EUROBORDER

Contract No. WA-95-SC.153

Supported by the Commission of the European Communities - DGVII
R&D Project - Transport

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Final Report for Publication
Document: Final Report for Publication

Work Area: WP100

Abstract: The report comprises the new developments and the work performed by the EUROBORDER consortium. It provides information on the project objectives, the approach and the main results and thereby summarises all knowledge accumulated during the project work.

Contributors to the report: The authors of this report are Lars Hultén, Lars Källström and Christiane Warnecke, TFK

Contributions have been made by all partners with their previous work.

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Supporting Partners: 21 companies from Spain, Greece, Denmark, Finland, Sweden, Norway and Germany.
## Partnership details

<table>
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<tr>
<th>Partner</th>
<th>Role</th>
<th>Description of Role</th>
<th>Type of Organisation</th>
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</table>
| TFK           | Coordinator | • Technical management  
• Administrative coordination  
• User interaction and coordination with other projects  
• Leader of the conclusions and recommendations workpackage                                                                                       | ROR                  |
| NTU           | Contractor | • Responsible for user-interaction, Support for feasibility assessment and evaluation.                                                                                                                                   | ROR                  |
| Sintef        | Contractor | • Coordinator of Norwegian partners  
• Leader of the network modelling workpackage  
• Validation of the port model                                                                                                                        | ROR                  |
| MTC           | Contractor | • Coordination of Finnish users  
• Contributions to legal requirements                                                                                                                   | OTH                  |
| Cecil         | Contractor | • Programming and development of the NeuComb/Port model                                                                                                                                                                 | ROR                  |
| TRUTh         | Contractor | • Co-ordinator of the Greek consortium  
• Coordination of the Piraeus scenario work  
• Validator of the port model                                                                                                                        | ROR                  |
| EPPE          | Contractor | • Interface between the Ministry and the Spanish scenario port                                                                                                                                                    | IND                  |
| ISSUS         | Associated Contractor | • Leader of Problem Analysis workpackage                                                                                                                                                                             | EDU                  |
| Color         | Associated Contractor | • Contributor to the identification of the current situation and the solution to be analysed                                                                                                                         | IND                  |
| OsloP         | Associated Contractor | • Owner of the scenario port Oslo  
• Coordination of the Oslo scenario work  
• validator of the port model                                                                                                                         | IND                  |
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• Leader of scenario generation workpackage                                                                                                                                                                        | IND                  |
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• Evaluation manager of the project                                                                                                                        | EDU                  |
| Port of Piraeus | Associated Contractor | • Owner of the scenario port Piraeus  
• Contributor to the identification of the current situation and the solutions to be analysed  
• Contributor to the scenario development                                                                                                           | IND                  |
<p>| Port of Volos | Associated Contractor | • Contributor to the identification of the current situation and the solution to be analysed                                                                                                                         | IND                  |
| ITP           | Associated Contractor | • Responsible for all scenario related work at the Port of Bilbao                                                                                                                                                   | IND                  |</p>
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<th>Partner</th>
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<tr>
<td>Enyca</td>
<td>Associated Contractor</td>
<td>• Leader of the functional modelling workpackage</td>
<td>IND</td>
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<td></td>
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<td>• Development and update of www site</td>
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<tr>
<td>Isdefe, S.A.</td>
<td>Associated Contractor</td>
<td>• Quality Assurance</td>
<td>OTH</td>
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<th>Description</th>
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<tbody>
<tr>
<td>AEI</td>
<td>Automatic Equipment Identification</td>
</tr>
<tr>
<td>AGV</td>
<td>Automated Guided Vehicle</td>
</tr>
<tr>
<td>AVI</td>
<td>Automatic Vehicle Identification</td>
</tr>
<tr>
<td>DGPS</td>
<td>Differential Global Positioning System</td>
</tr>
<tr>
<td>EDI</td>
<td>Electronic Data Interchange</td>
</tr>
<tr>
<td>EDIFACT</td>
<td>Electronic Data Interchange for Administration, Commerce and Transport</td>
</tr>
<tr>
<td>EDP</td>
<td>Electronic Data Processing</td>
</tr>
<tr>
<td>FLT</td>
<td>Fork Lift Truck</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communication</td>
</tr>
<tr>
<td>HIT</td>
<td>Hongkong International Terminal</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITU</td>
<td>Intermodal Transport Unit</td>
</tr>
<tr>
<td>JIT</td>
<td>Just-In-Time</td>
</tr>
<tr>
<td>LoLo</td>
<td>Load on/Load off; for container vessels with unwheeled cargo</td>
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<tr>
<td>mill.</td>
<td>Million</td>
</tr>
<tr>
<td>MIS</td>
<td>Management and Information System</td>
</tr>
<tr>
<td>MTL</td>
<td>Modern Terminals Limited</td>
</tr>
<tr>
<td>NPV</td>
<td>Net Present Value</td>
</tr>
<tr>
<td>OBU</td>
<td>On Board Unit</td>
</tr>
<tr>
<td>OCR</td>
<td>Optical Character Reading</td>
</tr>
<tr>
<td>OD</td>
<td>Origin-Destination</td>
</tr>
<tr>
<td>PBP</td>
<td>Pay Back Period</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>RF tag</td>
<td>Radio Frequency tag</td>
</tr>
<tr>
<td>RMG</td>
<td>Rail Mounted Gantry crane</td>
</tr>
<tr>
<td>RoRo</td>
<td>Roll on/Roll off; for ferries with wheeled cargo</td>
</tr>
<tr>
<td>RTG</td>
<td>Rubber Tyred Gantry crane</td>
</tr>
<tr>
<td>SME</td>
<td>Small and Medium size Enterprise</td>
</tr>
<tr>
<td>SMP</td>
<td>Small and Medium size Port</td>
</tr>
<tr>
<td>SSS</td>
<td>Short Sea Shipping</td>
</tr>
<tr>
<td>TEN</td>
<td>Trans European Networks</td>
</tr>
<tr>
<td>TEU</td>
<td>Twenty-foot equivalent unit</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign</td>
</tr>
<tr>
<td>YMS</td>
<td>Yard Management System</td>
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1 Executive summary

This Final Report for Publication presents the results from the work performed by the EUROBORDER consortium during 2½ years, starting in March 1996. It provides information on the project objectives, the approach and the main results and thereby summarises the knowledge accumulated in the project. The detailed work has been documented in several deliverables (see list in chapter 6). Many of them are of public character and are available for a more in depth study of the EUROBORDER results.

Objectives and approach

EUROBORDER was carried out with support from the European Commission, as part of the 4th Framework Programme. It was part of the waterbone section of the transport directorate (DGVII) was related to the following research task:

Research task 6.1.3/7
Identification of bottlenecks of ports as nodal points in the intermodal transport chain, identification of informational, organisational and administrative requirements, concepts and functionalities to integrate ports into the intermodal transport chain including the Trans-European Networks.

