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MERENKULKUALAN KOULUTUS- JA TUTKIMUSKESKUKSEN JULKAISUJA

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E-PORT

Improving efficiency of Finnish port community by intelligent systems

Final report of the Mobile Port project

Antti Posti (ed.)

Euroopan unioni
Euroopan aluekehitysrahasto

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FOREWORD

The management of port-related supply chains is challenging due to the complex and heterogeneous operations of the ports with several actors and processes. In order to improve the information exchange of the port-related supply chains, many ports around the world have developed port community systems (PCS) to serve the information exchange of the port community comprehensively.

This is the final report of the Mobile port (MOPO) project which has sought ways to improve the management and control of port-related sea and inland traffic with the aid of ICT technologies. The project has studied port community systems used worldwide, evaluated the suitability of a PCS for the Finnish port operating environment and created a pilot solution of a Finnish PCS in the port of HaminaKotka. Further, the dry port concept and its influences on the transportation system have been explored.

During the Mobile Port project, a development community for the Portconnect service was established to support and steer the development of the Finnish PCS. The community will further develop the system together with the service provider.

The partners of the project have been the University of Turku, Centre for Maritime Studies, Maritime Logistics Research unit; the Kymenlaakso University of Applied Sciences and the Lappeenranta University of Technology Kouvola unit. The Mobile port project has been funded by European Regional Development Fund (ERDF) and the Finnish Funding Agency for Technology and Innovation (Tekes) and the following companies: Cursor Oy, Port of HaminaKotka Ltd (formerly Port of Kotka Ltd), KYMP Oy, SE Mäkinen Logistics, Steveco Oy, Suomen 3C Oy, Oy TransPeltola Ltd and VR Group.

The partners of the Mobile port project also would like to thank M.Soc.Sc. Tapio Karvonen and Ph.D. Jani Häkkinen for reviewing the report, and other parties who have contributed to the drawing up of this report.

Kotka 10th January, 2012
Ulla Tapaninen
Professor
Centre for Maritime Studies

THE FINANCIERS OF THE MOBILE PORT PROJECT

European Union
European Regional Development Fund

Leverage from the EU 2007–2013

Tekes

cursor

PORT OF HAMINAKOTKA

STEVECO

VR

SE Makinen LOGISTICS

TRANSPELTOLA Oy Ltd

KYMP FINNET

CCC

THE PARTNERS OF THE MOBILE PORT PROJECT

CENTRE FOR MARITIME STUDIES

Kymenlaakson ammattikorkeakoulu
University of Applied Sciences

Open your mind. LUT.
Lappeenranta University of Technology

MERI KOTKA

ABSTRACT

The management of port-related supply chains is challenging due to the complex and heterogeneous operations of the ports with several actors and processes. That is why the importance of information sharing is emphasised in the ports. However, the information exchange between different port-related actors is often cumbersome and it still involves a lot of manual work and paper. Major ports and port-related actors usually have advanced information systems in daily use but these systems are seldom interoperable with each other, which prevents economies of scale to be reached. Smaller ports and companies might not be equipped with electronic data transmission at all.

This is the final report of the Mobile port (MOPO) project, which has sought ways to improve the management and control of port-related sea and inland traffic with the aid of ICT technologies. The project has studied port community systems (PCS) used worldwide, evaluated the suitability of a PCS for the Finnish port operating environment and created a pilot solution of a Finnish PCS in the port of HaminaKotka. Further, the dry port concept and its influences on the transportation system have been explored.

The Mobile Port project comprised of several literature reviews, interviews of over 50 port-related logistics and/or ICT professionals, two different kinds of simulation models as well as designing and implementing of the pilot solution of the Finnish PCS. The results of these multiple studies are summarised in this report. Furthermore, recommendations for future actions and the topics for further studies are addressed in the report.

The study revealed that the information sharing in a typical Finnish port-related supply chain contains several bottlenecks that cause delays in shipments and waste resources. The study showed that many of these bottlenecks could be solved by building a port community system for the Finnish port community. Almost 30 different kinds of potential services or service entities of a Finnish PCS were found out during the study. The basic requirements, structure, interfaces and operation model of the Finnish PCS were also defined in the study. On the basis of the results of the study, a pilot solution of the Finnish PCS was implemented in the port of HaminaKotka. The pilot solution includes a Portconnect portal for the Finnish port community system (available at https://www.portconnect.fi) and two pilot applications, which are a service for handling the information flows concerning the movements of railway wagons and a service for handling the information flows between Finnish ports and Finland-Russian border. The study also showed that port community systems can be used to improve the environmental aspects of logistics in two different ways: 1) PCSs can bring direct environmental benefits and 2) PCSs can be used as an environmental tool in a port community.

On the basis of the study, the development of the Finnish port community system should be continued by surveying other potential applications for the Finnish PCS. It is also important to study if there is need and resources to extend the Finnish PCS to operate in several ports or even on a national level. In the long run, it could be reasonable to clarify whether there would be possibilities to connect the Finnish PCS as a part of Baltic Sea wide, European-wide or even worldwide maritime and port-related network in order to get the best benefit from the system.

TIIVISTELMÄ

Satamasidonnaisten toimitusketjujen hallinta on haasteellista toimijoiden ja prosessien heterogeenisyydestä johtuen. Erityisesti informaatiovirtojen hallinnan merkitys korostuu monitahoisessa satamatoimintaympäristössä. Satamasidonnaisten toimijoiden välinen tiedonvälitys on kuitenkin valitettavan usein hankalaa pitäen sisällään paljon manuaalista työtä ja paperisia dokumentteja. Suurimmilla satamilla ja toimijoilla on usein käytössään kehittyneitä informaatiojärjestelmiä, mutta eri järjestelmät ovat harvoin yhteensopivia keskenään, mikä heikentää mittakaavaetujen saavuttamista. Pienillä satamilla ja toimijoilla ei ole välttämättä käytössä lainkaan tietojärjestelmiä, jolloin toimintoja joudutaan hoitamaan manuaalisesti perinteisiä tiedonvälitystapoja käyttäen.

Tämä on Mobiilisatama (MOPO) -hankkeen loppuraportti. Mobiilisatama-hankkeessa on etsitty keinoja satamasidonnaisen meri- ja maaliikenteen hallinnan parantamiseksi älykkään liikenteen avulla tieto- ja viestintäteknologioita hyödyntäen. Tutkimuksessa on selvitty maailmanlaajuisesti käytössä olevia sataman informaatiokeskusratkaisuja (Port Community System, PCS), arvioitu PCS-järjestelmän soveltuvuutta Suomen satamatoimintaympäristöön ja kehitetty pilot-ratkaisu Suomen PCS-järjestelmästä HaminaKotkan satamaan. Hankkeessa on lisäksi tutkittu kuivasatamakonseptia ja sen vaikutuksia kuljetusjärjestelmään.

Mobiilisatama-hankkeessa on tehty useita kirjallisuusselvityksiä, haastateltu yli 50 satamasidonnaista logistiikka- ja ICT-alan asiantuntijaa, luotu kaksi erilaista simulaatiomallia kuivasatamakonseptista sekä suunniteltu ja kehitetty pilot-ratkaisu Suomen PCS-järjestelmästä. Näiden tutkimusvaiheiden tulokset on koottu tässä raportissa yhteen. Lisäksi raportissa annetaan suosituksia jatkotoimenpiteille ja jatkotutkimusaiheille.

Tutkimuksen mukaan satamasidonnaisessa tiedonvaihdossa on havaittavissa pullonkauloja, jotka paitsi hidastavat tavaratoimitusten käsittelyä myös kuluttavat turhaan resursseja. Tutkimustulokset osoittavat, että useimmat näistä pullonkauloista olisi mahdollista ratkaista kehittämällä Suomen satamatoimintaympäristöön PCS-järjestelmä. Tutkimuksessa löydettiin lähes 30 erilaista Suomen PCS-järjestelmään soveltuvaa palvelua tai palvelukokonaisuutta. Tutkimuksessa määriteltiin myös Suomeen soveltuvan sataman informaatiokeskuksen perusvaatimuksia, rakennetta, rajapintoja ja toimintamalleja. Tutkimuksessa saatujen tulosten pohjalta Suomen PCS-järjestelmästä tehtiin HaminaKotkan satamaan pilot-ratkaisu, joka pitää sisällään Portconnect-portaalin (https://www.portconnect.fi) sekä kaksi todellisiin tarpeisiin vastaavaa sovellusta, vaununvaihtosovelluksen ja rajaliikennepalvelun. Tutkimus osoitti myös sen, että sataman informaatiokeskus voi tuoda mukanaan suoria ympäristöhyötyjä (esim. turhien ajosuoritteiden väheneminen). Järjestelmää voidaan hyödyntää myös ympäristötyökaluna.

Tutkimusprojekti osoitti, että Suomen PCS-järjestelmän kehittämistä kannattaa jatkaa myös tulevaisuudessa tutkimalla muita potentiaalisia sovelluksia järjestelmälle. Jatkossa on tärkeää selvittää, onko tarvetta ja resursseja laajentaa järjestelmää toimimaan useassa satamassa tai kansallisella tasolla. Pitkällä aikavälillä on syytä selvittää, onko Suomen PCS-järjestelmän kytkeminen osaksi Itämeren, Euroopan tai jopa maailmanlaajuista meri- ja satamasidonnaista verkostoa mahdollista ja tarkoituksenmukaista.

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1 INTRODUCTION

1.1 Background

About 80 % of all the world trade is transported by sea (UNCTAD, 2009). This is why ports are vital parts in global supply chains. The efficiency of the ports will become even more important when environmental regulations and increasing fuel prices will slow down the speed of sea transport and the efficiency of maritime transport has to be sought in ports. The management of port-related supply chains is challenging due to the complexity of operations and heterogeneous actors in the ports (Pulli et al. 2009).

Information sharing is a key component for successful supply chains. It provides the basis for the controlling of logistics-related operations and for seamless supply chain integration (Tapaninen et al. 2010). Information in the supply chains is used to prevent uncertainty that is related to lead times, capacity availability and product quality (Ketzenberg et al. 2006). Information sharing improves supply chain coordination, reduces a bullwhip effect, decreases supply chain costs, and makes it possible to respond to changing customer needs more quickly (Ketzenberg et al. 2006; Li and Lin 2006). Information shared in the supply chain has to be of good quality. This contains aspects such as accuracy, adequacy, completeness, credibility, accessibility, compatibility between users and timeliness (Monczka et al. 1998). The most gain from information sharing is achieved when every actor in the supply chain contributes to information exchange and a full transparency in the chain can be attained (Posti et al. 2011a; Pulli et al. 2007a). Any bottlenecks in information exchange are reflected to the whole supply chain (Inkinen et al. 2009).

The importance of information sharing is emphasised in the ports where multiple transport modes, shipments and actors are present. The information exchange between different port-related actors is often cumbersome and it still involves a lot of manual work and paper. Major ports and port-related actors usually have advanced information systems in daily use but these systems are seldom interoperable with each other, which prevents economies of scale to be reached. Smaller ports and companies might not be equipped with electronic data transmission at all. Generally at each port call, the same data has to be entered several times and often manually, which may cause errors and delays and waste resources (e.g. Baltzersen et al. 2009; Kondratowicz et al. 2007; Pulli et al. 2007b; PORTEL 2009). Studies (e.g. van der Horst & de Langen 2008; Pulli et al. 2007b; Pulli et al. 2008) have also shown that port-related actors do not get all the information they need in their activities.

In order to improve the information exchange of the port-related supply chains, many ports around the world have developed port community systems (PCS) to serve the information exchange of the port community comprehensively. When using a PCS, there is ideally no need for bilateral communication and multiple communication methods between various parties because every port-related actor sends its information to the central system that can be accessed by other actors to get the information they need (Smit 2004). PCSs offer the users a single window based solution for information sharing, which makes it possible to lodge standardised information and documents with a

single entry point so that individual data elements should only be submitted once (UN/CEFACT 2005). Port community systems make it possible to decrease clerical and paperwork, improve information quality, enable data integrity among different port-related parties, enhance delivery times and make the port offering such a system easier to use and, therefore, more attractive to existing and potential users (e.g. Keceli et al. 2008; Long 2009; Vincent 2003).

In Finland, there is a national vessel traffic information system called PortNet for information exchange towards authorities. The PortNet has some features that are typical for port community systems. However, the PortNet cannot be considered as a port community system since it lacks business-to-business interactions. There are some bottlenecks concerning the port-related information exchange of the Finnish port community. The potential benefits of port community systems are so promising that there is a real need to study whether these information exchange bottlenecks could be solved by developing a port community system in the Finnish port community. The existing port community systems are designed especially for large container ports (Dębicka 2011; Posti et al. 2011b; Posti et al. 2010). The question arises: is it possible to apply a PCS in smaller ports, such as Finnish ports, as well and what kind of features and services this kind of system could include? It is also important to know whether a PCS could be used as a way to improve environmental aspects of logistics and what kind of role the dry port concept could have in this context.

1.2 Mobile Port project

The Mobile Port (MOPO) project has sought ways to improve the management and control of port-related sea and inland traffic with the aid of information and communication technologies. The project has studied the port community systems used worldwide, evaluated the suitability of a port community system for the Finnish port operating environment and created a pilot solution of a Finnish port community system in the port of HaminaKotka. Further, the dry port concept and its influences on the transportation system have been explored.

The Mobile project has been scheduled to be carried out between September 2009 – June 2012. The partners of the project have been the University of Turku, Centre for Maritime Studies, Maritime Logistics Research unit; the Kymenlaakso University of Applied Sciences and the Lappeenranta University of Technology Kouvola unit. The Mobile port project has been funded by European Regional Development Fund (ERDF) and the Finnish Funding Agency for Technology and Innovation (Tekes) and the following companies: Cursor Oy, Port of HaminaKotka Ltd (formerly Port of Kotka Ltd), KYMP Oy, SE Mäkinen Logistics, Steveco Oy, Suomen 3C Oy, Oy TransPeltola Ltd and VR Group. The Mobile Port project consisted of the following 5 research work packages (WP1–WP5):

- **WP1 – Process descriptions and environmental impacts**
  The aim of work package 1 was to make a summary of port-related cargo shipment processes and to discover possible bottlenecks of these processes, to make

a survey of port community systems (PCS) used in different countries and ports around the world, to examine the suitability of PCS for Finnish port environment, and to evaluate potential environmental impacts of the Finnish PCS. The work package provided a basis and a framework for other work packages of the project. Making of the summary report that combined the results of the Mobile Port project was also one of the objectives of work package 1. The work package was implemented by the University of Turku, Centre for Maritime Studies.

- **WP2 – Port processes and the Finnish PCS**
  A description of the Finnish port community system and its interfaces was conducted in work package 2. The future demand for port-related information services in Finland and the potential users and the responsible organisation of these services were clarified. Implementation alternatives and costs of the Finnish PCS were also examined. The work package was implemented by the University of Turku, Centre for Maritime Studies and by the consulting company Talent Partners Oy.

- **WP3 – Case: Developing the dry port concept for Kouvola**
  In work package 3, the functionality of Kouvola's dry port concept was simulated, and the dry port concept and the traditional port-related supply chain were compared. Further, the environmental effects of the dry port concept and the information exchange demands in dry ports were studied in this work package. The work package was implemented by the Lappeenranta University of Technology, Kouvola Unit.

- **WP4 – Mobile communications**
  In work package 4, the network-technical possibilities that can be used to transmit WP5's piloted data to the vehicles were studied. The solutions that are based on wireless communication and their use for positioning purposes were also developed and tested. In addition, the suitability of these solutions for cross-border queuing between Finland and Russia was analysed. The work package was implemented by the Kymenlaakso University of Applied Sciences.

- **WP5 – Piloting a Finnish port community system**
  A pilot solution for a Finnish port community system was implemented and operated in work package 5. Information about the functionality and further development needs of the system was also gathered. Furthermore, this work package aimed to find a cooperation partner who wants to continue the developing of the Finnish PCS after the Mobile Port project has ended. The work package was implemented by the Kymenlaakso University of Applied Sciences.

1.3 Purpose and structure of the report

The Mobile Port project has comprised of several literature reviews, interviews of over 50 port-related logistics and/or ICT professionals, two different kinds of simulation models as well as designing and implementing of the pilot solution of the Finnish port

community system. All the publications produced in the Mobile Port project are presented in Appendix 1. The results of these multiple studies are summarised in this report. Furthermore, recommendations for future actions and the topics for further studies are addressed in the report.

In the report, the results of the Mobile Port project are introduced through work packages. First, chapter 2 introduces the main results of the Mobile Port project's work packages 1 and 2, in which Finnish port-related information exchange and ICT systems, basics of port community systems (PCS), suitability of a PCS for the Finnish port environment and potential environmental impacts of a PCS were examined. Chapter 3 introduces the main results of the Mobile Port project's work packages 4 and 5, in which a pilot solution of a Finnish port community system was created and mobile communications related to the pilot system were studied. Chapter 4 presents the main results of the Mobile Port project's work package 3, in which a dry port concept and its financial impacts, cost-efficiency and environmental impacts were studied. Finally, the results of the Mobile Port project are summarised in chapter 5, and recommendations for future actions and the topics for further studies are discussed in chapter 6.

