilots, ice breakers, VTS and the ports.

The nationwide AIS base station network is shortly going to be connected to PortNet and AIS-information is going to be automatically matched and connected to port calls, even if that in some cases may cause mismatch problems. In most cases it will be possible to estimate the ship arrival times with close to minute accuracy.

It is logical to conclude, that a departure notice in a Finnish port could ideally constitute an identical arrival notice in the destination port of another BSR country. FMA has tried to resolve the problem and to find interested collaboration partners within BSR. It has become painfully evident that there are several severe problems involved. Establishment of a PortNet system requires a seamless co-operation between several authorities and agreement about sharing information and mutual trust. This seems to be particularly difficult to establish on voluntary grounds. An effort in that direction is now in progress within the EU BaSIM project, where the aim is to establish three collaboration projects. The other party is probably going to be just ports, as the project time frame does not give time to wait for the establishment of a countrywide PortNet system in any of the Partner BSR countries. Denmark has already created a national PortNet community and has decided to build a national PortNet system within a few years. Also Norway has good potential, provided that the present internal two-prong collaboration develops into one.

The EU MARNIS project also addresses the problem but does not and cannot address the issue about authority co-operation but concentrates on the technical solution. Another logical possibility would be that EU would take the initiative and assume the responsibility of developing the idea on EU-scale. The problem within the EU Commission is, however, precisely the same as in the member countries. Maritime safety, security and logistic issues are handled by different entities within the Commission, who possibly do not have the ability and vision to see the advantages of a common process over Directorate and entity borders.

The Finnish Maritime Administration does not pursue the idea about creating a single EU-wide PortNet system. A cluster of autonomous national PortNet-systems exchanging relevant information, however, would be the ideal solution. An interoperable sys-tem is perhaps easier to build up than an integrated one.

The present PortNet has been in production since year 2000. Although it has served well, the amount of traffic it handles has exceeded all expectations. The system has been updated several times but it has been realized that it is time for major overhaul. A new PortNet project has been initiated called PortNet 2. From 2008 the system is going to be 100% government owned and financed as well as supported with a 24h/7d regime.