The EUROBORDER consortium developed a project programme, that focused specifically on small and medium size ports (SMPs), on port terminals as the node in the transport chain and on unitised cargo (LoLo, RoRo). The aim was to study potential improvements in information exchange, the organisational structure and administrative routines in the terminal and its relations to its customers and the rest of the port community. Information was understood as the tool to support organisation and administration.

The work of the EUROBORDER consortium was divided into several workpackages, which clearly show the project’s structure:

- Inventory of problems and bottlenecks
- Establishment of a functional port terminal model and of user requirements
- Development of a modeling software (port terminal)
- Development of transport network models
- Scenario generation
- Scenario evaluation
- Implementation and demonstration

The workpackages printed in bold contained the core work of the project, the search and analysis of solutions for problems experienced in the current operational situation. The other workpackages were developed to support this core work.

The methodology chosen for EUROBORDER was to perform case studies of a small number of ports. The project then searched for general tools which could be used to solve their particular problems as well as similar problems encountered in other ports. The case study ports in EUROBORDER were:

- Port of Piraeus (container terminal)
- Port of Bilbao (MacAndrews terminal, LoLo)
- Port of Oslo (Color Line terminal, RoRo; Ormsund terminal, LoLo)
- Port of Helsinki (virtual terminal)
**Main results**

Especially in RoRo-terminals, but also in LoLo-terminals, problems were found arising from the large number of actors involved. These problems were found both in relation to the organisations within the port and to the external actors. Port internally, the interactions between the port authority, the terminal operation and the customs were not always the best. Externally the customers which only occasionally used the terminal were a problem because they were not familiar with the procedures to be followed, e.g. related to completing the freight documents. Problems related to planning of the terminal operations occurred with the regular customers. The customers wanted to be able to arrive as late as possible before the vessels should leave, and have the right to make late cancellations of previously confirmed bookings.

The terminals are not able to put any efficient pressure on their customers, but have to provide high flexibility, which makes planning of the operations difficult. It is the terminal operator that has to make sure that he gets the necessary information and confirmation from its customers.

In all of the analysed terminals work was very much paper based and fax and phone were the main means of communication, both port internally and with the customers. This was in many cases not regarded as a problem since the port terminal handling has been working and still works with the adopted manual procedures. The potential efficiency gain through computerisation and automation of procedures is only gradually influencing strategic planning and leading to changes of „traditional“ ways of work.

Based on the problem and bottleneck analysis EUROBORDER developed improvement scenarios for the four case study ports. The scenarios suggest to raise efficiency and competitiveness via:

- Networking of terminal departments,
- Electronic data interchange for communications on a large scale,
- On-line monitoring of movements throughout the terminal,
- Automatic data capture and data handling within the terminal,
- Other organisational changes, e.g. longer opening hours,
- Changes in port terminal layout
- Changes for the interaction with customs and
- Acquisition of new terminal equipment.

The proposed scenarios largely change the administrative routines of port terminals (and to some extent the routines of their customers) and their organisational structure. If all tools from the EUROBORDER scenarios were combined, this would lead to a fully automatic terminal, with up-to-date control over the cargo and its status and electronic communication to all customers and other port organisations.

For small and medium size ports (SMPs) this vision might sound like an „overkill“. A comment from a terminal EDP manager to the final user validation questionnaire was that many improvements would be nice to have, but would not be appropriate. Naturally, the needs of each port terminal have to be analysed carefully, taking its interaction with other organisations into account. Investments into personnel, technology, infrastructure and handling equipment have to be made in accordance with the terminals requirements and possibilities. For an increased efficiency and competitiveness, each port terminal requires a different set of measures, based on the current organisational structure and the problems experienced today.
All proposed changes, be it organisational or administrative changes involving investments into technology, infrastructure or equipment have been collected in a toolbox. The aim of the toolbox is to serve as source of inspiration for European ports, port terminals and their customers.

The scenarios for the case study ports have been evaluated thoroughly. It has been analysed:
- how the terminal operations are changed
- if the scenarios are economically feasible for the port terminal and its customers
- which impacts the scenarios have on the terminals service quality
- if any legal regulations hamper the development
- how the large number of organisations involved interacts, how far it is possible to introduce changes in the market

Different organisations are involved in the scenarios. In addition to the terminal operator, other players as the road haulier, the ship’s agent or the forwarder might also need to decide on investments and implementations. The evaluation has shown, though, that the terminal operator is the party with most costs and benefits. Important quantitative evaluation results are shown in the tables below. The figures are related to the four cases and have to be seen in the context of the specific improvements.

### Operational results: Time savings/efficiency improvements

<table>
<thead>
<tr>
<th>Operational outcome</th>
<th>Percentage Change</th>
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<tbody>
<tr>
<td>Throughput time of truck reduced</td>
<td>-30% to -45%</td>
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<tr>
<td>Yard control routines reduced</td>
<td>-30% to -85%</td>
</tr>
<tr>
<td>Internal equipment handles more ITU</td>
<td>+30%</td>
</tr>
<tr>
<td>Different processes in the administrative follow-up of the transports</td>
<td>-66% to -100% *)</td>
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</table>

### Economic results

<table>
<thead>
<tr>
<th>Economic Evaluation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Pay back period (PBP) for IT technology</td>
<td>3-6 years</td>
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</table>

*) Note. Some processes are automated by EDI which means that time is reduced to 0.

Table 1: Main quantitative evaluation results from EUROBORDER

The scenarios also have positive impacts on the terminal’s customers. The end customer can profit from an increased container throughput per day, reduced storage costs and a reduced total transport time. The transport company can benefit from a reduced truck throughput time which enables it to transport more containers. For the shipping agent the evaluation shows reduced unload/load times and reduced personnel.

Other important results from the analysis are:
- The terminal operator has to carry most of the investments, but also receives most of the profits. However, supporting investments by the customer are a prerequisite.
- The terminal size (economies of scale) plays a major role for the profitability of investments in small and medium size ports (SMPs)
- It might be profitable for a port terminal to train the personnel of small companies/customers that do not have training resources in order to establish the necessary know-how outside the terminal.
- It would be more efficient, if the terminal operator prepares the vessel’s bay plan on behalf of the ship’s agent
- Automatic Identification has to be integrated with Electronic Data Interchange (EDI)
- Road hauliers can reduce total number of lorries for pick-up and delivery, when the
access/exit procedures are automated

- Investment into new heavy handling equipment can substantially increase space efficiency and might be feasible for SMP’s as an alternative to terminal extension or relocation
**Supporting models**

Several models have been developed to support the analysis of problems and potential solutions. A lot of work has been put into the development of a functional view of the port terminal procedures and its interaction with customers, as a basis for analysing the operations. The consortium was not able to find any model meeting our requirements reported in the literature on which we could have based our work. The model resulting from our work is a generic one and therefore applicable to most port terminals. However, it still requires further development. In some areas like for example the resource management, it stays on a very general level. What also needs more work is the integration of the port terminal functions into the overall system architecture for freight transport.