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2 PORT COMMUNITY SYSTEMS AND THEIR SUITABILITY FOR THE FINNISH PORT ENVIRONMENT

Antti Posti, Jani Häkkinen, Olli-Pekka Brunila and Ulla Tapaninen from the University of Turku, Centre for Maritime Studies, Maritime Logistics Research unit

This chapter presents the main results of the study concerning port community systems and their suitability for the Finnish port environment. The study was conducted in four stages. The First, second and fourth stage of the study were implemented by the University of Turku, Centre for Maritime Studies and the third stage of the study by the University of Turku, Centre for Maritime Studies with the help of subcontracting work by the consulting company Talent Partners Oy.

In the first stage of the study, the present state of port-related information sharing and systems in Finland was examined. The results of this stage are based on a literature review, a port related cargo shipment process description and an interview study where in total 17 logistics and ICT experts from 9 organisations operating in South Finland were interviewed.

In the second stage of the study, a literature review of port community systems (PCS) and an Internet survey of port community systems used in different countries and ports around the world were conducted in order to get information on potential features, service content, operating methods and benefits of PCSs. On the basis of these results, the suitability of a port community system for the Finnish port environment was evaluated and discussed.

In the third stage of the study, a description of the Finnish port community system and its interfaces was prepared. The future demand of port-related information services in Finland and the potential users and the responsible organisation of these services were also clarified. In addition, implementation alternatives and costs of the Finnish PCS were examined. The results of this stage of the study are based mainly on the interview study where in total 18 logistics and ICT experts from 13 organisations operating in Finland were interviewed.

The fourth stage of the study concentrated on environmental aspects of logistics and port community systems. The main aims of this research stage were to clarify the present state of environmental impacts caused by logistics in Finland and the Kymenlaakso region and evaluate potential environmental benefits of a port community system in the Finnish port environment. The results of this stage of the study are based mainly on the calculations of logistics' environmental impacts and a literature review.

The structure of this chapter is as follows. First, section 2.1 introduces the present state of port-related information sharing and systems in Finland. In sections 2.2 and 2.3, the results of the literature review and the survey of port community systems (PCS) are presented. In section 2.4 and 2.5, the suitability of a PCS for Finnish port environment and potential environmental impacts of the Finnish PCS are discussed. Finally, the results of the study are summarised and concluded in section 2.6.

2.1 Present state of port-related information sharing and systems in Finland

The study revealed that information systems and services used in Finnish ports are quite advanced (see more in Appendix 2). The examples of Finnish maritime and port-related information systems are: the nationwide vessel traffic information system PortNet for company-authority information exchange, mandatory ship reporting system GOFREP, traffic information system IBNet for icebreaking purposes, an enterprise resource planning system Port Data System for port authorities and Visy Gate – an automated access and area control system used in several Finnish ports. In addition, port-related actors use commercial information systems that are usually tailored to meet the needs of each company. Port operators and forwarding companies operate between the sea and land side and, therefore, they also have a central role in the exchange of port-related information. Smaller companies may not have their own sophisticated information systems but they may have connections to the larger companies' systems. Small companies also make extensive use of traditional bilateral communication ways (e.g. paper documents, telephone, fax, and e-mail).

Despite the quite advanced information systems and services, information sharing in a typical Finnish port-related supply chain has several bottlenecks that cause delays in shipments and waste resources. The process description of a port-related cargo shipment and the interviews made as a part of the study revealed that the main reasons behind these bottlenecks are the extensive use of traditional bilateral communication methods, the large number and diversity of documents/messages (the same data must be entered many times in several places) and the incompatibility of information systems of different port-related actors. The practices and requirements also vary between different actors, ports and states, which causes problems in the information exchange. Further, the information systems and services used in Finnish ports are quite scattered from the users' point of view. They are also more or less orientated to serve the needs of the authorities in the maritime environment while less attention is paid to the landside transportations and the business needs of companies. Below are presented some bottlenecks and targets of development that emerged during the interviews concerning the Finnish port-related information exchange and systems:

- paper documents should be replaced with corresponding electronic documents
- exception information (e.g. delays of the vessels) should be transmitted to all parties who may need the information
- information exchange service operating round the clock (24/7) would be useful
- information exchange should be more objective and real-time
- information sharing between landside companies and ports should be improved
- web forms should be used more widely
- general instruction of the port and port-related actors should be harmonised
- service times, address information and other general information of the ports and port-related actors should be more readily available
- importance of single window solutions should be emphasized and the re-entering of data should be got rid of
- lead times of ports should be shortened
- development of customs queuing system in order to avoid truck queues.

The present state of port-related information sharing and systems in Finland are described in more detail in the research report by Posti et al. (2010).

2.2 Literature review of the port community systems

A literature review of the port community systems (PCS) was made as a part of the study. The aim of the literature review was to survey existing studies on port community systems and in so doing provide an overview of the port community systems. The studies were mainly searched using numerous electronic article databases and a web search engine.

The literature review revealed that even though many ports around the world have developed port community systems to comprehensively serve the information exchange of the port community, there are only a limited number of comprehensive studies about port community systems. A summary of the main studies related to PCSs is given in Table 2.1.

Table 2.1 Studies on port community systems.

Author(s)	Objectives of the study
Aksentijević, Tijan & Hlaća 2009	The article outlines information security principles that should be accounted for during creation of port community systems.
Keceli, Choi, Cha & Aydogdu 2008a; 2008b	The papers examine the factors affecting PCS acceptance and adoption by the sea and land carrier companies located in the Busan port region.
Keceli, Choi, Cha, Aydogdu & Kim 2008c	The paper evaluates several technical aspects of Korea's national port community system PORT-MIS from the users' point of view.
Long 2009	The article traces the history of the Felixstowe Port Community System in order to provide an insight into the benefits that can be achieved by both Government and the trade, transport and logistics communities.
PORTEL 2009	The study develops an inventory of the reporting transactions carried out by European Sea Ports using their electronic data processing systems (including port community systems).
Rodon & Ramis-Pujol 2006	The paper provides understanding on the intricacies associated with the integration of firms with a business sector information infrastructure (BSII) such as a port community system.
Smit 2004	The thesis analyses the port community system of the ports of Antwerp, Hamburg and Rotterdam based on architecture and compares these three PCSs to find differences and similarities.
Srour, Oosterhout, Baalen & Zuidwijk 2007	The article documents lessons learned within each life cycle stage as derived from an international scan of port community system deployments.
Tijan, Kos & Ogrizović 2009	The paper presents the structural analysis of port community systems. Emphasis is put on information security within the PCS. The role of PCSs in disaster recovery is discussed in detail.

Port community system (PCS) can be defined as a holistic information hub that seamlessly integrates a heterogeneous collective of port-related actors electronically into a

global transportation network in order to enable the efficient exchange of relevant logistics information and to ensure smooth flow of shipments from cargo origin to destination (adapted from PORTEL 2009; Rodon & Ramis-Pujol 2006; Srour et al. 2007; Tijan et al. 2009). When using a PCS, there is ideally no need for bilateral communication and multiple communication methods between various parties because every port-related actor sends its information to the central system that can be accessed by other actors to get the information they need (Smit 2004). PCSs offer the users a single window based solution for information sharing, which makes it possible to lodge standardised information and documents with a single entry point so that individual data elements should only be submitted once (UN/CEFACT 2005). Port community systems make it possible to decrease clerical and paperwork, improve information quality, enable data integrity among different port-related parties, enhance delivery times and make the port offering such a system easier to use and, therefore, more attractive to existing and potential users (e.g. Keceli et al. 2008a; Long 2009; Vincent 2003). Figure 2.1 demonstrates the difference between traditional communication in a port and communication with a port community system.

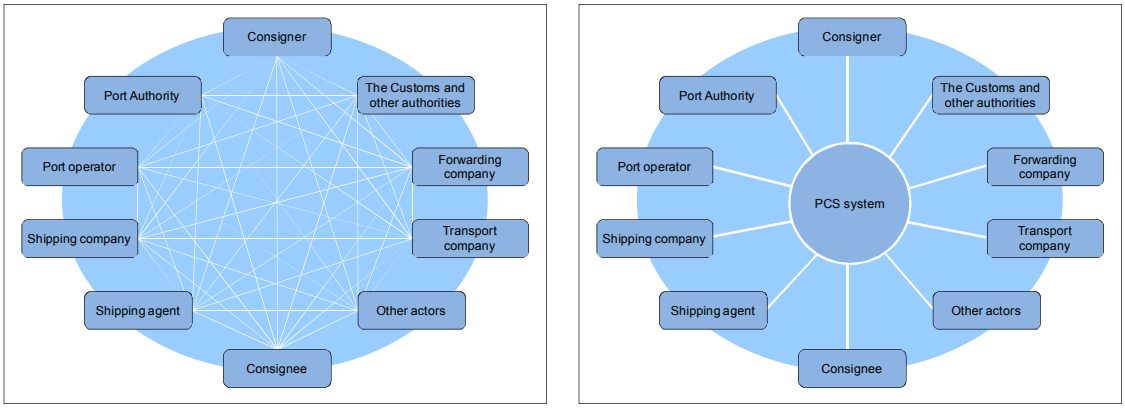

Figure 2.1 Traditional communication in a port versus communication with a port community system.

The main purpose of a port community system is to exchange information within a port community (Milá 2009). The way information exchange occurs can be described using information models (Posti et al. 2010). Boertien et al. (2002) introduced three information models that can be used in the port information systems and port community systems (Smit 2004; Srour et al. 2007):

1. Bilateral Information Model (BIM): Information is exchanged directly between the different actors on bilateral basis (Boertien et al. 2002). When basic communication channels (e.g. fax, telephone or e-mail) are used, BIM type of information exchange is easy and relatively cheap to implement. However, the bilateral information model suffers from problems of scalability and, therefore, it is best suitable for the situations where the number of parties involved in the information network is relatively small (Srour et al. 2007).
2. Centralized Information Model (CIM): An independent operator provides centralised information services and stores, forwards and retrieves all information. The service provider can also offer value-added services that may improve logistic processes of the companies. In the CIM model, information is not pushed from one actor to another as in the BIM model but it is retrieved on demand.

The centralised information model is well-suited for small and medium-sized companies in communication with big parties who have their own internal system with EDI access (Boertien et al. 2002).

3. Decentralised Information Model (DIM): In the DIM model, there still is a central broker but the broker is not responsible for the control of the actual information. It is only aware of who knows what information is stored where, how the information is retrieved and when the information is updated. In the DIM model, information is exchanged once it is needed (Boertien et al. 2002).

In addition to the information models mentioned above, Srour et al. (2007) introduced a modular distributed plug & play architecture, the purpose of which is to offer actors a simple way to integrate themselves into the network without months of hard integration work. This can be implemented by using Web Services technologies that make it possible to form interoperable machine-to-machine interaction over a network (W3C 2004). These kinds of PCSs have not been truly established yet but a collection of initiatives and plans that focus on realizing fast connect capabilities within a supply chain are under development (Srour et al. 2007).

Srour et al. (2007) documented lessons learned within each life cycle stage as derived from an international scan of port community system deployments. They suggest that the process of designing and implementing a port community system can be roughly divided into four stages: 1) project initiation, 2) system analysis and design, 3) implementation and adoption, and 4) maintenance and growth. The results of the study show that in order to gain support for the PCS, a specific, salient and tangible problem should be identified and recognised as urgent by all parties. Sponsorship should also be carefully considered in terms of both type and timing. It is important that the system architecture is carefully designed to match the technological capabilities of the participants and to mirror the existing port environment and culture. The study also revealed that the most important factor to gain successful implementation is to use a modular implementation strategy in which each module has clear objectives and quickly realisable tangible benefits for all parties involved. The study also emphasised that PCS should continually be maintained and updated in order to meet the requirements of evolving business practices. The system's ability and agility to grow and evolve are the key issues in this stage.

Rodon and Ramis-Pujol (2006) studied the complexity of integrating a group of companies with a PCS by using an interpretive case study (ePortSys system in Spain) and interviews. According to the results, the biggest challenges related to the introduction and development of ePortSys system have been companies' willingness to retain their autonomy, linking of the system with other BSIIs, limits of the standard, difficulties in aligning the interests of different actors, consequences of tighter integration with the system and unexpected uses and effects of the system.

Keceli et al. (2008a and 2008b) examined the factors affecting PCS adoption by the sea and land carrier companies located in the Busan Port region. According to the results, factors related to top manager support, adopters' technical and non-technical readiness, competition and perceived benefits have the most important influence on PCS adoption.

The technical reliability of the system has also direct impact on PCS adoption while the cost of the system is seen as a less important factor. Additional logistics services have the least impact on the system adoption, and e-Business functionality among the users may even decrease the intention to adopt the PCS. Most of the users consider that the port community system is a tool for port and customs-related document submission rather than a means for generating added value. The results also revealed that enacting power of government or the port authority does not have an impact on PCS adoption. Further, the employees of the large companies feel that there is no need to use external information systems because their in-house systems are considered more effective, cheaper and safer.

Keceli et al. (2008c) evaluated several technical aspects of Korea's national port community system PORT-MIS from the users' point of view by conducting a questionnaire survey targeted to sea and land carriers in the Busan Port region and by interviewing the operators of the system. The results show that the users of PORT-MIS are satisfied with the current level of the system to some extent but the system still needs further improvement in some areas. The main functions of PORT-MIS are well-standardised, and the integration of those functions into companies' daily business practices is easy. The system is also seen easy to use and only the novice users may have some difficulties in understanding the technical terms in the beginning. The services of PORT-MIS are highly reliable since reported network failures and congestions are almost nonexistent. The results also revealed that the usage cost of the system is determined by the amount of data transfer: all the user companies pay less than US$50 a month for using the system, except for two companies that pay US$10 000 a month because of the large amount of data transfer.

Smit (2004) studied and compared the port community system of the ports of Antwerp (Seagha), Hamburg (DAKOSY) and Rotterdam (Port infolink). The results showed that different PCSs usually differ quite a lot from each other but they often still have some similarities. The PCSs that were compared in the study are different, for example, in their technical implementation, operation area (operates either only in a port or also outside a port), functionality, payment policy and in the number of interfaces with other information systems. However, all of these systems use the same information models (BIM and CIM) in their operations.

Information security is one of the main challenges in the implementation of a port community system. Aksentijević et al. (2009) emphasised the role of cooperation between stakeholders involved in a PCS and internal education for users to achieve a proper organisational security. Unification of common security language between all port community stakeholders should also be considered. Further, the researchers recommended the standardization/certification of information security practices and risk management of the system in order to ensure continuity of the system. Tijan et al. (2009), in turn, emphasised the importance of the methods and sets of procedures that can be used to ensure port community business continuity and disaster recovery in case of a catastrophic event caused either by human error or inevitable accident. They proposed that every port community system should have a disaster recovery plan that clearly outlines the measures that should be executed within port security systems in order to

eliminate threats or to remedy possible disasters. They also recommended that the business continuity plan should be a part of overall PCS risk assessment.

The results of the literature review of the port community systems are described in more detail in the research report by Posti et al. (2010) and in the article by Posti et al. (2011).

2.3 Survey of existing port community systems

During the above-mentioned literature review, it was found that there are no comprehensive reviews about existing port community systems around the world. By using the Internet, a large number of websites of port authorities and logistics ICT service providers were reviewed in order to find out what kind of PCSs exist in the world. Electronic magazines in the field of logistics and ICT were also explored.

On the basis of the Internet survey there are at least 30 different kinds of port community systems around the world (Table 2.2). The number of existing PCSs may be even higher but there was no public information available about other systems. Some of the port community systems are used only in a certain port, some of the systems are national and some of the systems are used in several ports (either in the same country or different countries).