Based on the functional port terminal model, a simulation and optimisation software has been developed. EUROBORDER succeeded to develop a mathematical formulation of an “optimal” decision strategy for the simultaneous routing of cargo and allocation of resources in a port terminal. New about this tool is the combination of algorithms that have been used for the optimisation module. They enable a parallel optimisation instead of a serial. Furthermore, this strategy has been formulated in such a way that it can be incorporated in a “modest” computer environment. A computerised tool, The NeuComb Port Terminal Tool, which runs in Microsoft Windows environment, has been developed. The tool is not a commercial product but a research tool. Optimisation of the program code as well as the integration of additional functionalities would be necessary before the tool could be commercialised.

The simulation and optimisation software enables port terminals to analyse the differences in efficiency for
- pooled vs. unpooled terminal equipment
- dedicated cargo areas vs. handling and storage of cargo without distinction of cargo types
- terminal infrastructure and layout changes
- changes in the number of terminal equipment
- delays due to incomplete information

To analyse the effects of the EUROBORDER scenarios on transport chains, four network models have been developed. The analysis was restricted to a few relations and cargo types for each network. The networks are based upon a few real-life transport chains involving the Norwegian, the Spanish and the Greek scenario ports in EUROBORDER. EUROBORDER has found through analysing these real cases, that the port costs constitute a rather small part of the total generalised costs for a transport from door to door. The quantitative analysis based on generalised costs shows that even if price and time are important, these two factors alone do not explain the choice of a transport solution. The quality of service provided (reliability, flexibility, security, etc.) is equally or even more important.

**Conclusions**

Many of the scenario ideas can be found as “best practice” in the port industry. A common argument of the port industry is therefore that there is no need for further development. The EUROBORDER experience has shown that this argument conceals the real problem. While it is absolutely true that good examples exist, particularly in the larger ports, it is likely true that these solutions are not implemented throughout the industry, and especially not in the small to medium size ports.

EUROBORDER concludes that port terminals must position themselves as an integral part of intermodal transport chains (hinterland-port-sea-port hinterland). There is a big uncertainty when it
comes to information handling, internally and especially externally. Problems arise from the diversity of customers and their needs, lack of standards and lack of trained staff.

As a conclusion, EUROBORDER generalises on what we see (given the objectives of the project) as the three most important issues for ports to consider in order to improve the port terminal’s performance. These key issues are not due to characteristics innate only of the ports studied but are inherent in any system performing similar tasks. However, they still have to find their way into port terminal management. The key issues, or the tree I:s of successful port business are:

- interaction - to actively define a role and a business strategy
- integration - to coordinate investments and operation to exploit synergies
- information – to manage the intermodal transport tasks and contribute to the overall goal

Fine-tuning individual port processes, e.g. the inspection of damages, may achieve improvement of port performance. More importantly though, port performance may be improved by changing the actual way the processes are performed. The total system performance to a large extent is not only dependent on how the individual processes are performed, but on how they are combined and interrelated. This complexity does not encourage specific recommendations and EUROBORDER has therefore focused on tools and processes which can be used for creating and assessing individual solutions. All measures or tools aim at one or more of the three main areas for competitiveness in intermodal transport: Cost competitiveness, time competitiveness and quality competitiveness.

The following table gives an overview of the output of EUROBORDER, the reason for using it and the potential impact of such a usage.

<table>
<thead>
<tr>
<th>Output of EUROBORDER</th>
<th>To be used for</th>
<th>Potential impact</th>
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<tbody>
<tr>
<td>A terminal process model</td>
<td>Harmonisation of tasks to perform</td>
<td>Facilitation of communication and assessments.</td>
</tr>
<tr>
<td></td>
<td>Harmonisation of tasks to perform</td>
<td>Simplifying the use of (and cost for) standard software for terminal management</td>
</tr>
<tr>
<td></td>
<td>Common ground for discussions</td>
<td>Improving the efficiency of land use and organisation</td>
</tr>
<tr>
<td>A simulation/optimisation tool for modelling the processes in the terminal</td>
<td>Decision support in strategic terminal planning</td>
<td>Facilitation of strategies for investments and training in telematics systems for internal and external use</td>
</tr>
<tr>
<td>Feasibility assessment of (information) scenarios</td>
<td>Examples for potential benefits</td>
<td>Facilitation of strategies for organisational and administrative changes</td>
</tr>
<tr>
<td></td>
<td>Provision of methods for assessment</td>
<td></td>
</tr>
<tr>
<td>A “tool box” containing measures for improving information, administration and organisation</td>
<td>Inspiration for improvements based on best practice</td>
<td>More focus on the need to develop and improve information handling capacities.</td>
</tr>
</tbody>
</table>
Many of the changes or „tools” suggested by EUROBORDER need further development before they can be used successfully. This could be supported by future European and national research and development (R&D) projects. Users assessed the following four development areas as most important:

- Improving port terminal efficiency with a focus on city port problems
- Developing and implementing feasible communication systems based on EDIFACT, Internet or Extranets
- The use of technology for automatic identification (standardisation)
- Training of staff, as always important

In addition to the areas mentioned above, the EUROBORDER consortium has concluded that there is a need for further R&D related to:

- Attitudes to change (integration, interaction)
- Functional modelling (system architecture) to continue the EUROBORDER work
- Software tools to support automated procedures, simulation and optimisation tools
- Promoting the business’ interest in standardisation to overcome one of the major obstacles against a rapid development in this sector
2 Introduction

2.1 Aim of the report
This Final Report for Publication comprises the results from the work performed by the EUROBORDER consortium during 2 ½ years, starting in March 1996. It provides information on the project objectives, the approach and the main results and thereby summarises all knowledge accumulated during the project. It is information which the consortium wants to pass on to a wider audience.

All interested parties are naturally invited to go further into detail and study the deliverables which document the results from the different stages of EUROBORDER. A list of all project deliverables is included in chapter Error! Reference source not found.. It has to be noted that some of them are public, others are restricted to a certain audience. This is also indicated in the list.

2.2 Report structure
The third chapter explains the objectives of EUROBORDER. This is done in the context of logistical trends and the development of Short Sea Shipping within intermodal transport. The conclusions and contributions from EUROBORDER are discussed in relation to the original objectives.

The fourth chapter describes the approach used to reach the objective, explaining the workpackages EUROBORDER is composed of. More information on the approach in each workpackage is given in the next chapter. A special reference is made to the simulation and optimisation software developed in EUROBORDER.

The fifth chapter describes the work carried out in the workpackages. It explains the approach and the main results of each workpackage. For the purpose of this report the work is divided into core activities, which directly aim at the project objectives, and supporting activities which are needed to carry out the core activities.

The sixth chapter presents the general conclusions of EUROBORDER, including important areas for further R&D.
3 Objectives of the project

3.1 Background

3.1.1 Global logistical trends

In many countries the transport sector is facing a capacity crisis. Often straightforward expansion of the infrastructure is neither possible nor desirable from financial, socio-economic, and environmental standpoints. However, structural re-shaping of the transport networks’ and the related logistics systems have a great potential for finding efficient solutions, while making use of the limited infrastructure available. Concentration on logistics advancement may be even more important than investment in infrastructure.

Five important global logistic trends, which form the general background for the ports’ future development of logistic services, are briefly described below.

- Internationalisation
- Logistics as a competitive factor
- Specialisation
- Vertical distribution chains
- Networking of logistic data systems

Internationalisation can be seen to have several effects:

- Changes in the competitive environment; new competitors and possibly new competition rules
- Local suppliers will have international competitors
- New markets for logistic services will appear, offering the port the possibility to take on new business roles, in which they can provide customers with value-added services
- Raw material, products and services are purchased on a global market (“Global sourcing”); customers will demand larger geographical coverage from their transport service companies, but will expect no increases in costs, nor deterioration in quality or speed

With products becoming more similar, logistics can be decisive for the competitiveness. In the future logistics management will therefore play an increasingly important role in carma’s strategic management.

Customer orientation will be a key issue and the logistics systems must support this. Ports are no exemption and will also need to focus their activities to meet their customers requirements.

There is a conflict between the trend to focus on the companies core business and the importance of logistics as a means of competition. Outsourcing of the logistics may lead to lack of control over a strategically important activity. Still, it is likely that many companies will concentrate on their own, individual areas of expertise, and use specialists for supporting activities. Those third party logistics services providers must be able to provide their customers with the information they require in order to monitor the logistic activities. In ports, specialisation is likely to happen at least in the smaller ports where the volume of cargo is too low to make a wide range of services profitable.

The term vertical integration refers to organisations performing more than one task in the logistic chain. Vertical integration is on the rise and it is less common nowadays to find the all of the traditional participants involved in the logistic chain. In a vertically integrated chain less ”middle-men” will be involved, and contacts will be made in a more direct way. The information flow between the parties in the logistics chain will therefore be less complex. It will also be easier to develop integrated information systems across organisational borders. Vertical integration enables the
companies to put more emphasis on throughput times and quickly respond to market changes. Ports are affected by these changes and as nodes in the logistics chain, ports may be partners of alliances.

Stiffer competition often means increased competition in mastering information collection, handling and control. In ports the movement of cargo and transport resources needs to be co-ordinated and directed. As critical nodes in the logistics chain ports are important places for information exchange. What role the port will play in the information network is a strategic issue for the port management.

Major trends in this area are:
- Networking within different departments in the company to support the internal logistics
- Networking between companies, and integration of the EDP-systems
- Dynamic information systems in order to support rapid reactions, JIT (Just-In-Time) philosophy

Currently, larger ports and companies in maritime transport are a step ahead of small and medium-size enterprises (SMEs) in using information systems. The use of IT in SMEs in shipping has been hampered by the lack of standards for software and hardware.

**3.1.2 Changing conditions for Short Sea Shipping**

The port industry is undergoing large changes as a consequence of global trends. Increased exploitation of economies of scale in transportation is leading to a concentration of flows, which dramatically changes the conditions for small to medium sized ports (SMPs). In order to assure frequency and minimise the port-time needed to fill the ships, cargo is concentrated to a few Mega ports. These mega ports serve not only their traditional hinterland, but also act as cargo centres in feeder systems.

For the small to medium sized port this often means that they no longer are called by the ocean-going ships. To survive, the SMPs must therefore find new market niches. A SMP can concentrate on special kinds of cargo, in which case it must compete both with other ports in the same niche and with (larger) ports handling this special cargo together with other cargo. The SMP can also become a feeder port or a port in a short-sea shipping network. In both cases the sea transport systems competes with land transport systems, and has the disadvantage of introducing extra transhipments and, sometimes, intermediate storing.

At the same time as the trend towards larger ships introduces difficulties for the SMPs, the port’s users have new requirements on the services because of new production methods and increased awareness of the importance of supply chain management. The whole logistics market is undergoing restructuring; the way of doing business and the roles of the different players are changing. At the same time technological development creates new possibilities. Also the rules of the game are changing. Politicians intervene to create a more efficient and environmentally friendly transport system. There is a pressure on ports to be more efficient and respond stronger to the needs of the market. However, the ports’ limited freedom of action means that rationalisation and adaptation to new requirements have to be done within a physically given system. Changes must be made with great consideration exploiting the possibilities of new technologies.
3.2 EUROBORDER objectives and scope

As a consequence of the changing conditions the competitiveness of the small to medium sized ports is at stake. Trends are, however, changing. A port’s infrastructure is long-lived. New trends that make SMPs more attractive can occur within the life-time of the infrastructure. This has been recognised by EU who has initiated research to increase the competitiveness and efficiency of ports in the area of “soft” factors, like organisation, administration and information. In the 4th framework R&D program the EU supported projects that addressed the following objectives:

Objectives for section 6.1.3 Ports
To increase overall port efficiency and competitiveness and to develop ways to increase the integration of ports as service centres for transshipments and distribution within Trans-European Networks.

More specifically, EUROBORDER choose to focus on the following task:

Research task 6.1.3/7
Identification of bottlenecks of ports as nodal points in the intermodal transport chain, identification of informational, organisational and administrative requirements, concepts and functionalities to integrate ports into the intermodal transport chain including the Trans-European Networks.

Picture 1: Manual check in at the Finnsteve terminal, Helsinki

The EUROBORDER consortium developed a project programme, that focused specifically on port terminals as the node in the transport chain and on unitised cargo (LoLo, RoRo). The aim was to study the information exchange, the organisation and the administrative routines in the terminal and its relations to its customers and the rest of the port community. Information was understood as the tool to support organisation and administration.
The main objective of EUROBORDER was:
“To estimate the impact of changes and development related to the port terminal on the port’s attraction as a node in the intermodal transport chain. Such measures could be changes and improvements of old procedures, but could also incorporate development of new services.”¹

Intermediary objectives were identical to the EU task description given above:

- Detection of problems and bottlenecks in the participating port terminals
- Identification of the requirements of the users
- Identification of improvement measures (combined in scenarios)

All project work was related to a better integration of the port terminal procedures into the transport chain, always considering the terminal’s customers and other port related organisations. The focus for the improvements was on organisational and administrative procedures and the information underlying all these procedures.

During the project a secondary objective became increasingly important. The EUROBORDER work plan foresaw the use of a simulation and optimisation model in the evaluation, to enable the quantitative assessment of the scenario impacts. The model development was more demanding than originally expected. A promising model is in place at the end of the project. Further development is needed, though, for it to be sold on the market.