Table 2.2 Existing port community systems around the world. (Sources: websites of port authorities and logistics ICT service providers / PCS developers)

Port community system	Port(s) where the system is in use
ADEMAR	Le Havre
BHT	Bremen
DAKOSY	Hamburg
Destin8	Felixstowe, Harwich, Ipswich, Immingham, Hull, Teesport, Tyne, Grangemouth, Aberdeen, Glasgow, Liverpool, Bristol, Thamesport, the Medway Ports, Tilbury, Greenock, Great Yarmouth and approximately 70 inland customs places
Easyport	Yantai
EDCS	Panama Canal
EDI	Kobe
eModal	Many ports and logistics terminals in US
FIRST	New York and New Jersey
GASYNET	National system in Madagascar
Harbour View	E.g. Melbourne, Tanzania and several Belgian ports
Indian Port Community System	National system in India
KleinPort	Several ports in America, Australia and Europe
Nanhai Port Community System	Nanhai
PACE	London
PLUS	Gothenburg, Johor, Mombasa and Muscat
Port Klang Community System	Klang
Portbase	Amsterdam and Rotterdam
PortBIS	National system in Australia
PortIC	Barcelona
PORT-MIS	National system in Korea
PORTNET	Seattle and Singapore
PortXcs	Zeeland
PROTIS	Marseille
Seagha	Antwerp
SPIN	Southampton
Tradelink	Hong Kong
TradeNet	National system in several countries (e.g. Ivory Coast and Singapore)
TradeXchange	Singapore
Valenciaportpcs.net	Valencia

Port community systems can be found in practice in every continent. The PCSs are concentrated on large ports and particularly on the container ports where the annual container volume is 1 million TEUs or more. This is clearly seen when the worldwide geographical distribution of the port community systems (Figure 2.2) and the biggest container ports (Figure 2.3) are compared. Many of the PCSs have been established in the ports located in Western Europe and southern, eastern and south-eastern parts of Asia where also the biggest container ports are concentrated. In the United States, the tendency has been to develop port community systems that serve many ports and terminals

simultaneously, and thus, the number of different kinds of PCSs is considerably small in the US. Highly advanced port community systems can be found, for example, in the port of Hamburg (DAKOSY system), in the ports of Amsterdam and Rotterdam (Portbase system), in the port of Singapore (TradeNet/TradeXchange system) and in Korea (national PORT-MIS system).

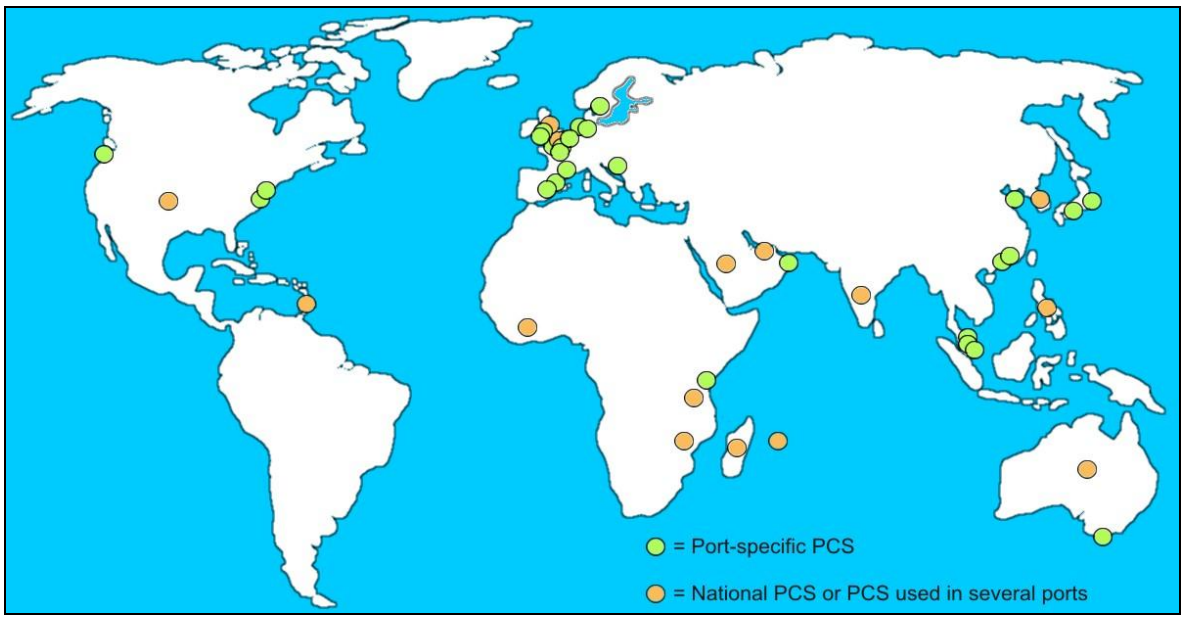

Figure 2.2 Geographical distribution of the port community systems found in the survey.

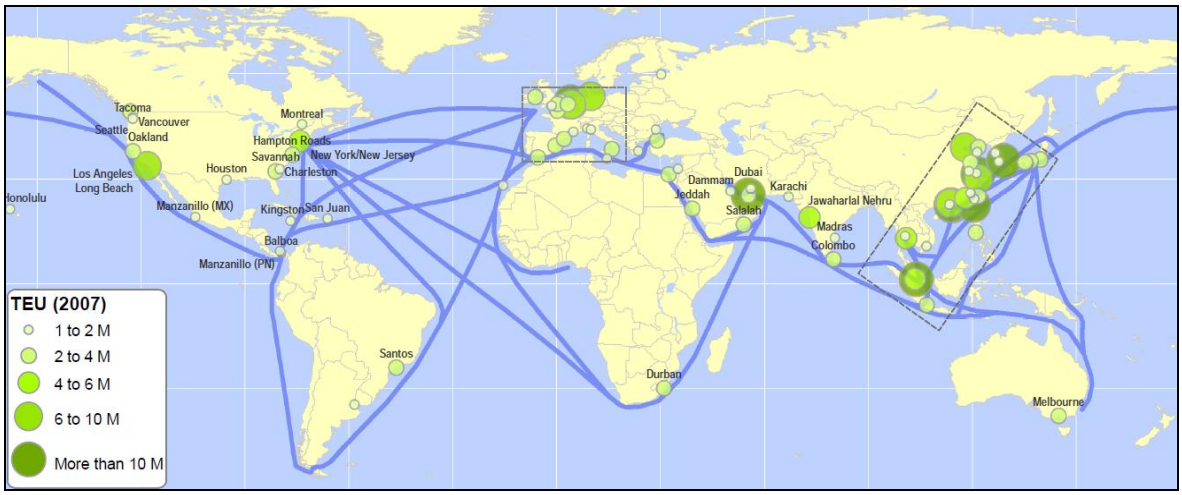

Figure 2.3 The biggest container ports in the world. (Rodrigue 2009)

In the Baltic Sea region, there are only a few comprehensive port community systems. The port of Gothenburg in Sweden has a PCS in use, and there have been plans to develop such a system in the Polish ports of Gdansk and Gdynia. Unlike the biggest container ports in Germany (e.g. Hamburg and Bremen), the German ports located in the Baltic Sea do not have comprehensive PCSs. In the Russian ports, information exchange takes place mainly by paper, fax and telephone and through port operators, and very few single window systems seem to be in use in Russia (Jakovlev 2009; Korostel-

ev 2009). In Finland, there is a national vessel traffic information system called PortNet for information exchange towards authorities but it cannot be considered as a comprehensive port community system while it lacks business-to-business interactions.

On the basis of the PCS survey, the first port community systems have been established already about 30 years ago. Because of the relatively long history, the PCSs in different ports differ from each other both in their technical implementation and their service contents. The older port community systems typically combine both the older approved and new advanced technology (e.g. DAKOSY system in the port of Hamburg) while it has been possible to develop the newer PCSs by using only the latest proven technologies (e.g. Portbase system in the ports of Rotterdam and Amsterdam). The older port community systems have one great advantage: the user network and infrastructure of the system and other related properties have been integrated in the port and its practices over a long period of time. Regardless of the age of the system, most of the PCSs seem to be based on the centralised information model and in most cases the bilateral information model is used alongside with the CIM model.

The national administrative cultures, laws, rules and trading habits also have an impact on the operation models of the port community systems. In most cases, the PCSs have initially been established to serve the needs of the national and port authorities (G2G and B2G) but a considerable number of systems have been extended to cover the needs of business life (B2B) as well. Some of the port community systems operate mainly as message delivery centers and do not offer actual applications in it (e.g. Portbase system in the ports of Amsterdam and Rotterdam) while some of the PCSs (e.g. DAKOSY system in the port of Hamburg) do not only exchange messages between various port-related actors but different kinds of applications can also be connected to the system, and the information they produce can be combined and utilised in the PCS. In most cases, a port authority has led the implementation process of the port community system but the management of the system has then been passed on to a private company or association later on. At the initialization stage, the PCSs are usually voluntary or even sponsored for its users but in the past some of the systems have become chargeable and/or compulsory later on.

According to the websites of port authorities and logistics ICT service providers / PCS developers, the port community systems can bring, for example, the following advantages: simplification and acceleration of processes, improved efficiency, decrease of documents and paper work, lower costs, time savings, improved service provision and customer satisfaction, increased visibility and facilitation of planning, reduction of lead times, enhanced information quality and decrease of mistakes, optimal reuse of information, improved availability of information (24/7), improved adaptation to failure situations, and environmental friendliness. The benefits of the different port community systems have been mentioned to be very similar to each other. A relatively small number of measured results about the concrete benefits of the PCSs was found. The majority of the measured benefits that were found in the study has been reached through reduction in paper use, number of the documents and transmission times as well as through time savings and positive environmental effects. For example, it has been reported that with the national PORT-MIS system used in Korea it has been possible to reach logis-

tics cost savings of USD 100 million mainly due to the reduction in personnel and paper work, and the harmonization and automation of the port-related systems (KL-Net 2003). The TradeNet system used in the port of Singapore has, in turn, improved the productivity of the port by 20–30 % and reduced personnel expenses by 50 % (Hines-Smith 2005).

The results of the survey of existing port community systems are described in more detail in the research report by Posti et al. (2010) and in the article by Posti et al. (2011).

2.4 Promoting information exchange of Finnish ports with a PCS

Altogether 35 Finnish logistics/ICT experts in 22 organizations in South and Southeast Finland were thematically interviewed in order to study the suitability of a port community system for the Finnish port operating environment and to clarify requirements, operating principles and potential service content of a Finnish PCS. In practice, all the experts interviewed in the study were quite positive about the idea of establishing a port community system in the Finnish port community. However, most of the experts did not see an acute need for the Finnish PCS because the present state of the information exchange and information systems in Finnish ports is seen as quite good and functioning. On the other hand, it can be seen that the Finnish port-related actors do not recognise all the possible needs or improvement areas of their operation. Furthermore, some actors are so used to their present information exchange practices and systems that they do not want any major changes in their operation. It was also emphasised in the interviews that the port community system should be quick and easy to use and it really should intensify the operations of companies, not increase the amount of work. The system should be a single window solution and be merged into other information systems as extensively as possible.

The study addressed some requirements that should be taken into account when the Finnish port community system will be designed and implemented. The main requirements that came up during the interview study were:

- operation on the basis of the single window principle
- focusing on business related services, but other types of services should also be considered
- focusing on serving small and medium-size actors but the needs of other stakeholders should also be taken into account
- the needs of different transport modes and stakeholders should be taken into account
- harmonisation of different interfaces and procedures
- connections to the international information systems
- continuously available service (24/7)
- ubiquitous and mobile services
- up-to-date and reusable information
- multi-language support.

In the study, potential services of the Finnish port community system were examined on the basis of the literature review of the port community systems, the Internet survey of port community systems and the interviews of Finnish logistics and ICT experts. Almost 30 different kinds of potential services or service entities were discovered during the study. These services or service entities are listed in Table 2.3 and described in more detail in Posti et al. (2010).

Table 2.3 Potential services of the Finnish port community system.

Potential services of the Finnish port community system	
Access control services	Monitoring of cross-border traffic
Address and service time information	Port call procedure information
Archiving service	Port information
Booking and rental services	Rail transportation planning and management
Communication channel for each shipment	Road transportation planning and management
Customs services	Service requests
Data bank for paper and electronic documents	Statistical and reporting services
e-Business services	Timetables of different transport modes
Electronic exchange of documents	Tracking and tracing of shipments
Help desk service	Transmission of messages and files
Information board	User management
Invoicing, payment transactions and taxation	Weather and driving condition information
Management of fault and deviation events	Winter time services
Map and route services	

Koskinen et al. (2010) stated that the Finnish port community system could serve smaller companies and smaller data volumes, whereas there was no demand for services directed at large companies and big volumes. The main contents of the service would be status and deviation information as well as general instructions and information sheets, which are generated in port authorities' and operators' IT-systems. The Finnish PCS would then be a channel for distributing this information to the users. The Finnish PCS could be an information service which is different from the EDI service, and it could be a portal service rather than an application service. The Finnish PCS could also have interfaces with other maritime and port-related information systems, for example Port-Net. At first, the Finnish PCS could operate as a regional service in the port of HaminaKotka where the pilot solution of the system has been implemented. In the long run, the aim could be to develop the Finnish PCS to cover other Finnish ports as well and to operate at the national level. Koskinen et al. also noted that the Finnish PCS could be sponsored by service provides (port-related actors) and owned by a community of port-related stakeholders. At least at the early stages, the service should be free for users. Figure 2.4 summarises what kind of information service the Finnish PCS could be.

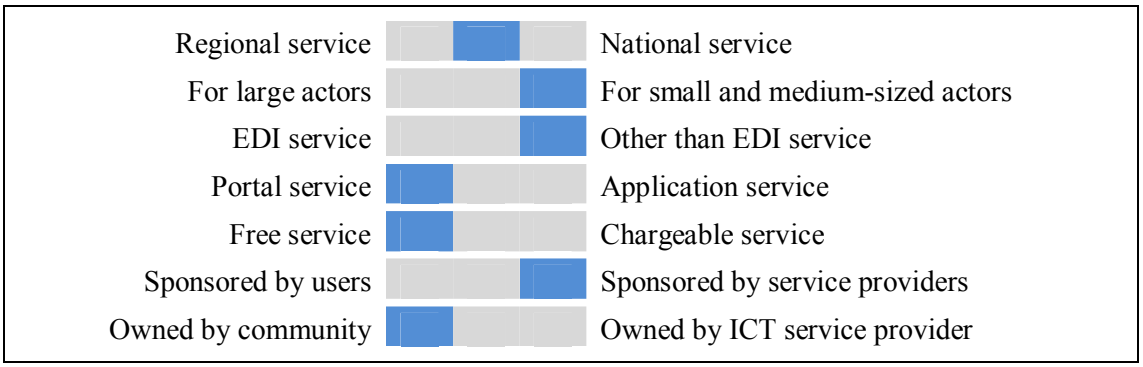

Figure 2.4 Positioning of the Finnish PCS as a service. (Koskinen et al. 2010)

The interviewed experts highlighted some challenges of establishing the port community system in the Finnish port environment. Data security was seen as the biggest challenge. Getting clear evidence of the benefits produced by the PCS and sharing them equitably were also considered challenging. Usually, larger companies benefit from such information systems more than smaller ones and, therefore, small companies tend to be sceptical of the benefits that a port community system can bring to their operation. In order to commit all parties to participate in the PCS, it is important to clearly explicate the expected benefits of the system. The reliable operation of the PCS and the adaptation to a new operational culture were mentioned to be considerable challenges when developing such a comprehensive information system. In addition, the restrictions imposed by the authorities and legislation were considered to hinder the establishment of the Finnish port community system.

The suitability of a port community system for the Finnish port operation environment is described in more detail in the research reports by Posti et al. (2010) and Koskinen et al. (2010).

2.5 Potential environmental benefits of the Finnish PCS

Environmental impacts caused by logistics in Finland and the Kymenlaakso region were calculated on the basis of the LIPASTO calculation system provided by VTT Technical Research Centre of Finland and statistics provided by the Finnish railway operator VR. The study also examined what kind of steering instruments are provided by the EU to reduce environmental impacts caused by logistics and what kind of logistics-related ICT and ITS projects and visions are ongoing or pending at the moment. Further, the potential of ICT solutions in the reduction of adverse environmental effects was examined at this stage of the study. On the basis of these results, potential environmental benefits of a PCS in the Finnish port environment were evaluated.

Logistics and especially transportations cause large amount of direct air emissions and other environmental impacts on people and nature. In Finland and other EU countries, over 20 % of all emissions are caused by logistics and especially transportation of goods. Environmental impacts of logistics can be divided into two categories: direct and

indirect emissions. Direct emissions have direct impact on people, animals and nature. Examples of direct emissions are emissions into air, noise, vibration and climate change. Indirect emissions are factors that have a long term effect on humans, animals and nature. For example, maintenance and use of logistics infrastructure cause indirect emissions that can have an effect on biodiversity and human health. (Kalenoja & Kallberg 2005)

Calculations of logistics emissions in Finland in the year 2009 revealed that over a half of Finland's cargo transport CO_2 emissions are caused by road transportation. The reason for this is that more than a half of all the fuel and energy used in cargo transportation in Finland is consumed by heavy road transportation. According to the results, the most ecological transport mode is rail because most lines of the Finnish railway network are electrified and it is more environmentally friendly to produce energy in the power plants than for example with combustion engines. Most of the sulphur emissions in the Finnish cargo traffic are caused by vessel traffic. That can be explained by the fact that vessels use bunker, the sulphur content of which is in average 1.1 %, while trucks use low sulphur content diesel oil. Excluding sulphur, the amount of the other emission components are directly proportional to consumed amount of fuel and energy. Table 2.4 presents a summary of logistics emissions into air caused by different transport modes in Finland in the year 2009. Table 2.5, in turn, presents a summary of fuel and primary energy consumption of different transport modes used in cargo traffic in Finland in the year 2009.

Table 2.4 Emissions of different transportation modes into air in tonnes in Finland in the year 2009. (Mäkelä et al. 2010a; Mäkelä et al. 2010b; Mäkelä & Auvinen 2010)

	CO	HC	NOx	Particles	CH_4	N_2O	SO_2	CO_2
Water transport	1,404	631	3,193	522	14	32	6,343	1,247,049
Rail transport	279	114	2,000	47	6	3	64	121,999
Heavy road transport	4,268	2,684	15,919	590	147	95	17	2,634,934

Table 2.5 Fuel and primary energy consumption of different transport modes used in cargo traffic in Finland in the year 2009. (Mäkelä et al. 2010a; Mäkelä et al. 2010b; Mäkelä & Auvinen 2010)

	Fuel consumption [t]	Primary energy consumption [GJ]
Water transport	387,493	16,062,935
Rail transport	24,865	2,487,769
Heavy road transport	860,973	36,900,000
Total	1,273,331	55,450,704

Around 4 % of the transportation emissions of Finland in tonnes come from the Kymenlaakso region. Almost 70 % of cargo transport CO2 emissions in Kymenlaakso are caused by road transportation (Table 2.6). Short transportation distances, decentralised industry and transit traffic are the key factors for the significant usage of road transportation in Kymenlaakso. Rail transportation causes the least amount of emissions in the Kymenlaakso region. However, it has to be noted that transported tonnage is not taken into account in the calculations. Finland's largest general port called HaminaKotka is

located in Kymenlaakso. Therefore, the amount of vessel calls and carbon dioxide, sulphur and nitrogen oxides emissions in Kymenlaakso is quite large. Table 2.7 shows the fuel and primary energy consumption of different transportation modes in Kymenlaakso. Even though transportation distances in Kymenlaakso are quite short, the consumption of fuel and energy is high. This can be explained with high cargo volumes and frequent traffic in Kymenlaakso. In addition, significant amount of transit traffic from/to Russia is transported through the Kymenlaakso region. The transit traffic increases consumption of fuel and energy in Kymenlaakso.

Table 2.6 Emissions of different transport modes used in cargo traffic in Kymenlaakso in the year 2009. (Mäkelä et al. 2010a; Mäkelä et al. 2010b; Mäkelä & Auvinen 2010)

	CO	HC	NOx	Particles	CH_4	N_2O	SO_2	CO_2
Water transport	72	27	842	19	3	1	75	45,325
Rail transport	12	4	60	3	0	0	9	10,018
Heavy road transport	188	117	737	26	7	4	1	120,296

Table 2.7 Fuel and primary energy consumption of different transportation modes in Kymenlaakso in the year 2009. (Mäkelä et al. 2010a; Mäkelä et al. 2010b; Mäkelä & Auvinen 2010)

	Fuel consumption [t]	Primary energy consumption [GJ]
Water transport	14,296	608,353
Rail transport	10,127	261,335
Heavy road transport	39,807	1,446,371
Total	64,230	2,316,059

The European Union has many logistics- and maritime-related action plans, directives and projects that aim to improve various aspects of sea and land transport by using different kinds of ITS- and ICT-related solutions. The ultimate aim of these policies is to guarantee a cleaner, safer and more efficient transport system in both water and land areas. Some examples of these kinds of action plans, directives and projects are the European maritime transport space without barriers policy, e-Maritime, e-Freight, e-Customs, the single window concept, e-Navigation and the ITS action plan. Some results of these action plans, directives and projects can already be seen but the utilisation of the results at a comprehensive level will take many years.

ITS and ICT solutions can be used to reduce environmental impacts of logistics. According to McKinsey & Company (2009) the solutions can roughly be categorised into three groups: 1) intelligent solutions that ease the everyday lives of people and steer human behaviour to an environmental direction (e.g. automatic CO_2 calculators and social media services), 2) different kinds of technical solutions and improvements (e.g. intelligent engines, buildings, logistics, networks and sensors), and 3) optimisation of current activities (e.g. optimisation of transport routes and supply chains, intermodal transportations and maximisation of capacity utilization). For example, it has been estimated that increasing the loading capacity of trucks by 50 % would decrease emissions of transportation by 15 %. In practice, this means that two trucks could transport the load of three trucks in the present situation. (McKinsey & Company 2009) As a conclu-

sion it can be stated that potential environmental benefits provided by ICT solutions vary from small improvements (e.g. emission simulation models) to large global solutions (e.g. optimisation of transport routes and tracking of cargo through global supply chains).

The study also revealed that port community systems can improve the environmental aspects of logistics in two different ways. Firstly, PCSs can provide direct environmental benefits. The most potential direct environmental benefits of PCSs are the reduction of emissions through the intensification of logistic activities, and the decrease of paper documents and use of printing paper by means of electronic documents provided by a PCS. Port community systems can also affect the environmental aspects of logistics for instance through optimisation of transport routes and load capacity, tracking of cargo and use of central servers. For example, a port community system can provide advance information about vessel delays, port strikes, damaged road or any other significant deviations. This can help stakeholders to re-plan their own activities and to reduce unnecessary transport and vehicle idling, and in this way reduce the environmental impacts of logistics. In any case, the study showed that the potential benefits of the Finnish PCS in reducing environmental impacts of logistics are difficult to estimate without practical measurements.

Secondly, port community systems can be used as an environmental tool by a port community. A PCS solution could contain a section for the environmental issues including, for example, a data bank for environment reports and other documents, certification systems (e.g. ISO and EMAS), logistics environmental calculators and simulation models, an information channel for environmental issues, a communication channel for environment and quality personnel as well as cargo tracking and tracing services. This kind of environmental tool would guarantee that all port-related environmental information would be reliable and standardised for all port-related stakeholders. Figure 2.5 demonstrates what kinds of services the environmental section of the Finnish port community system could include.

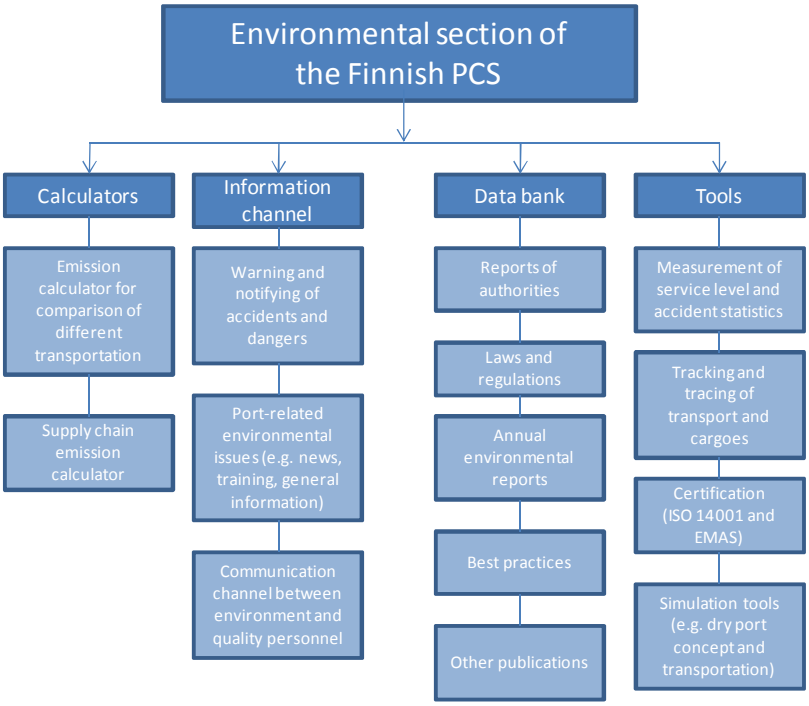

Figure 2.5 Potential service content of the environmental section of the Finnish PCS.

The potential environmental benefits of a Finnish PCS are described in more detail in the research report by Brunila et al. (2011).

2.6 Summary and conclusions

The study revealed that the information systems and services used in Finnish ports are quite advanced. However, information sharing in a typical Finnish port-related supply chain has several bottlenecks that cause delays in shipments and result in wasting resources. Some examples of these bottlenecks are the extensive use of traditional bilateral communication methods (e.g. paper documents, telephone, fax and email), a large number and diversity of documents/messages, incompatibility of information systems of different port-related actors as well as varying practices and requirements between different actors, ports and states. Further, the information systems and services used in Finnish ports are quite scattered from a user's point of view. They are also more or less orientated to serve the needs of the authorities in the maritime environment while less attention is paid to land-side transportations and the business needs of companies.

In order to improve the information exchange of the port-related supply chains, many ports around the world have developed port community systems (PCS) to serve the information exchange of the port community comprehensively. The results of the study revealed that at least 30 different kinds of port community systems exist globally in various ports. Especially the large container ports located in Western Europe and in southern, eastern and south-eastern parts of Asia have highly developed PCSs. Port community systems are usually developed to meet certain needs of a port community. Therefore, PCSs in different ports usually differ from each other from both their technical

implementation and their service contents. Good examples of port community systems are the Portbase system in the ports of Amsterdam and Rotterdam, the DAKOSY system in the port of Hamburg, the TradeNet system in the port of Singapore and the Korean national system Port-MIS. The study also revealed that the potential benefits of port community systems are manifold. However, there are very few concrete and measured results on the beneficial features of the PCSs.

The Finnish port community system can be used to solve the information flow problems that have not yet been resolved in other ways. Since the authorities and the largest companies operating in Finnish ports have already established practices for data exchange, the Finnish PCS should be focused on serving information services to small and medium-sized companies but the needs of other actors should also be considered. The PCS could benefit the members of the community by improving customer services, enabling more automated service processes, and serving as one common source of information. Exchanging business-related information should have a key role in the system but other kinds of applications should also be taken into consideration. The Finnish PCS should operate on the basis of the single window principle, take the needs of different transport modes into account, have interfaces with other maritime and port-related information systems, offer ubiquitous and mobile services, and provide up-to-date and reusable information 24 hours a day. Almost 30 different kinds of potential services or service entities for the Finnish port community system were found in the study.

Port community systems around the world appear to be concentrating on the container ports where annual container handling volume is 1 million TEUs or more. Compared to these numbers, the Finnish ports are relatively small. In 2009, the total container volume of foreign traffic in the Finnish sea ports was approximately 1.1 million TEUs (Särkijärvi et al. 2010). When considering only the container volumes, it can be noted that there are only four container ports big enough in Finland (Helsinki, Kotka, Rauma and Hamina) in which the implementation of the port-specific PCS solution could be justified at some level. Besides container ports, port community systems can certainly be applied in the ports that handle other kinds of freight (e.g. dry and liquid bulk, ro-ro traffic). While the data transfer demands rise, also the benefits of the PCS often increase. On the whole, the goods flows of the Finnish ports can be considered quite diverse, and thus, the information exchange needs in the Finnish ports are remarkable. However, if even the smallest Finnish ports and port-related actors are to be included into a PCS, then the establishment of the national port community system might be the most suitable solution.

The promotion of the Finnish port community system would need a broad-based development community to which ports and port-related companies would commit to. The development community would make decisions on what services should be implemented, find the necessary financing for the investments, act as a commissioner of development projects, and further on take responsibility for the operating costs of the technical environment. In order to make the funding of the Finnish port community system possible, the costs of the system should be kept to a minimum and, therefore, the open source code solutions would be worth considering when purchasing software for the system. Incorporation of the port community system's functions into the existing service centre

would be the most reasonable solution since it involves a lesser economic risk and requires less staff of one's own compared to a separate service centre (Koskinen et al. 2010).

The Finnish port community system is planned to be phased by using a modular implementation approach, in which each module has clear objectives and concrete benefits for all parties involved. During 2011, a pilot solution of a Finnish port community system was built in the new HaminaKotka port and the ideas developed during this project are now being tested. The content and implementation of the pilot PCS is described in more detail in chapter 3.

The study also revealed that port community systems can improve the environmental aspects of logistics in two different ways. Firstly, PCSs can provide direct environmental benefits. The most potential direct environmental benefits of PCSs are the reduction of emissions through the intensification of logistic activities, and the decrease of paper documents and use of printing paper by means of electronic documents provided by a PCS. Port community systems can also affect the environmental aspects of logistics, for example through the optimisation of transport routes and load capacity, the tracking of cargo and the use of central servers. Secondly, port community systems can be used as an environmental tool by a port community. A PCS solution could contain a separate section for the environmental issues including, for example, a data bank for environment reports and other documents, certification systems (e.g. ISO and EMAS), logistics environmental calculators and simulation models, an information channel for environmental issues, a communication channel for environment and quality personnel as well as cargo tracking and tracing services. Despite the potential environmental benefits, economical profits and service content are usually considered more important factors when ICT systems are designed and deployed. However, green values should be taken very carefully into account in the planning and implementation of PCSs since they can bring a major competitive advantage to related actors and promote environmental protection in a broader context as well.

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3 PILOTING A FINNISH PORT COMMUNITY SYSTEM

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This chapter presents the main results of the study concerning a pilot solution of a Finnish port community system. The aim of the study has been to build a web platform to test a port community system for Finnish ports and to study potential mobile technology user interfaces for the portal. The results of the earlier research stages presented in chapter 2 were used as a basis when the pilot solution of the Finnish PCS was designed.

At the time of writing this report (December 2011) the pilot solution of the Finnish PCS has not yet been finalised and tested through but the main features, technologies and applications can already be described as if they were the final system. Testing the system and making minor improvements to the system will be continued till May 2012.

The pilot solution of the Finnish PCS aims to test electronic information sharing between different actors in transport chains through sea ports. The pilot solution contains a portal named Portconnect for the pilot system (www.portconnect.fi) and two different kinds of applications: Rail Wagon Exchange Service and Border-Crossing Service. In the following sections, technologies and software used in the pilot solution of the Finnish port community system are described and the features and operations of Rail Wagon Exchange Service and Border-Crossing Service examined.

3.1 Technologies and software used in the pilot solution

Technology in the Portconnect portal

The technical solution of the pilot solution of the Finnish PCS is based on an open source portal product called Liferay 6.0. The application server stores all information into the Postgre database. The users use the applications on web browsers and it is also possible to use mobile phone browser views provided by Liferay's own tools.

The message proxy server Mule ESB handles data integration. Each interface is configured and implemented in the proxy server. Communication is always encrypted over the Internet, for example using the https protocol. It is also possible to create VPN-related systems. E-mails are transmitted via the service provider's mail server (SMTP).

The application server and portal

The pilot solution of the Finnish PCS is based on an open source portal product called Liferay Portal 6.0, which is one of the world's most widely used web portal products. Applications in the pilot system are implemented in Java. Liferay itself has a lot of features such as content management, user management, communications, encryption and access control. Although the pilot system of the Finnish PCS is based on the Liferay open source code, it is also available as commercial support (COS Commercial Open

Source). The portal is built on the Spring application development platform on top, and it includes over 50 ready portlets as well as online publications and a content management system (CMS). Portlets are reusable web user interface components. The web server product used in the pilot system of the Finnish PCS is Apache Tomcat.

Messaging server

The Mule ESB (Enterprice Service Bus) message broker product has been selected to provide integration services in the pilot system of the Finnish PCS. Mule ESB is the world's most widely used open source integration product, and it supports almost all types of interfaces, allowing multiple connections. Messaging server-based integration has the following advantages: Integration services can be implemented by configurations instead of application development. Integration becomes as a separate entity, which clarifies the structure of the system. It is possible to make changes to integration services without changes in applications. Authentication, authorization, and security integration can be encapsulated as a separate entity. In the following are examples of supported protocols and connection methods:

- http / https
- FTP / SFTP
- JMS (string formatted messages)
- E-mail
- SMS
- SQL
- SOAP.

All protocols can be used to transfer, for example, EDIFACT and XML messages.

Open source advantages

Using the selected open source product platforms brings a number of advantages compared to commercial products. These benefits include operating system and hardware environment independent solution, service-oriented implementation of the portal and large savings in licence fees, avoiding commitment to the vendor. Using an open source solution is also in line with the public sector IT strategy. Liferay is an MIT-licensed product, but it allows the free use of the product and further development.

3.2 Rail Wagon Exchange Service

The Rail Wagon Exchange Service is designed to provide the wagon exchange order information electronically between the parties. This speeds up the process of unloading the wagons and makes the process information real-time and transparent. The reasons behind problem situations are also easier to discover afterwards by using systems log files. The piloting partners in this application are the Finnish logistics operator VR Transpoint Corp and the Finnish stevedoring company Steveco Ltd.

In the current model, a bill of lading information is transferred from the supplier by EDIFACT messages between the railway operator (VR) and the port operator (Steveco). The port operator orders rail wagon exchanges by phone, email or fax, after which the rail operator is responsible for the order and confirms the time of delivery of the wagons. In the new pilot model, the railway operator sends advance information on arriving trains and wagons as EDI messages to the Portconnect portal. The port operator will make the wagon exchange orders using a web application on Portconnect. The railway operator confirms orders on Portconnect (Figure 3.1).