3.3 Definitions

3.3.1 The port terminal
Given the focus of EUROBORDER and the need to limit the field of study, it was decided to focus on the transshipment of cargo between the land and the sea modes within the organisational context of RoRo and LoLo terminals. Regardless of who is operating the port terminal, it has to fulfill the task of loading/unloading the ships, accept, store and enable the pick-up of the load units.

3.3.2 Organisations addressed
The project also had to be limited in terms of what players to consider. At the start the primary users of the project were defined as port terminal operator and port authority. Euroborder also defined secondary users, namely the customers of the terminal like ship operators forwarders, transport operators (road, rail, waterborne) and ultimately the consignors and the consignees.

In the beginning of the project the influence and importance of other actors in the port environment were also considered. While we found that there is a large and important network of actors that in one way or the other affects the ports, it was necessary to make a choice of which ones to consider in EUROBORDER. Among those actors who we decided not to consider further were various service providers to the port like repair companies, packing centres, container depots, etc..

¹ EUROBORDER Technical Annex, January 1996, TFK et al
During the investigation of problems and possible changes, the organisations involved in the intermodal transport were in the foreground of EUROBORDER's attention. With regard to the conclusions and recommendations political/regulatory bodies and labour unions become similarly important. The following list sums up the organisations taken into account in and affected by the EUROBORDER work:

- Terminal operators, Stevedores
- Port authorities
- Shipping lines, Ship owners, Shipping agents
- Road transport operators, Railway operators
- Shippers, Forwarders
- Customs
- Consignors, Consignees
- Government bodies
- Labour Unions

### 3.3.3 Informational, organisational, administrative aspects

According to the objectives of EUROBORDER and of the related task from the EU work programme, EUROBORDER concentrated on informational, organisational and administrative aspects of port terminals.

**Informational** refers to the content of, and means and procedures for, communication, inside the port as well as with the external actors.

**Organisation** is used both in a structural and procedural sense. In structural terms **organisation** refers to the totality of institutions, structures and arrangements framing and regulating the coordination of work. In procedural terms **organisation** is the allocation of tasks to various processes as well as the sequential arrangement of tasks and processes.

The **administration** related to a particular process, or a set of processes, are all the supporting activities carried out in order to control, co-ordinate and document (for terminal internal and external purposes) the process(es) in question. One aspect of **administration** is the documentary side of the internal and external procedures of the port terminal.
4 Means used to achieve the objectives

4.1 Focussing on a few cases

EUROBORDER aimed at finding means of improving the performance of small to medium sized European ports. For the project it was necessary to find a methodology which, within the time and budgetary constraints, would ensure that the project objective were met.

The methodology chosen for EUROBORDER was to perform case studies of a small number of ports. The situation in these ports was carefully investigated in order to identify areas calling for improvements. The project then searched for general tools which could be used to solve these particular problems as well as similar problems encountered in other ports.

The case study ports in EUROBORDER were:
- Port of Piraeus (container terminal)
- Port of Bilbao (MacAndrews terminal, LoLo)
- Port of Oslo (Color Line terminal, RoRo; Ormsund terminal, LoLo)
- Port of Helsinki (virtual terminal)

EUROBORDER has made the assumption that even if the situation in European ports differs, they may reach a similar final state, in this case a state of high efficiency, by using partially the same set of tools, but the road to this state will differ. EUROBORDER does not prescribe what particular tools to use or how they should be implemented. This will have to be judged by the individual port, as the port itself best knows its conditions. EUROBORDER provides the toolbox and a number of scenarios from which other ports can learn how the tools can be used.
4.2 The overall approach
In order to reach its objectives, EUROBORDER was composed of several interrelated workpackages. Some of the workpackages were directly related to the objectives (core activities), others were only indirectly related to the objectives and were needed to assist or give input into the main activities (supporting activities). Another distinction can be made for workpackages related to the overall management of the project (management activities).

EUROBORDER was composed of nine workpackages:

<table>
<thead>
<tr>
<th>Number</th>
<th>Name and content</th>
<th>type</th>
<th>Workpackage leader</th>
<th>% of total available resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP100</td>
<td>Project management • Technical and administrative management, quality assurance</td>
<td>management</td>
<td>TFK</td>
<td>10%</td>
</tr>
<tr>
<td>WP200</td>
<td>Concertation and dissemination • Contacts to potential users and to other R&amp;D projects</td>
<td>management</td>
<td>TFK</td>
<td>8%</td>
</tr>
<tr>
<td>WP300</td>
<td>Inventory of problems and bottlenecks • Analysis of current situation and enhancement potential</td>
<td>core</td>
<td>ISSUS</td>
<td>18%</td>
</tr>
<tr>
<td>WP400</td>
<td>Functions and user requirements • Establishment of functional view of port terminal • Analysis of user requirements (core)</td>
<td>support</td>
<td>ENYCA</td>
<td>12%</td>
</tr>
<tr>
<td>WP500</td>
<td>Modelling the port’s functions • Adapting a simulation and optimisation software to port terminals</td>
<td>support</td>
<td>CECIL</td>
<td>8%</td>
</tr>
<tr>
<td>WP600</td>
<td>Modelling the network integration • Defining four network models related to EUROBORDER ports, based on generalised costs</td>
<td>support</td>
<td>SINTEF</td>
<td>5%</td>
</tr>
<tr>
<td>WP700</td>
<td>Scenario generation • Developing improvement scenarios for some case ports in Europe</td>
<td>core</td>
<td>VIATEK</td>
<td>14%</td>
</tr>
<tr>
<td>WP800</td>
<td>Scenario evaluation • Feasibility studies of probable scenario effects, quantitative and qualitative</td>
<td>core</td>
<td>AUTh</td>
<td>15%</td>
</tr>
<tr>
<td>WP900</td>
<td>Implementation and demonstration • Drawing conclusions from the scenario development and the evaluation results</td>
<td>core</td>
<td>TFK</td>
<td>9%</td>
</tr>
</tbody>
</table>

Table 2: Workpackage list

The project plan foresaw, that about half of the work would take place in the core workpackages, and about one fourth of the work in the management and the supporting workpackages respectively. This division has roughly been kept during the project. Deviations appeared
especially for the software development which required more resources than originally planned.

The following diagramme explains the interconnection between the workpackages.

### Core activities

- **WP300 (+ parts of WP400)**
  - Understanding problems and requirements

- **WP700**
  - Generating scenarios = proposing changes

- **WP800**
  - Evaluating the tools proposed in the scenarios
    - qualitative and quantitative analysis of economic, operational effects, analysis of legal background

- **WP900**
  - Conclusions and recommendations for implementation and demonstration

### Supporting activities

- **WP400**
  - Modelling the processes

- **WP500**
  - Developing a simulation and optimisation model

- **WP600**
  - Modelling the network integration

### Management

- **WP100**
  - Project management

- **WP200**
  - Concertation and dissemination

---

*Figure 1: Interconnection between the workpackages*

**Core activities**

The current situation in the case study ports and in some additional ports was carefully investigated in order to identify areas calling for improvements (WP300). The project then searched for general tools which could be used to solve the particular problems of the case study ports as well as similar problems encountered in other ports. The port community at the scenario ports contributed their ideas for new developments (User requirements analysis in WP400).