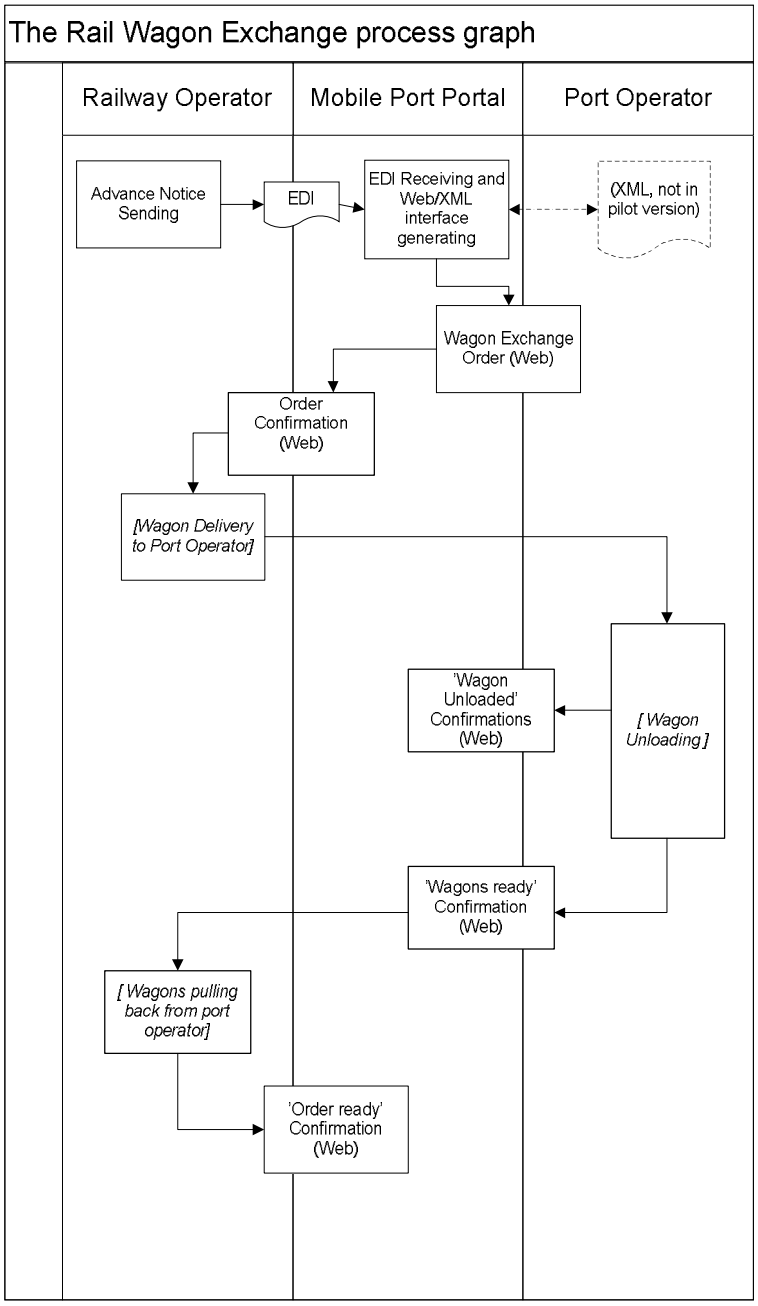

Figure 3.1 Process graph of the Rail Wagon Exchange application.

The most important feature of the Rail Wagon Exchange application is to provide real-time information on wagon exchange request, and the statuses and locations of the wagons. Port operators can see only their own data while the train operator can see all the information. It should be ensured that various port operators do not get to see each other's information unless otherwise agreed. Security management is implemented in the portal by Liferay built-in tools.

In the following, some example screens of the application are shown to demonstrate the functionalities of the application. The graphical appearance of the application is from the testing phase and does not represent the final appearance of the application.

Browsing wagon orders

Users can browse the orders to either process them further or to check back on individual orders in case of exceptions (Figure 3.2).

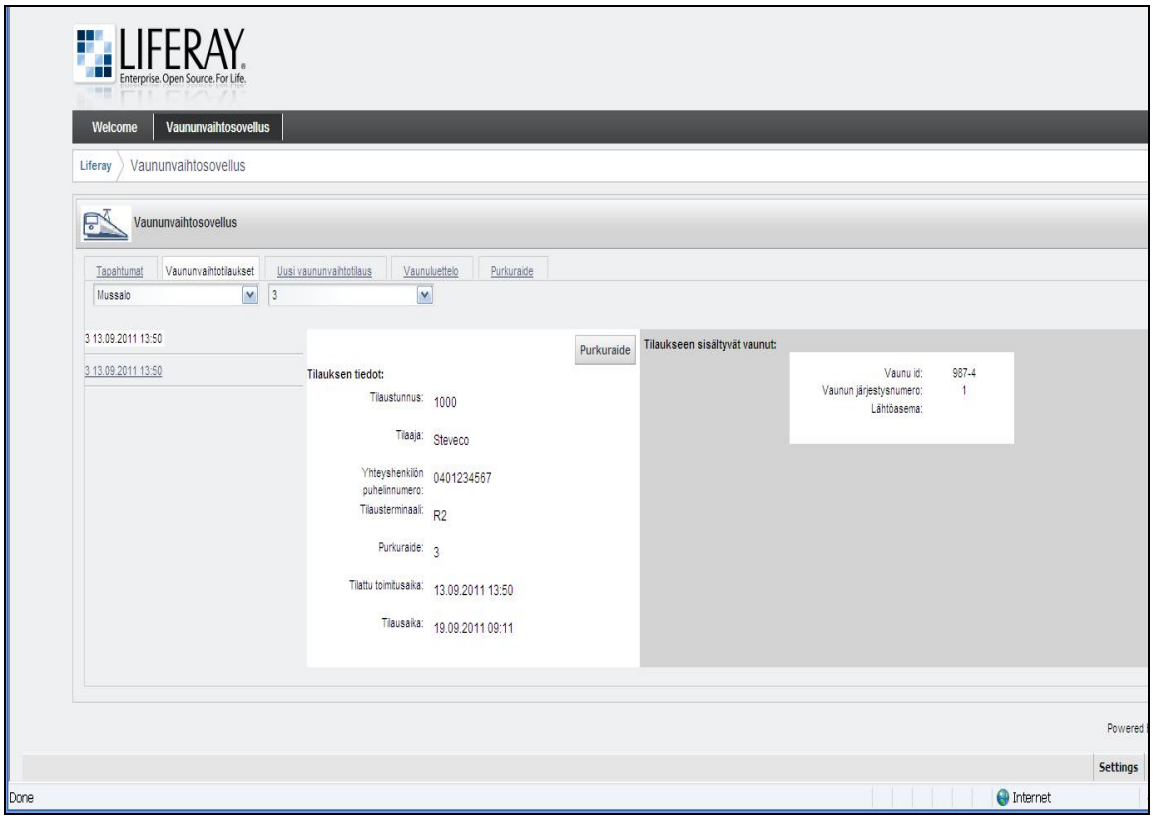

Figure 3.2 Order browsing.

Entering a new order

The port operator worker starts process phase one of a new order by selecting the wagons from the rail yard list (Figure 3.3).

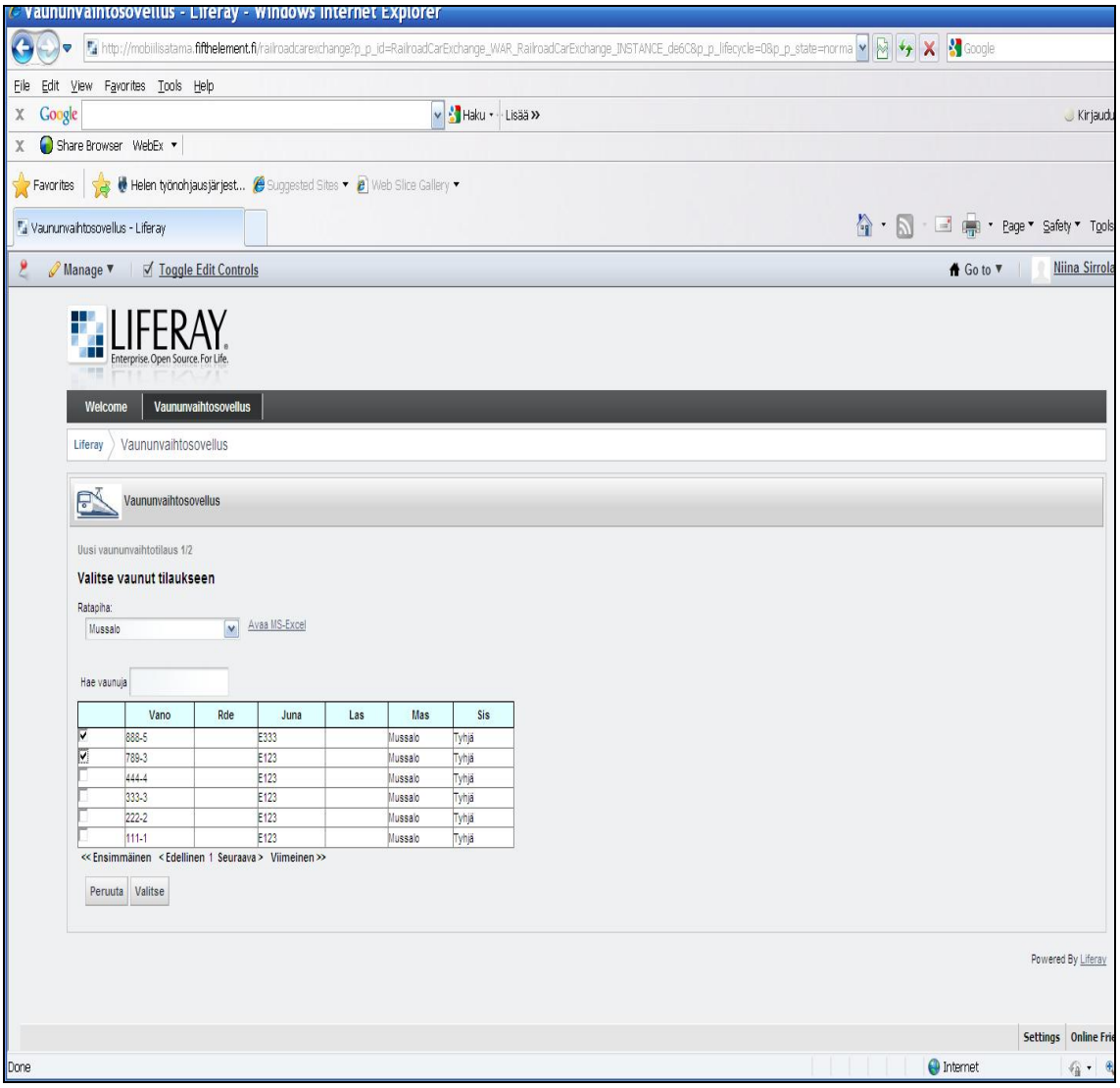

Figure 3.3 Wagon selection.

In the second phase, the port operator worker types in the basic information of the exchange order and sets the picking order of the wagons (Figure 3.4). At the end, the order is sent to the railway operator.

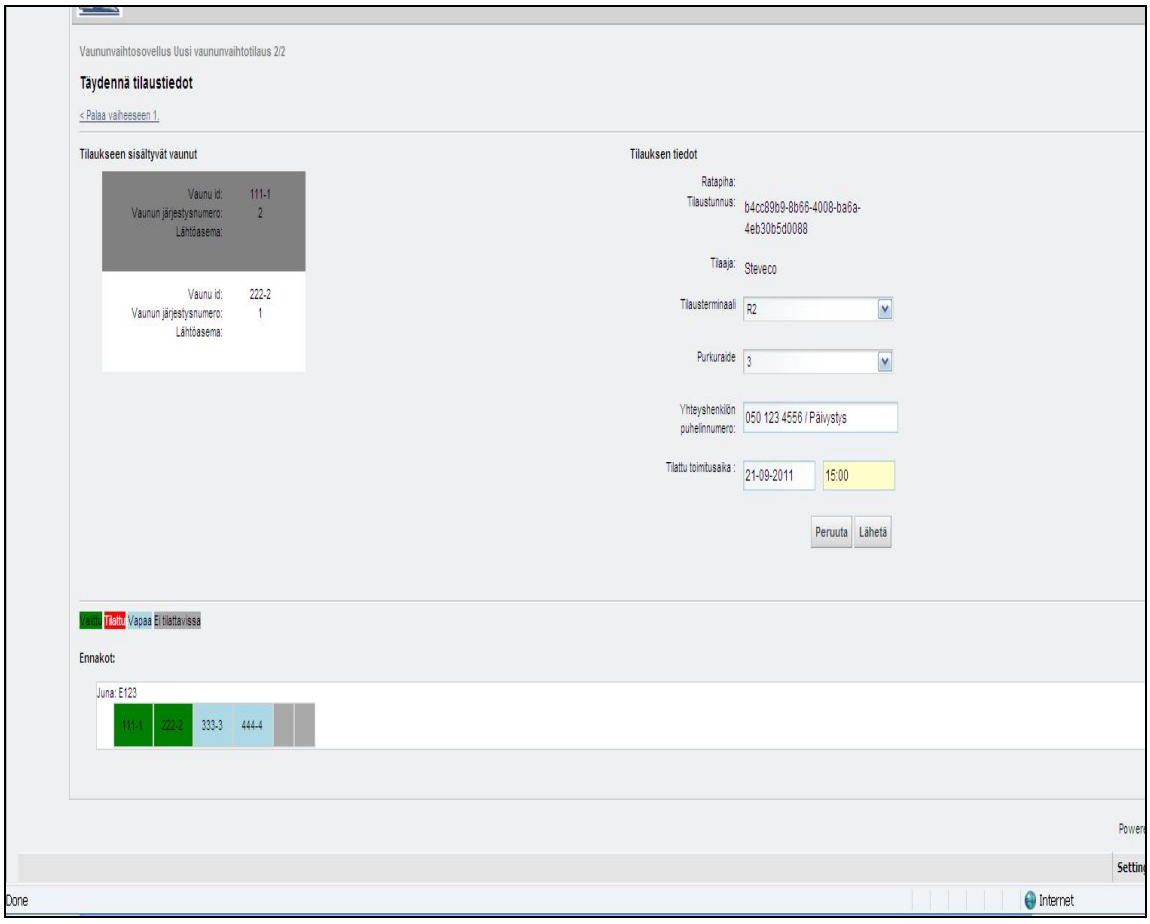

Figure 3.4 Order form, phase 2.

The railway operator can then accept or cancel the order. If the railway operator cancels the delivery, the port operator has to change its initial time of order to a later one.

<u>Order delivery</u>

The railway operator can confirm the delivery of the ordered wagons using 'Delivered'-button on web form (Figure 3.5).

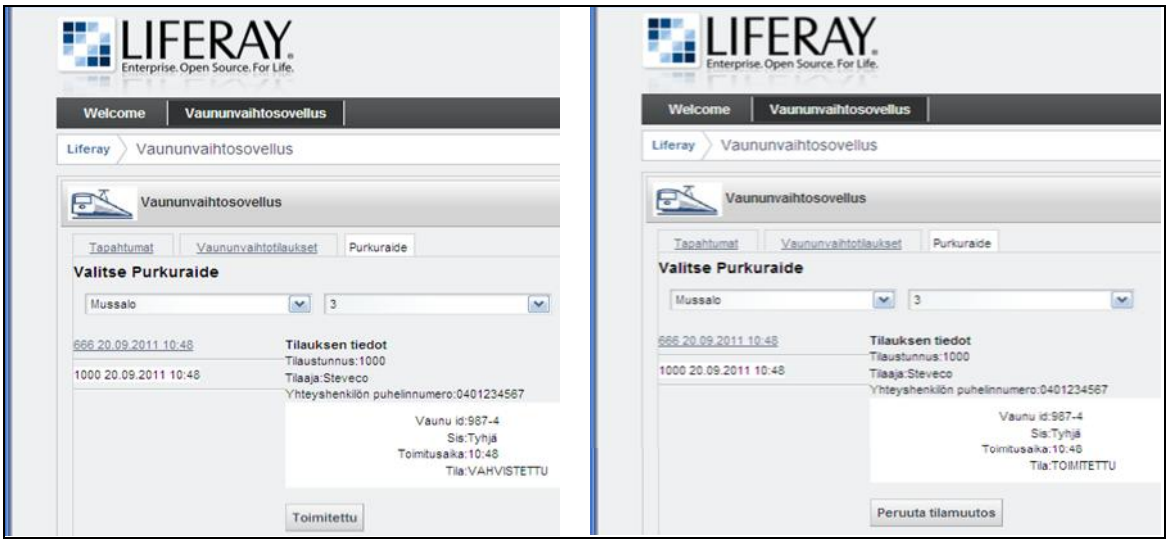

Figure 3.5 Order delivery confirmation.