Together with organisations from the port communities at the four case study ports, long and short term visions for more efficient terminal operations were developed (WP700) and evaluated (WP800). Based on the evaluation results, recommendations for implementation and further research and development are made.
Supporting activities
In the first stage of the project, a joint functional view of terminal procedures related to physical and administration handling was developed (WP400). This common procedural understanding was underlying the scenario development and evaluation work. It was also a major source for the development of the simulation and optimisation software (WP500). The simulation and optimisation model was planned to be used in the evaluation, to enable the quantitative assessment of the scenario impacts in complex port terminal systems. The software development had been underestimated at the start of the project. Only at a very late stage of the project it was possible to use it for the evaluation of changes in port terminals. The evaluation workpackage had to change strategy, though, and carry out the evaluation without the software.

In order to relate the results for the port terminal improvements to the overall transport chain, a selected number of real transport chains was studied (WP600). The objective was to assess the impacts of changes in the port on the selection of mode and route. Price and time data were collected and analysed.

Management
These workpackages will not be specifically commented on in the following chapters. They enable a smooth running of a project and assure information exchange with other projects and with interested organisations. A lot of dissemination has taken place in EUROBORDER, in form of newsletters, www presence and the organisation of special information meetings. EUROBORDER and the computer software developed in EUROBORDER has also been presented at several national, European and international conferences.
5 Scientific and technical description of the project

5.1 Problem and bottleneck analysis

5.1.1 Approach

As a starting point in EUROBORDER a study was made in order to identify procedural problems and bottlenecks in ports. The methodological approach of this was to perform interviews supported by questionnaires in two consecutive stages. While the first questionnaire served for acquiring the quantitative data of the ports and a general view of the procedural problems and bottlenecks, the second questionnaire focused on the port procedures in detail. This two-step approach also ensured that problem areas which were discovered during the work were sufficiently covered. The empirical study was complemented by a literature study. The problem analysis is given in detail in deliverable D 3.1 and in the public abstract of the same deliverable.

The interviews covered a wide range of different players related to the port and the port terminal: terminal operators, port authorities, shipping lines and shipping agents, customs, forwarders etc. Organisations that were related to the ports listed below were interviewed. The most detailed analysis took place at the scenario ports.

<table>
<thead>
<tr>
<th>EUROBORDER scenario ports</th>
<th>EUROBORDER partners</th>
<th>sponsoring partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilbao (Spain), Helsinki (Finland), Oslo (Norway), Piraeus (Greece), Volos (Greece)</td>
<td>Aalborg (Denmark), Thessaloniki (Greece), Gothenburg (Sweden)</td>
<td>Aarhus (Denmark), Copenhagen (Denmark), Kiel (Germany)</td>
</tr>
</tbody>
</table>

Table 3: Ports participating in the EUROBORDER problem analysis

5.1.2 Problems identified in the current situation

Problems were identified in different areas as shown in Table 4. The interviewees pointed out problems in the areas marked by an "X". A blank square does not necessarily mean that the ports did not experience any problems in the corresponding area, but that it was not detected, i.e. mentioned, in the interview. If there were problems in the "blank spaces" they were probably not regarded as critical by the interviewees.

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<th>10</th>
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</thead>
<tbody>
<tr>
<td>Necessity of new/better terminal information systems</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Insufficient communication / co-ordination with external organisations</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
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<td>Insufficient communication / co-ordination within the port (customs, terminal, port authority)</td>
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<td>Customs procedures</td>
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<td>(Complicated, paperwork,</td>
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<td>customers insufficient,</td>
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<td>Access to the terminal</td>
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<td>Security</td>
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<td>(Control of load units)</td>
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<td>Poor government support</td>
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<td>High competition of</td>
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<td>road/rail transport</td>
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<tr>
<td>High cost of pilots</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<td>High cost of recruiting</td>
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<td>workers</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
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</tr>
</tbody>
</table>

Table 4: Common areas of problems and bottlenecks in port terminals.

A road-to-road or road-to-rail terminal is normally owned and operated by an organisation that also controls at least one of the modes connected by the terminal. In a public port terminal the organisational structure is often far more complicated, and requires co-operation between numerous actors in the port as well as along the transport chain. Port terminals often have openness both in terms of the wide variety of clients and in terms of the multitude of cargo types it handles.

Especially in RoRo-terminals, but also in LoLo-terminals, problems were found arising from the large number of actors involved. These problems were found both in relation to the organisations within the port and to the external actors. Internally, the interactions between the port authority, the terminal operation and the customs were not always the best. Externally the customers which only occasionally used the terminal were a problem because they were not familiar with the procedures to be followed, e.g. related to completing the freight documents. Problems related to planning of the terminal operations occurred with the regular customers. The customers wanted to be able to arrive as late as possible before the vessels should leave, and have the right to make late cancellations of previously confirmed bookings.

The terminals are not able to put any efficient pressure on their customers, but have to provide high flexibility, which makes planning of the operations difficult. Sometimes it is the terminal operator that has to make sure that he gets the necessary information and confirmation from its customers. In Helsinki, for example, the terminal operator calls the ship’s agents for advance information. The same happens in Oslo and Kiel where it is mostly the terminal operator who asks the large customers to confirm their pre-bookings.

Another aspect which is sometimes related to as a problem specific to the port terminal is the fact that different labour unions are involved resulting in organisational and handling problems regardless of whether the complete operation-production-warehousing-stevedoring-ship operation is in the hands of one company.

No large differences between the countries involved were discovered regarding the problem areas. The differences between them were more a question of advancement in information handling. However, all terminals and ports involved were starting or well underway to invest in new
technologies and computer supported management systems. Still, the medium size ports appear to lag behind in the development due to their restricted economic and personnel resources.