Order receiving and unloading notice

The port operator worker can then confirm the receiving of the wagons by pressing button on web form (Figure 3.6). When the unloading of wagons is proceeding, the port operator worker can confirm the wagons unloaded one by one. Thus the railway operator workers can estimate when they can fetch the unloaded wagons.

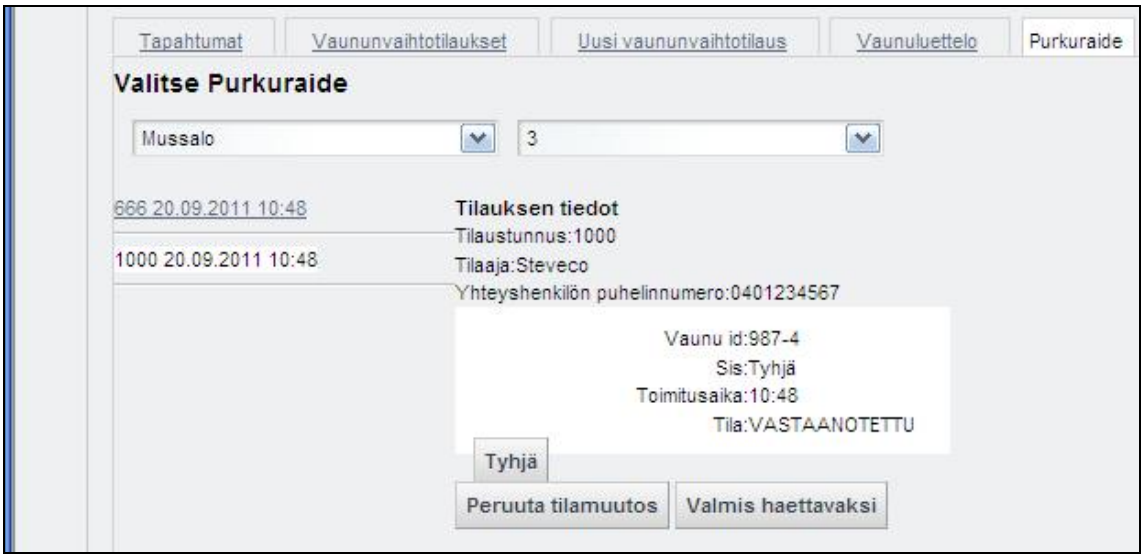

Figure 3.6 Order receiving.

3.3 Border-Crossing Service

Border-Crossing Service is designed to exchange information between stakeholders of transport which is crossing the Finnish-Russian border, and to send the extended electronic TIR document files to the Russian Customs authorities. The application is capable of importing data from the forwarding and shipping systems. The application also collects information about vehicle movements both in Russia and in Finland with GPS. GPRS data transmission between the vehicle terminal and the service is also available. The piloting partners in Border-Crossing Service are a Finnish transport data operator Helpten Ltd., a company of independent surveyors, loss adjusters and claims managers Lars Krogius Ltd. and a Finnish transport company T Lehtinen Ltd. Finnish and Russian Customs authorities are the external stakeholders in this application.

Border-Crossing Service has interfaces with forwarding agents' systems and customs systems via Lars Krogius's Border system. It also has map views provided by Helpten Ltd's systems for tracking the vehicles.

Lars Krogius Ltd's Border system is a portal that transmits electronic documents and TIR extension data to the Russian authorities, especially to Russian Customs. The interface uses xls or xml file formats. Border-Crossing Service is also linked to Helpten's system, which collects information on the movements of vehicles in Russia and in Finland. Helpten's service includes vehicle-mounted devices that allow wireless data transfer between the vehicle and Helpten's service. Vehicle equipment include a telematics unit with a GPRS modem and a GPS receiver, and the terminal, which also acts as a navigator.

A detailed description of Border-Crossing Service cannot be presented yet as precisely as the wagon exchange application was presented above, because the user interface has not yet been implemented at the time of writing this. The main principals of the service are presented in the following. The process of the service is visualised in Figure 3.7.

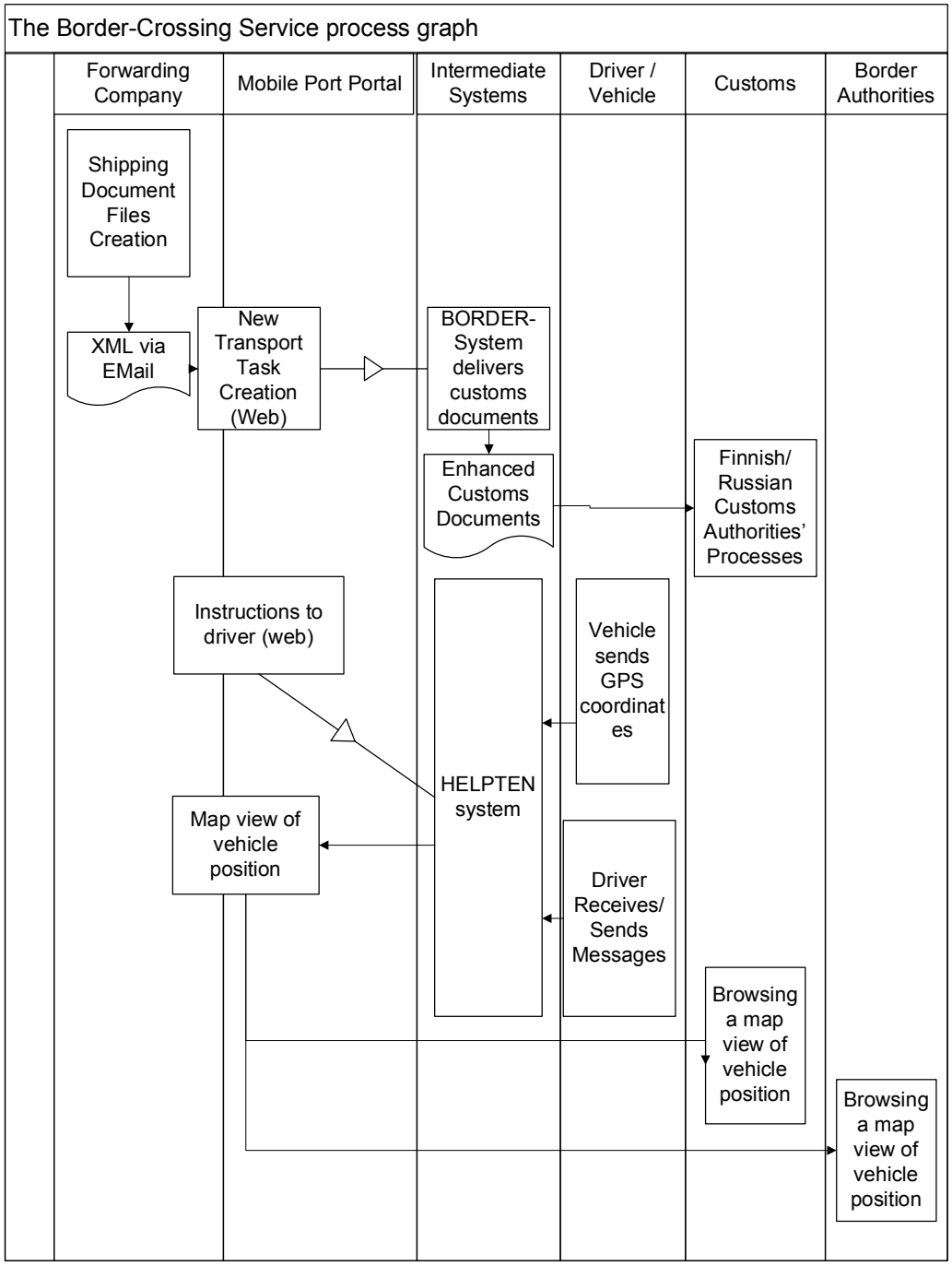

Figure 3.7 The process graph of Border-Crossing Service.

The system network

Border-Crossing Service is intended to solve some problems that are related to the Finnish transit traffic from/to Russia. Border-Crossing Service helps to manage the various information flows between the parties as well as to manage and track shipments. The service is implemented in part using the existing interfaces and applications. This means that services are built on top of existing services: Border-Crossing Service is connected to Lars Krogius Ltd's Border system and to Helpten Ltd's services.

User groups and stakeholders

A forwarding company is an important user of the Border-Crossing Service. It manages the preparation of documents in transit transport and ensures the delivery of the goods to the customer.

Customs brokers in Russia can prepare the customs process in Russian inland customs terminal more easily once they have received electronic documents from the Border-Crossing Service.

In the vehicle terminal, the driver may receive messages from Helpten Ltd's system on the right route points as well as instructions and information on customs clearance. In addition, the driver of the vehicle has an opportunity to send messages to the office.

Border and customs authorities can use the system for monitoring the border for incoming vehicles.

Electronic customs clearance

User fills in the web form on shipment details in the Portconnect portal and the control of the process is directed to Lars Krogius Ltd's Border system, where the final forming of the electronic TIR Carnet and other documents is done.

Border-system uses the M-Files document management system. The integration of Portconnect's Border-Crossing Service and M-Files has been implemented in co-operation with Lars Krogius Ltd and M-Files Ltd. Border system sends the final documents to both the Border-Crossing Service application and to the authorities in Russia and Finland.

3.4 Conclusions

The Portconnect web platform and its integration extension Mule ESB have been quite easy to implement. The features in the Liferay portal are flexible enough to fulfil the needs of the PCS portal. The programming of the user interface of the application has been realised without any major problems. The difficult part has been the system integration definition and implementation. It has been time consuming to have all the parties to co-operate effectively. The business network has many organisations, which all have their own restrictions in integration implementation. There have been restrictions on resources, security, responsibilities etc. For example, Rail Wagon Exchange Service has a business network of seven companies. All these companies have given their own major or minor inputs in the integration process. If message flow stopped somewhere in the chain, it was difficult to find out which company of the network was able to fix the errors. In the next new interfaces, the integration process will be easier because the first bottlenecks have already been solved in the first pilot phase.

The Portconnect portal is now running and it is up to the logistics sector to find synergies in the ICT services production the same way that has been done in advanced PCS solutions around the world. The portal will have a new hosting organisation in spring 2012. The Portconnect stakeholder's business network has also had its first meetings. Presently, promising prerequisites exist for enlarging the Finnish PCS from the pilot phase to a fully operating portal, which will serve for all Finnish ports and their business communities.

4 DRY PORT CONCEPT

Ville Henttu, Lauri Lättilä, Sirpa Multaharju and Olli-Pekka Hilmola from the Lappeenranta University of Technology, Kouvola unit

Environmental problems and issues have received more and more attention during the last decades. Reasons for this are the various increased external costs such as congestion, CO2 emission, noise and accident costs. The transportation sector is the only sector with increasing external costs. The dry port concept is seen as one possibility to decrease emission levels originating from transportation sector. (Aronsson & Brodin 2006; European Commission 2009; UIC 2009)

This research studies the dry port concept. Main geographical focus is in Finland, and more specifically in South-Eastern Finland, which means that results are based on the Finnish transportation network. The financial impacts and cost-efficiency of the dry port structure are taken into account. In addition, the environmental impacts of the dry ports are studied. The environmental impacts taken into account are carbon dioxide (CO2) emissions, noise, congestion and accidents. The research has an aim to more strongly integrate environmental issues, through the usage of the dry port concept, into the development of transportation systems in the Kymenlaakso area.

The study of the dry port concept was conducted in three stages. First, the financial and environmental impacts of a dry port to support two major Finnish seaports were studied. Second, a regional survey study on the dry port concept in South-East Finland was conducted. Third, the transhipment costs of intermodal transport in the Finnish context were clarified. In addition, two simulation models were produced during the study in order to simulate and estimate transportation costs and environmental impacts of the dry port concept in the Finnish transportation network.

In the following sections, the main results of the dry port concept research are described starting from the first, second and third stage of the research in sections 4.1, 4.2 and 4.3 and then introducing the key features of the two simulation models in section 4.4. Finally, the results of the study are summarised and concluded in section 4.5.

4.1 Financial and environmental impacts of a dry port to support two major Finnish seaports

The aim of the first stage of the research was to find out if a dry port solution could decrease costs of transportation, especially external costs. The main research method used at this research stage was cost accounting, which concerned road and rail transportation to allow comparison between these two different transport modes. Cost accounting included both the internal and external costs of both the road and rail transport. The external costs included cost estimations concerning CO_2 emissions, noise, accidents and congestion. The results of cost accounting were further used in simulation models, which were used to simulate the dry port concept. The last method used was the examination

of gravitational models. The aim of these models was to compare different Finnish cities and their attractiveness, if distances and populations are the driving factors.

4.1.1 Literature review

The dry port concept is a part of an intermodal transportation system, where inland transportation between the seaport and the dry port is performed by rail transport instead of conventional road transport. The dry port itself is an inland intermodal terminal, which has direct rail connection to seaport. In addition, part of the seaport related services are outsourced to the dry port (e.g. customs clearance, maintenance of loading units and warehousing). (Roso 2009a & 2009b)

Rail transportation is an environmentally friendlier mode of transport than road transport according to the literature review. In addition, cost-efficiency of the transport system can be decreased by increasing the proportion of rail transport. Other possible benefits of dry ports according to Roso et al. (2008) and Roso (2009b) are e.g.:

- less road congestion in seaport area and seaport cities
- land use opportunities in seaport cities
- economies of scale for railway operators
- less time in congested roads and terminals for road operators
- improved seaport access for shippers
- lower environmental impacts for the society.

4.1.2 Results

The results of the first stage of the study revealed that the main transport mode of the dry port concept, which is rail transport, is both a more cost-efficient and environmentally friendlier mode of transport than road transport. Transportation costs and environmental costs of dry port implemented transportation can be further decreased in comparison with unimodal road transportation if the distance between seaport and dry port increases. It has to be noted that transhipment costs of transhipping an intermodal loading unit from one transport mode to another are not taken into account at this stage of the study. These costs were estimated at the third stage of the study (see section 4.3). Figure 4.1 summarises the results of cost accounting between road and rail transportation.

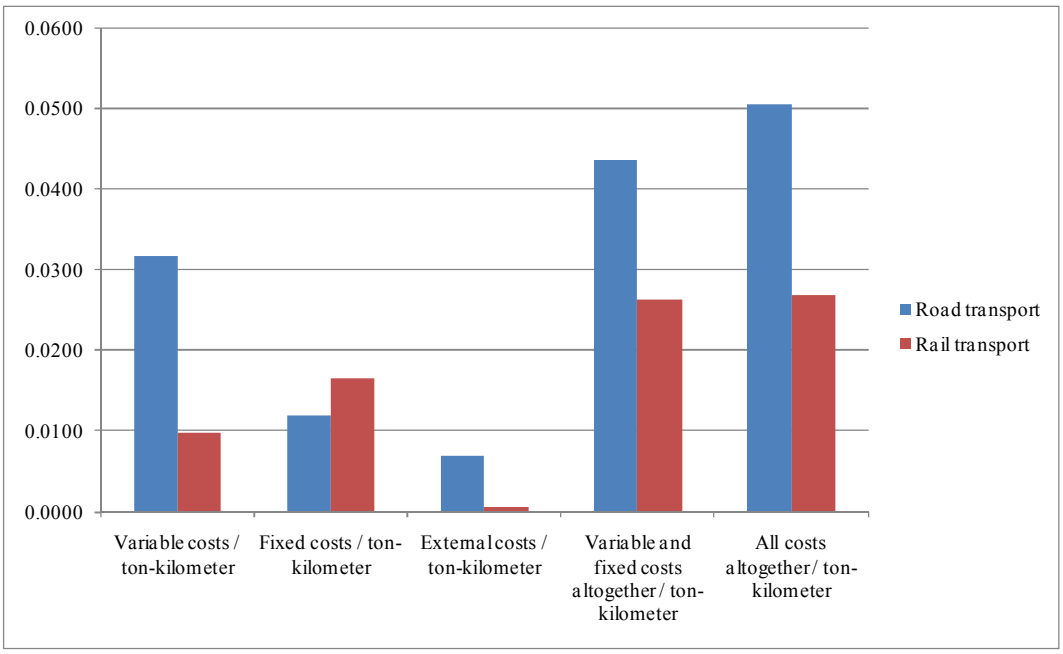

Figure 4.1 Cost comparison of road and rail transport (€ / ton-kilometre).

Static gravitational models were created to estimate and compare different locations of Finland that could serve as a dry port. The location of the city of Kouvola is mediocre, if only Finnish inland transport is taken into account. The location of Kouvola increases its suitability, if eastern transit traffic is taken into account together with Finnish inland transport. The optimal number of dry ports in Finland would be around four to five, if total costs of transport are minimised. If only environmental costs of transport are minimised, then the optimal number of dry ports would be around nine or even more, because rail transport is a much more environmentally friendly mode of transport than road transport. Because of that, the environmental friendliness of the Finnish transport system can be increased by progressively replacing road transportation with rail transportation.