A summary of identified problems in the studied terminals is given in Table 5.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>• Current computer application does not support marketing procedure</td>
<td>• Manual communication and monitoring</td>
</tr>
<tr>
<td></td>
<td>• Manual communication and monitoring</td>
<td>• Changes on booking information</td>
</tr>
<tr>
<td></td>
<td>• Late arrival of cargo</td>
<td>• Booking too late</td>
</tr>
<tr>
<td></td>
<td>• Changes on booking information</td>
<td>• Changes on booking information</td>
</tr>
<tr>
<td></td>
<td>• Changes on booking information</td>
<td>• Long queues</td>
</tr>
<tr>
<td></td>
<td>• Duplication of work</td>
<td>• Delays due to absence of computerised data handling</td>
</tr>
<tr>
<td>Booking/Loading List</td>
<td>• Booking too late, after loading list is made</td>
<td>• Current static data processing</td>
</tr>
<tr>
<td></td>
<td>• Changes on booking information</td>
<td>• Manual cross-checking</td>
</tr>
<tr>
<td></td>
<td>• Work done manually</td>
<td>• Current information flow</td>
</tr>
<tr>
<td></td>
<td>• Duplication of work</td>
<td>• Delays due to absence of computerized data handling</td>
</tr>
<tr>
<td>Entrance/Exit control</td>
<td>• Current system security risk</td>
<td>• Long queues</td>
</tr>
<tr>
<td></td>
<td>• Control of authorisation to enter or leave does not exist</td>
<td>• Delays due to absence of computerised data handling</td>
</tr>
<tr>
<td></td>
<td>• Work done manually (duplication of work)</td>
<td>• Current static data processing</td>
</tr>
<tr>
<td></td>
<td>• Manual communication and monitoring</td>
<td>• Manual cross-checking</td>
</tr>
<tr>
<td>Check In/Out</td>
<td>• Routines not known by smaller customers (customers documents not complete)</td>
<td>• Long queues</td>
</tr>
<tr>
<td></td>
<td>• Delays and congestion due to parking in traffic area</td>
<td>• Delays due to absence of computerised data handling</td>
</tr>
<tr>
<td></td>
<td>• Work done manually (duplication of work)</td>
<td>• Current information flow</td>
</tr>
<tr>
<td>Damage control/cross-checking</td>
<td>• Smaller customers unfamiliar with the procedures</td>
<td>• Delays due to manual monitoring of storage area</td>
</tr>
<tr>
<td></td>
<td>• Delays due to customs spot check and self-drive clearance</td>
<td>• Manual document handling</td>
</tr>
<tr>
<td>Customs check</td>
<td>• Pressure on available space due to delays</td>
<td>• Delays due to insufficient container transfer equipment</td>
</tr>
<tr>
<td>Terminal handling</td>
<td>• Information given incorrect</td>
<td>• Conflicts between external and port vehicles</td>
</tr>
<tr>
<td></td>
<td>• Late arrival of cargo</td>
<td>• Lack of appropriate area</td>
</tr>
<tr>
<td></td>
<td>• Delays due to parking in front of ticket office</td>
<td>• Failures of mechanical equipment</td>
</tr>
<tr>
<td></td>
<td>• Available space and store facilities</td>
<td>• Delays due to wrong stowage</td>
</tr>
<tr>
<td></td>
<td>• Late arrival of cargo</td>
<td>• Delays on stowage plan</td>
</tr>
<tr>
<td>Waiting/Storing (Loading lanes,</td>
<td>• Lack of space</td>
<td>• Inadequate signing of storage area</td>
</tr>
<tr>
<td>storage area)</td>
<td>• Loading list does not match</td>
<td>• Lack of space</td>
</tr>
<tr>
<td></td>
<td>• Number of weighting bridges limited</td>
<td>• Storage area used as warehouse by customer</td>
</tr>
<tr>
<td></td>
<td>• Lack of real time monitoring of boarding</td>
<td>• Current manual monitoring</td>
</tr>
<tr>
<td>Load/Unload</td>
<td>• Manual boarding process</td>
<td>• Poor on-line feedback on the storage area status</td>
</tr>
<tr>
<td>Access from sea</td>
<td>• Port network is not working well enough.</td>
<td>• Shortage of pilots</td>
</tr>
<tr>
<td></td>
<td>• Data exchange problems</td>
<td>• Ineffective towage</td>
</tr>
<tr>
<td></td>
<td>• Delayed and inaccurate calculation of fees</td>
<td>• Insufficient mooring space</td>
</tr>
<tr>
<td></td>
<td>• Manual communication in/around the terminal</td>
<td>• Human errors, manual monitoring</td>
</tr>
<tr>
<td>Information flow</td>
<td>• Manual exchange of information</td>
<td>• Decision making</td>
</tr>
<tr>
<td></td>
<td>• Port network is not working well enough.</td>
<td>• Old institution framework</td>
</tr>
<tr>
<td>Parking control</td>
<td>• Lack of exclusive parking area</td>
<td>• Manual procedures</td>
</tr>
<tr>
<td></td>
<td>• No parking rules on loading lanes</td>
<td>• Insufficient gantry cranes</td>
</tr>
<tr>
<td>Training</td>
<td>• Lack of exclusive parking area</td>
<td>• Human errors, manual monitoring</td>
</tr>
<tr>
<td></td>
<td>• Lack of knowledgeable personnel</td>
<td>• Lack of exclusive parking area</td>
</tr>
</tbody>
</table>

Table 5: Summary of problems in the main processes
5.1.3 Improvement ideas from the users

In the interviews performed in the problem analysis, the respondents were also asked to give suggestions for solutions. These answers reflected to some degree "the state of the art". A list of the suggestions given for the solution of the problems is given in Table 6. Some of the answers extend beyond the scope of EUROBORDER and have not been taken up for the development of the future scenarios.

<table>
<thead>
<tr>
<th>New computer systems and telematics solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computerized data handling</td>
</tr>
<tr>
<td>Terminal wide monitoring and information system</td>
</tr>
<tr>
<td>Terminal wide integrated information system</td>
</tr>
<tr>
<td>Electronic monitoring of containers</td>
</tr>
<tr>
<td>Dynamic monitoring and control system</td>
</tr>
<tr>
<td>Exclusive parking area electronically monitored</td>
</tr>
<tr>
<td>Video stored pictures</td>
</tr>
<tr>
<td>Automated cargo identification</td>
</tr>
<tr>
<td>Automatic Identification Control</td>
</tr>
<tr>
<td>On-line monitoring of boarding process</td>
</tr>
<tr>
<td>Automatic monitoring of boarding activity</td>
</tr>
<tr>
<td>Efficient system for drivers tickets, Smartcards</td>
</tr>
<tr>
<td>Direct generation of manifest by Data Network</td>
</tr>
<tr>
<td>EDI Systems</td>
</tr>
<tr>
<td>IT Systems</td>
</tr>
<tr>
<td>Documents transmitted electronically</td>
</tr>
<tr>
<td>Timely submission of stowage plan</td>
</tr>
<tr>
<td>Computer Link to customs and clients</td>
</tr>
<tr>
<td>PC Network</td>
</tr>
<tr>
<td>Development of Portnetwork system</td>
</tr>
</tbody>
</table>

| Work organisation                             |
| Better information of customers               |
| Flexible service                              |
| Change of vehicles classification mechanism   |
| Designated customs check area                 |
| No entrance if vehicles ID is not in booking list|
| License for entering                          |
| Improve organisation of storage area          |
| Improve terminal layout and loading procedures|
| Parking area for external vehicles and more dynamic guidance |
| Enhance units handling                        |
| Communication between inventory and customs control|
| Priority in container ship pilotage           |