The results of the first stage of the dry port concept research are described in more detail in the research report by Henttu et al. (2010) and in the articles by Henttu et al. (2011) and Henttu & Hilmola (2011).

4.2 Regional survey study on the dry port concept in South-East Finland

The second stage of the study covered a survey research concerning the dry port concept. It was mainly researched by asking regional logistics companies about their opinions of the dry port concept, intermodal transport and the environmental impacts of transport. Furthermore, information management systems were also briefly studied as well as the most important seaports and import and export cities for the logistics companies. Data gathering was conducted with a web-based questionnaire. About 320 companies were invited to fill in the questionnaire, of which 27 answered. The target companies are located in South-East Finland.

The respondent companies (located near the cities of Hamina, Lahti, Lappeenranta, Kotka and Kouvola) found many advantages but also disadvantages in the dry port concept. They believed that it is possible to increase capacity and cost-efficiency of a transport system by implementing a dry port concept. It is important that the dry port concept has to be seamless in operation so that lead-times will not increase heavily. In addition, dry ports enable logistics companies to follow stricter regulations (e.g. following the driving and resting time directive). Other possible benefits include more versatile and affordable services, reduction of environmental impacts and reduced warehousing needs of customers. The mentioned disadvantages of the dry port concept included increased lead times and more complex transport systems due to increased transport modes and transhipments. In addition, the respondent companies believed that the tracking and tracing of freight becomes harder. Furthermore, implementing the concept was believed to be expensive.

According to the results of the study, intermodal transport is not common in Finland, although many companies have planned to use intermodal transport in the near future. Some of the companies who took part in the survey assumed that cost-efficiency and environmental impacts of transport can be enhanced with the use of intermodal transport. Local logistics companies are not sure whether or not intermodal transport is an environmentally friendlier mode than unimodal road transport. Decreasing environmental impacts originating from transport is seen as an important task, but few companies have made investments towards environmentally friendlier transportation. Almost every respondent company will invest in decreasing environmental impacts of transport in the near future.

The survey study showed that in the respondent companies the most common ways of exchanging information between different actors are traditional email and fax. Email is used in every respondent company and fax is used approximately in 80 percent of the respondent companies. More advanced information management systems (e.g. SAP) are rarely used in the logistics companies in South-East Finland.

The survey study also revealed that the two most important export and import cities for the logistics companies of South-East Finland are Kouvola and Lappeenranta. The three most important seaports are Port of Kotka, Port of Hamina and Port of Helsinki. During late spring of 2011 Ports of Kotka and Hamina merged as Port of HaminaKotka.

The results of the second stage of the dry port concept research are described in more detail in the research report by Henttu (2011).

4.3 Transhipment costs of intermodal transport in Finnish context

The aim of the third stage of the research was to study transhipments and the costs of transhipments (road and rail transport modes are taken into account). Cost accounting with the help of two case companies was the main method at this research stage. Case companies are large logistics service providers, of which the first one is situated inland

and the other one is located in a seaport area. Process charts of both companies' transport processes were drawn up to help in cost accounting.

4.3.1 Literature review

Intermodal transport needs certain minimum distance to gain better cost-efficiency than unimodal road transport. Reason for this is the costs of transhipping an intermodal loading unit from one transport mode to another during intermodal transportation. In unimodal transport, there are no transhipment costs, i.e., unimodal road transport is most cost-efficient in short distance transportation. Figure 4.2 illustrates the cost structure of unimodal road transport and intermodal transport. (Arnold et al. 2004; Macharis et al. 2010; Macharis & Bontekoning 2004)

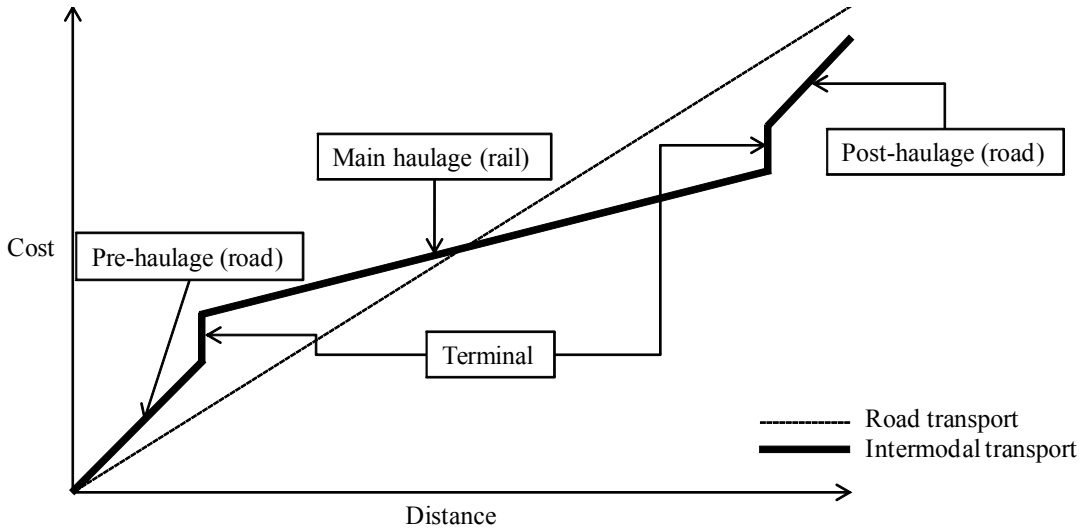

Figure 4.2 Cost structures of unimodal road transport and intermodal transport. (Adapted from Rutten, 1998)

4.3.2 Results

The study revealed that transhipping intermodal loading unit from one transport mode to another costs about 35 to 44 euros. If the loading of intermodal loading unit is included in the cost estimations, then the costs are about 100 to 150 euros per one intermodal loading unit. Smaller cost estimations (35 and 100 euros) can be achieved in an inland intermodal terminal, whereas the higher costs occur in an intermodal terminal situated in seaport or near seaport. Costs are summarised in Table 4.1.

Table 4.1 Summary of cost estimations for transhipping ILUs and loading ILUs and transhipping them.

		Seaport situated company	Inland situated company
Costs of transshipping ILUs	Total costs	790	634
	Costs per container	44	35
	Costs per ton	2.9	2.3
Costs of loading ILUs and transshipping	Total costs	2,650	1,834
	Costs per container	147	102
	Costs per ton	9.8	6.8

The main reasons for different costs in inland and seaport situated terminals are different salary and rental levels. Furthermore, procurement costs of sites and premises are often higher near or in a seaport area. It is possible to achieve large cost savings, if large part of intermodal loading units handled near or in a seaport area could instead be handled in an inland intermodal terminal.

The results of the third stage of the dry port concept research are described in more detail in the research report by Henttu & Multaharju (2011).

4.4 Simulation models

During the research on the dry port concept, two different simulation models were created. The aim of both simulation models is to simulate the effects of the dry port concept in the Finnish transportation network. Both simulation models can be used on the Internet site at www.kuivasatama.fi.

The city of Kouvola is used as a dry port in the first simulation model. User of the model can choose different import and export cities used in the Finnish context and the number of the intermodal loading unit used. The simulation model simulates the current state of the transport network, in which no rail transport is used, and the dry port implemented transport network, in which only rail transport is used between Port of Kotka and the city of Kouvola (all the other connections use road transport). The model calculates transportation costs for both scenarios. In addition, the simulation model calculates different environmental costs, which are caused by carbon dioxide, noise, accidents and congestion. The result of the first simulation model is that transportation costs can be decreased by implementing a dry port concept. Furthermore, environmental costs can be considerably decreased by implementing a dry port concept instead of only using road transport.

The second simulation model is the first interactive model that simulates intermodal transportation flows in the Finnish context. The aim of the simulation model is to research possible effects in transportation costs and carbon dioxide emissions in a dry port implemented transportation network. User can choose what cities are used as dry ports. Transhipment costs are included in this simulation model. About 200 different municipalities are included in the simulation model as import and export cities for freight. In addition, the user can see what will be the effects if different dry ports and different number of dry ports are chosen. The main finding of the simulation model is that with

the current cost structure it is not sensible to use many dry ports in Finland. Transportation costs can be optimised by using up to five dry ports. If dry ports are implemented in Finland, they should be located so that the length of the rail connection and attainability of people is maximised. A good possible location for a dry port is Middle-Finland. Number of dry ports can be significantly increased if only carbon dioxide emissions are taken into account, because every implemented dry port decreases CO_2 emissions. Depending on the number of dry ports, CO_2 emissions could be decreased by 20–40 %.

4.5 Summary and conclusions

According to the research results, the dry port concept could be used in Finland cost-efficiently. Cost-efficiency could not be significantly enhanced in Finland, because distances between the main populated areas in Finland are rather short. If transit traffic is taken into account, the cost-efficiency can be significantly increased by using a dry port concept in the Finnish transportation network. Cost-efficiency increases alike if rail transportation distance increases in comparison with road transportation. Transhipments at intermodal terminals increase the costs of the whole intermodal transport. This is why rail distances need a certain minimum distance (break-even distance) to become more attractive, if compared to unimodal road transport.

Environmental impact (e.g. CO_2 emissions, noise, congestion and accidents) can be decreased in major amounts by using the dry port concept. The environmental impact originating from transportation can be decreased considerably by adding up to eight or nine dry ports. Environmental impact can further be decreased by adding more dry ports, but the decrease is very small. There is a direct connection between the amount of rail transportation and environmental emissions if road transportation is decreased at the same. This is due to rail transportation being an environmentally friendlier mode than road transport.

The study revealed that traditional email and fax are still commonly used ways of exchanging information between different actors in the logistics companies in South-East Finland, while more advanced information management systems (e.g. SAP) are used rarely. If a dry port solution is to be implemented in the whole of Finland, it is important to consider how the information exchange between different actors can be carried out as efficiently as possible. Because all dry port customers are also customers of Finnish seaports, seaports and dry ports should use the same information systems to allow better information sharing between them. In the future, it would be important to study whether it is possible to connect the dry port solution and its information flows to the Finnish port community system.

According to the cost model, rail transport is a less expensive mode of transport in external and internal costs. In addition, a simulation model was created to compare conventional road transport and dry port implemented transport. The result of the model is that if only costs of freight movement are considered, the dry port implemented transport is environmentally friendlier and more cost-efficient. If transhipment costs are also included, the cost difference between intermodal transportation and unimodal road

transportation is slight in Finnish inland transportation. Still, the environmental impacts can be decreased in large amounts by using intermodal transport. The results of the gravitational models are that the city of Kouvola is in a mediocre position to be a dry port if only Finnish inland distribution is considered. Russian transit traffic through Finland improves the location of Kouvola to serve as a dry port.

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5 SUMMARY

This is the final report of the Mobile Port project which has sought ways to improve the management and control of port-related sea and inland traffic with the aid of information and communication technologies. The project has studied the port community systems used worldwide, evaluated the suitability of a port community system for the Finnish port operating environment and created a pilot solution of a Finnish PCS in the port of HaminaKotka. Further, dry port concept and its influences on the transportation system have been explored.

The Mobile Port project comprised several literature reviews, interviews of over 50 port-related logistics and/or ICT professionals, two different kinds of simulation models and included the designing and implementing of the pilot solution of the Finnish port community system. The results of these multiple studies are summarised in this report. Furthermore, recommendations for future actions and the topics for further studies are addressed in the report.

The study revealed that the information systems and services used in Finnish ports are quite advanced. However, information sharing in a typical Finnish port-related supply chain has several bottlenecks that cause delays in shipments and result in wasting resources. Some examples of these bottlenecks are the extensive use of traditional bilateral communication methods (e.g. paper documents, telephone, fax and email), a large number and diversity of documents/messages, the incompatibility of information systems of different port-related actors as well as the varying practices and requirements between different actors, ports and states. Further, the information systems and services used in Finnish ports are quite scattered from the user's point of view. They are also more or less orientated to serve the needs of the authorities in the maritime environment, while less attention is paid to land-side transportations and the business needs of companies.

In order to improve the information exchange of the port-related supply chains, many ports around the world have developed port community systems (PCS) to serve comprehensively the information exchange of the port community. When using a PCS, there is ideally no need for bilateral communication and multiple communication methods between various parties because every port-related actor sends its information to the central system that can be accessed by other actors to get the information they need. The potential benefits of port community systems are manifold: decreased clerical and paperwork, improved information quality and integrity, enhanced efficiency and customer satisfaction, reduced costs and delivery times, etc. For example, it has been reported that with the national Port-MIS system used in Korea it has been possible to reach logistics cost savings of USD 100 million mainly due to reduced personnel and paper work as well as harmonization and automation of the port-related systems.

The Internet survey on port community systems revealed that there are at least 30 different kinds of port community systems around the world. Some of the systems are used only in a certain port, some of the systems area national and some of the systems are used in several ports. Many of the PCSs have been established in the ports located in

Western Europe and southern, eastern and south-eastern parts of Asia where also the biggest container ports are concentrated. Port community systems are usually developed to meet certain needs of a port community. Therefore, PCSs in different ports usually differ from each other in both their technical implementation and their service contents. The national administrative cultures, laws, rules and trading habits also have an impact to the operation models of the port community systems. Some of the port community systems operate mainly as message delivery centres and do not offer actual applications, while some of the PCSs do not only exchange messages between various port-related actors but different kinds of applications can also be connected to the system and the information they produce can be combined and utilised in the PCS. Good examples of port community systems are Portbase system in the ports of Amsterdam and Rotterdam, DAKOSY system in the port of Hamburg, TradeNet system in the port of Singapore and Korean national system Port-MIS.

The Finnish port community system can be used to solve the information flow problems that have not yet been resolved in other ways. Since the authorities and the largest companies operating in Finnish ports have already established practices for data exchange, the Finnish PCS should be focused on serving information services to small and medium-sized companies. The PCS could benefit the members of the community by improving customer services, enabling more automated service processes, and serving as one common source of information. The exchange of business-related information should have a key role in the system but other kinds of applications should also be taken into consideration. In any case, the service content of the Finnish PCS should be based on the real needs of the Finnish port community. At first, the Finnish PCS would operate in the port of HaminaKotka where the pilot solution of the system has been implemented. In the long run, the aim should be to develop the Finnish PCS to cover other Finnish ports as well and to operate at the national level. The Finnish PCS should also have interfaces with other maritime and port-related information systems, for example PortNet. Almost 30 different kinds of potential services or service entities were discovered during the study.

In order to make funding of the Finnish PCS possible, its costs should be kept as low as possible and, therefore, the open source code solutions would be worth considering. Implementation of the Finnish PCS should be phased in by using a modular implementation approach, in which each module has clear objectives and concrete benefits for all parties involved. The promotion of the Finnish PCS would need a broad-based development community to which ports and port-related companies would commit themselves and which would make decisions on what services to be implemented, find the necessary financing for the investments, act as a commissioner of development projects, and further on take responsibility for the operating costs of the technical environment.

The study also showed that port community systems can improve the environmental aspects of logistics in two different ways. Firstly, PCSs can provide direct environmental benefits. The most potential direct environmental benefits of PCSs are the reduction of emissions through the intensification of logistic activities, and the decrease of paper documents and use of printing paper by means of electronic documents provided by a PCS. Port community systems can also affect the environmental aspects of logistics, for

example through optimisation of transport routes and load capacity, tracking of cargo and use of central servers. Secondly, port community systems can be used as an environmental tool by a port community. A PCS solution could contain a separate section for the environmental issues including, for example, a data bank for environment reports and other documents, certification systems (e.g. ISO and EMAS), logistics environmental calculators and simulation models, an information channel for environmental issues, a communication channel for environment and quality personnel as well as cargo tracking and tracing services. The results of the study clearly showed that green values should be very carefully taken into account in the planning and implementation of PCSs since they can bring a major competitive advantage to related actors and promote environmental protection in a broader context as well.

A pilot solution of a Finnish PCS was created during the study in order to test electronic information sharing between different actors in transport chains through sea ports. The pilot solution contains a portal named Portconnect for the pilot system (www.portconnect.fi) and two different kinds of applications: Rail Wagon Exchange Service and Border-Crossing Service. *The Rail Wagon Exchange Service* is designed to electronically provide the parties with the wagon exchange order information. This speeds up the process of unloading the wagons, and makes the process information real-time and transparent. The reasons behind the problem situations are also easier to discover afterwards by using systems log files. The piloting partners in this application have been the Finnish logistics operator VR Transpoint Corp and the Finnish stevedoring company Steveco Ltd. *Border-Crossing Service*, in turn, is designed to exchange information between stakeholders about transport which is crossing the Finnish-Russian border, and to send the extended electronic TIR document files to the Russian Customs authorities. The application is capable of importing data from the forwarding and shipping systems. The application also collects information about vehicle movements both in Russia and in Finland with GPS. GPRS data transmission between the vehicle terminal and the service is also available. The piloting partners in Border-Crossing Service are a Finnish driving-related data operator Helpten Ltd., a company of independent surveyors, loss adjusters and claims managers Lars Krogius Ltd. and a Finnish transport company T Lehtinen Ltd. Finnish and Russian Customs authorities are the external stakeholders in this application.

The pilot solution of the Finnish PCS was implemented by using open source products. This brings a number of advantages compared to commercial products (e.g. operating system and hardware environment independent solution, service-oriented implementation of the portal and large savings in license fees). The portal of the pilot system is based on an open source portal product called Liferay Portal 6.0 and applications in the pilot system are implemented in Java. Mule ESB (Enterprice Service Bus) message broker product was selected to provide integration services in the pilot system of the Finnish PCS. The following protocols and connection methods, among others, are supported: http / https, FTP / SFTP, JMS (string formatted messages), e-mail, SMS, SQL and SOAP. All these protocols can be used to transfer, for example, EDIFACT and XML messages.

Piloting the Finnish port community system has mainly gone well. The Portconnect web platform and its integration extension Mule ESB have been quite easy to implement. The features in the Liferay portal are flexible enough to fulfil the needs of the PCS portal. The programming of the user interface of the application has also gone without any big problems. The difficult part has been the system integration definition and implementation. It has been time consuming to have all the parties to co-operate effectively. The business network has many organisations, which all have their own restrictions in integration implementation. There have been restrictions on resources, security, responsibilities etc. In the next new interfaces, integration process will be easier because the first bottlenecks have already been solved in the first pilot phase. The Portconnect portal is now running and it is up to the logistics sector to find synergies in the ICT services production the same way that has been done in advanced PCS solutions around the world. The portal will have a new hosting organisation in spring 2012. The Portconnect stakeholder's business network has also had its first meetings. Presently, promising prerequisites exist for enlarging the Finnish PCS from the pilot phase to a fully operating portal, which will serve all Finnish ports and their business communities.

A dry port concept and its potential in South-Eastern Finland were also studied as a part of the research. The results of the study revealed that the dry port concept could be used cost-efficiently in Finland. The cost-efficiency of the dry port concept increases if transit traffic is taken into account. The cost-efficiency also improves if rail transportation distance increases in comparison with road transportation. Transhipments at intermodal terminals increase the costs of the whole intermodal transport. This is why rail distances need a certain minimum distance (break-even distance) to become more attractive, if compared to unimodal road transport. The environmental impact can also be decreased by using the dry port concept. The more dry ports are used, the more environmental impact originating from transportation decrease. Since rail transport is an environmentally friendlier mode than road transport, the amount of emissions can be reduced by using more rail transport instead of road transport. The study showed that the city of Kouvola is in a mediocre position to be a dry port if only Finnish inland distribution is considered. Russian transit traffic through Finland improves the location of Kouvola to serve as a dry port. If a dry port solution is to be implemented in the whole of Finland, it is also important to consider how the information exchange between different actors can be carried out as efficiently as possible. In the future, it would be important to study whether it is possible to connect the dry port solution and its information flows to the Finnish port community system.

6 RECOMMENDATIONS FOR FUTURE ACTIONS

Koskinen et al. (2010) drew up in their study an outline for the development path of the Finnish port community system for the years 2011–2017 (Figure 6.1). They suggested that the Finnish PCS should be developed as a series of software projects. The development community could make decisions of the final results, the implementers and the purchases of the projects. Using different progression stages makes it possible to systematically develop the system and, therefore, it is rather fast to respond to possible changes concerning the development of the Finnish PCS.

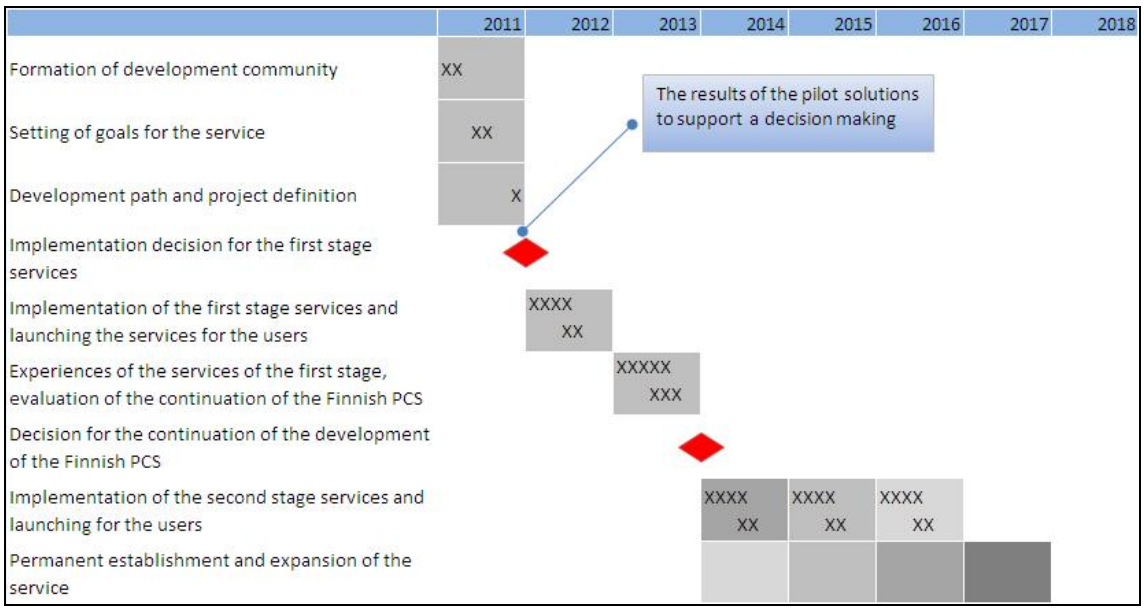

Figure 6.1 Development path of the Finnish port community system. (Adapted from Koskinen et al. 2010)

During the Mobile Port project, the Portconnect portal for the Finnish port community system (available at https://www.portconnect.fi) and two pilot applications for the system have been developed. In the near future, these two pilot applications should be completed and be taken into operational use. Especially at the early stages of the deployment of the pilot applications of the Finnish PCS, it would be important to monitor the user acceptance of the new system by collecting feedback from the users of the system and taking into account different aspects of the system (e.g. possible malfunctions, ease of use and needed additional functions). In this way, the applications could be developed to meet the needs of different users as well as possible. It would also be reasonable to develop a way to measure and monitor benefits provided by the new applications. Clear evidence of the benefits gained by the pilot applications will help further development of the Finnish PCS and the marketing of the system to the whole port community. The results of the Mobile Port project showed that port community systems can bring many benefits including, for example, operational, economical and environmental benefits. Therefore, different aspects of the system should be taken into account when the benefits of the system are measured and monitored.

The development of the Finnish port community system should be continued by surveying other potential applications for the Finnish PCS and their market potential so that

the system can be developed as a comprehensive port community system that can really serve the whole Finnish port community with all its potential. Thanks to the modular implementation and open source code solutions of the pilot solution of the Finnish PCS, adding new applications to the Finnish PCS promises to be easy and fast. It is important to discover applications that can meet the real needs of the Finnish port community. The survey of potential new applications should cover both authorities and companies, and the survey should be targeted both on management and on operational level of organisations in order to get as broad a picture of the needs of the Finnish community as possible. Existing information systems and ongoing/pending maritime and port-related information system projects (e.g. national single window (NSW) solution) should be taken into account when new applications for the Finnish PCS are considered.

The results of the Mobile Port project showed that the port community system has a lot of potential to reduce the environmental impacts of logistics in Finland. The Finnish PCS can be used as a means to meet the growing demands of tighter emissions regulations. Therefore, green values should very carefully be taken into account in the planning and implementation of the Finnish PCS. When new potential applications for the Finnish PCS are surveyed, it should also be examined whether there is a need to build an environment section into the system and be clarified what kinds of services the environment section could contain. This should be carried out in close cooperation with environment and quality professionals and with authorities.

During the Mobile Port project, a development community for the Portconnect service was established to support and steer the development of the Finnish PCS. The Portconnect community is convened by the Finnish Port Association and it consists of both authorities and companies. The development community makes decisions on what services will be implemented, finds the necessary financing for the investments, acts as a commissioner of development projects, and further on takes responsibility for the operating costs of the technical environment. The role of the community in the development of the Finnish PCS is very important. Therefore, it should be ensured that all the members of the community are committed to develop the Finnish PCS in the future. It is also important to make sure that the constitution of the community will remain heterogeneous enough so that different viewpoints of various actors can be taken into account in the development of the system.

The pilot solution of the Finnish PCS is developed to operate in the port of Hamina-Kotka. However, the pilot solution is designed in a way that makes it possible to extend the system to cover other ports in Finland as well. At the latest when the number of applications of the Finnish PCS increases, it should be appropriate to study if there is a need and resources to extend the Finnish PCS to operate in several ports or even on a national level. At this stage, the potential of the system in dry ports and other inland terminals should also be examined. In the long run, it could be reasonable to study whether there would be possibilities to connect the Finnish PCS to a Baltic Sea wide, European-wide or even worldwide maritime and port-related network since the biggest benefits from this kind of information system can be achieved when information on the whole supply chain can be utilised by the system.

The study of the dry port concept revealed that it would be reasonable to more accurately examine what kind of solution could be the most suitable for a Finnish dry port. Is there a need to build only one dry port or many dry ports in Finland to guarantee the efficient operation and sufficient capacity for a Finnish dry port solution? What would be the most suitable location(s) for (a) Finnish dry port(s)? What kind of infrastructure and superstructure a Finnish dry port solution should have? What kind of information flows are needed in a dry port, and could the Finnish port community system be utilised to exchange these information flows between different stakeholders? The Swedish dry port network could be used as a case example when looking for answers to these questions. In addition, it would be beneficial to clarify whether a dry port or a dry port network would help Finland to achieve the low sulphur fuel requirements set by the International Maritime Organization.

APPENDICES

Appendix 1 List of publications produced during the Mobile Port (MOPO) research project.

Research reports and theses

Brunila, O.-P., Posti, A. & Tapaninen, U. (2011). Sataman informaatiokeskuksen mahdollisuudet ympäristövaikutusten vähentämisessä [Potential of port community system in the reduction of environmental impacts]. Publications from the Centre for Maritime Studies University of Turku, B 183.

Henttu, V. (2011). Regional Survey Study from Dry Port Concept in South-East Finland. Lappeenranta University of Technology, Department of Industrial Management. Research Report 230.

Henttu, V., Lättilä, L. & Hilmola, O.-P. (2010). Financial and Environmental Impacts of a Dry Port to Support Two Major Finnish Seaports. Lappeenranta University of Technology, Department of Industrial Management. Research Report 224.

Henttu, V. & Multaharju, S. (2011). Transhipment Costs of Intermodal Transport in Finnish Context. Lappeenranta University of Technology, Department of Industrial Management. Research Report 234.

Hyle, J. (2010). Tiedonkulun sähköistämismahdollisuuksien kartoittaminen ja priorisointi eri toimijoiden välillä huolitsijan näkökulmasta [Identification and Prioritization of Electronic Data Interchange between Different Parties from Freight Forwarders Perspective]. Bachelor's thesis, Kymenlaakson ammattikorkeakoulu, University of Applied Sciences, Logistics.

Koskinen, P., Rautiainen, P. & Rinta-Keturi, I. (2010). Sataman informaatiokeskus ja sen rajapinnat [Port information system and its interfaces]. Publications from the Centre for Maritime Studies University of Turku, B 179.

Kuparinen, J. (2011). Transitoliikenteen hallintajärjestelmät osana Mobiilisatama-projektia [Transit traffic control systems as a part of the Mobile port project]. Bachelor's thesis, Kymenlaakson ammattikorkeakoulu, University of Applied Sciences, Industrial management.

Posti, A. (ed.) (2012). e-Port – Improving the efficiency of Finnish ports with intelligent systems. Final report of the Mobile Port project. Publications from the Centre for Maritime Studies University of Turku, A 58.

Posti, A., Häkkinen, J., Hyle, J. & Tapaninen, U. (2010). Satamayhteisön informaatiokeskus tiedonvälityksen tehostajana [Promoting information exchange with a port community system]. Publications from the Centre for Maritime Studies University of Turku, B 175.

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Scientific, conference and popular articles

Henttu, V. & Hilmola, O.-P. (2011). Financial and Environmental Impacts of Hypothetical Finnish Dry Port Structure. Research in Transportation Economics (2011) 1–7.

Henttu, V. & Hilmola, O.-P. (2011). Dry Port Concept, Intermodal Transport and Environmental Impacts of Hinterland Transport in South-East Finland. Logistics: modern trends of development. St. Petersburg State Engineering University of Economics, 14.–15.4.2011.

Henttu, V., Lättilä, L. & Hilmola, O.-P. (2011). Optimization of Relative Transport Costs of a Hypothetical Dry Port Structure. Transport and Telecommunication, 2011, Volume 12, No 2, 12–19. Transport and Telecommunication Institute, Lomonosova 1, Riga, LV-1019, Latvia.

Jurvanen, N. & Posti, A. (2011). Mobiilisatama-hanke [The Mobile Port project]. Liikenteen suunta 4/2011, pp. 38–41.

Lindholm, T. (2010). Saving the Baltic sea: the Finnish point of views - Enhancing port related logistics - the Mobile Port project. Russian Regional Business Review / Issue 1, 2010.

Posti, A., Häkkinen, J. & Tapaninen, U. (2010). Satamayhteisön informaatiokeskus tiedonvälityksen tehostajana [Promoting information exchange with a port community system]. Tie & Liikenne 9/2010, pp. 8–10.

Posti, A., Häkkinen, J. & Tapaninen, U. (2011). Promoting information exchange with a port community system – case Finland. Hamburg International Conference of Logistics 2011 (HICL2011), Maritime Logistics and International Supply Chain Management 8.–9. September 2011.

Posti, A., Pulli, H. & Tapaninen, U. (2011). Positioning technologies in product tracking. NOFOMA Conference, June 9–10, 2011, Harstad, Norway, pp. 1005-1021.

Posti, A. & Tapaninen, U. (2011). Port Community Systems – Case Finland. Baltic Transport Journal 2/2011, pp. 24–25.

Other publications

Brochure of the Mobile Port project (in Finnish).

Brochure of the Mobile Port project (in English).

Roll-up poster of the Mobile Port project.

Two dry port simulation models.

Appendix 2 Examples of maritime and port-related information systems used in Finland. (Finnish Customs 2010; Finnish Transport Agency 2010a, 2010b, 2010c, 2010d; IDABC 2005; IMO 2010; Satamatieto Oy 2010; Visy Oy 2010; VR Transpoint 2010 & 2011; VTT 2009 – These references can be found in the reference list presented in chapter 2)

System	Description
AIS	An automated tracking system which makes it possible to get real-time information from a large area about ships and their movements.
eServices of Finnish Customs	eServices of Finnish Customs can be used to submit declarations to Customs electronically. For example, import declarations, export declarations, entry summary declarations and exit summary declarations of goods, and transit declarations can be submitted to Finnish Customs by using eServices.
eServices of Finnish railways	VR Transpoint, a leading railway transport company in Finland, offers its customers various electronic services which can be used, for example, to manage and submit transport documents, share transport order information in real-time and book transport capacity, track and trace the progress of transportations in real-time, and send and receive sale invoices.
GOFREP	A mandatory ship reporting system which aims to improve the safety of navigation, to monitor compliance with the International regulations for preventing collisions at sea and to increase the protection of the marine environment.
IBNet (Ice Breaking Net)	A distributed traffic information system used by the Finnish and Swedish icebreaking services.
IBPlott	An extension module of IBNet which provides a graphical map-based presentation displaying the traffic situation on top of satellite images and ice charts.
LRIT (Long Range Identification and Tracking)	A worldwide vessel tracking and identification system which allows the tracking of vessels beyond the coverage of coastal radio communications stations.
PDS (Port Data System)	An enterprise resource planning system which is developed mainly to the needs of the port authorities.
PortEnSys	A software for calculating and simulating of air emissions caused by the land and sea traffic of a port.
PortNet	A Finnish national maritime information system serving the different parties of maritime transport. The vessel notifications, cargo declarations, dangerous goods notifications and waste notifications from every ship call directed Finnish sea ports are entered to the PortNet system.
RailTrace	An Internet-based consignment and wagon tracking and tracing system for rail freight traffic between Europe and Russia.
SafeSeaNet	A European platform for maritime data exchange between member states' maritime authorities. The member states of the EU are obliged to send information about the routes, the hazardous materials and the possible accidents of every vessel that are visiting the ports of the state to SafeSeaNet system.
Visy Gate	An automated access and area control system which is capable of identifying and tracking vehicles and commercial containers/cargo at ports and other logistics areas.
VTS (Vessel Traffic Service)	A vessel traffic service, the purpose of which is to improve the maritime safety, enhance the smoothness of vessel traffic, and prevent accidents and environmental hazards caused by accidents.

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