| Terminal organisation                         |
| Improve terminal layout                       |
| Clear and classified parking lanes             |
| Separate sections according to destinations   |
| longer opening hours                          |

| Expansion                                      |
| Extend terminal area                           |
| More space                                     |
| Increase number of gates                       |
| Two-storey entrance lanes                      |
| Increase number of weighting bridges           |
| New or expanded storage area                   |
| Acquire equipment/gantry cranes                |
| Expand onto disused railway-lanes             |
| Increase mooring space                         |
| Increase pilots and pilotage boats             |

| Labour issues                                  |
| Introduce more working shifts                  |
| Reconsider framework of labout agreements      |

| Training                                       |
| Familiarisation with new technologies          |
| Seminars                                       |
| Inform customers better about document exchange|

| Labour issues                                  |
| Introduce more working shifts                  |
| Reconsider framework of labout agreements      |

| Others                                         |
| Maintenance and renovation of equipment        |
| Improve signing                                |
| Relocation of ticket office                    |
| Reduce storage time                            |

Table 6: Measures for improvements suggested by the interviewees
The empirical study also investigated the decision-making criteria of the port terminals. The situation was found to be almost the same in all ports. Three criteria were mentioned by all of the port terminals: Profit, environmental issues and service relations.

With regard to organisational matters, the problem of not being able to respond rapidly to trends and customer demands tends to result in the port becoming a separate unit or a stock company. Albeit, in several cases with a public institution as the owner. Organisation of the operational level in the ports showed two different development paths; either specialised operators for certain clients or a concentration to one operator taking care of all activities in all terminals. If the port in the latter case had a dominating position this sometimes resulted in complaints regarding the prices charged. The objective to control the port operation also shows tendencies to result in measures to extend the control of the transport chain which make the port a competitor to its own clients.

As for the implementation of new information technology the small to medium sized ports have a problem in affording to keep up with the latest development. For example, even though PCs have widely been used for a number of years now, a terminal operator might not yet have a PC network installed. The SMPs have to rely on generally accepted, standardised and well established systems. Such off-the-shelf products are now starting to have an impact on this market.

5.1.4 Literature review

A study of literature was carried out in order to get a picture of the state of the art in the project’s environment. The study included trends in the commercial environment, use of information technology and port bottlenecks. It largely confirmed the issues identified during the interviews.

Trends in the commercial environment and port bottlenecks are covered elsewhere in this report and those parts of the literature study are not reported here. Information technology is an area undergoing rapid change and which has a large influence on logistics and transport systems. In terms of applying IT to support operations, both large shipping lines and ports have already done a lot. Still, there is a large potential for increasing the use of IT in the shipping industry involving waterborne transport as a whole, especially for the SMEs.

5.1.4.1 Tracking and Tracing

Cargo and equipment tracking is becoming increasingly important both for the transport companies and for the shippers, especially if they are involved in intermodal transport. If delays are to be avoided information about any disturbances and of the current state of the system is necessary, which explains the request for real-time tracking information. One aspect of traceability is increased possibility for control; processes that have previously been out of reach can be controlled and measured.. Another aspect is traceability as a customer service weapon and a means of establishing logistics partnerships.

5.1.4.2 EDI

Until now the information systems have primarily been directed towards supporting the companies' own logistics. This was supposed to change with EDI with the various systems being interconnected. Despite the fact that EDI has been around for quite some time now this vision has far from come true. However, great efforts are being undertaken by the shipping community to increase the use of EDI.
There are good reasons to implement EDI systems. According to some investigations 70% of the input to a data system is output from another system and the same information can be input ten times or more during the transport process. In international trade, with its extensive documentation, it happens quite frequently that the cargo has to wait for the information.

Why then is EDI not implemented to a greater extent throughout the transport chain? One reason, often referred to, is poor standards and incompatibility between different standards. Some of the standards also give too much room for different interpretations. Other reasons for the slow spread of EDI are claimed to be human and organisational factors.

Another problem is the fact that if EDI shall be used throughout the transport chain some parties must connect to a system from which they can see no benefits for their own part. Previous research on usage of EDI have focused on the benefits for a single organization rather than for a whole industry. Communication systems show so called "network externalities" in that they are more valuable to the customer if they have many users.

There are three major reasons for the unwillingness of a shipper to connect to the forwarder with EDI; the costs in time and resources, failure to recognize the benefits and a fear of being tied up to a particular forwarder. As IT services are becoming a way of attracting customers for the carriers, this may change. At the other end the various suppliers such as container depots and repair shops may simply be forced to connect.

There are also legal matters constraining the possibility of introducing EDI. In the future these problems can hopefully be overcome by better security of EDI. There is much effort put in by various interest groups to develop safe means of transferring legal documents as well as "electronic money" by EDI.

5.1.4.3 Terminal Information Systems

The use of port specific IT applications has increased in the last few years. As recently as 1990, only a handful of container terminals had installed sophisticated high resolution-graphics based, easy-to-use systems for pre-planning and planning, to replace the otherwise intuitive process based on dozens of manual bay and yard plans.

The increased use of terminal information systems can be explained by the hardened competition among ports, the better availability of systems and the improved price-performance ratio of computers. In order to attract customers, ports must offer value-added services to their clients and IT-services are becoming an important means of gaining competitive advantages.

Operational resource management systems include yard planning, bay planning, berth allocation, crane and terminal handling equipment planning. A wide range of systems are available as off-the-shelf products as well as customised systems, but the market is dominated of just a handful of players. Most systems are geared at container terminal operations but other systems can handle also break-bulk and ro-ro traffic.

The various terminal planning systems depend on correct information and hence require on-line, or at least frequently updated, information. Therefore data capturing and in-terminal data exchange by e.g. RDT is becoming of increased importance.
5.1.4.4 Equipment Identification and Location

The technologies available for the identification depend on whether only static information about the identity of a unit should be read or if also other dynamic information (origin, destination, cargo, etc.) should be contained in the device. The requirements also differ between different terminals because of geographical location, meteorological conditions, terminal layout and handling system.

The main rivalling technologies for identification of containers and trailers in terminals are optical recognition and radio frequency (RF) tags. Optical recognition have been tested at Singapore and Dubai who report promising results, while the Eurokai-Terminal-Group reports that in their trials the performance has not been satisfactorily. Trucks can be identified by optical recognition of licence plates.

RF-tags have been tested and used both at terminals and on trucks and railways. A drawback with the RF-technology has been the high costs, but costs are expected to decrease with increased usage. Since information is transmitted by radio signals the transmission between the tag and the reader is not hindered by poor visibility and to a certain extent the tags can be read through physical objects meaning that dirt is not a problem. The lack of standards is the main obstacle for a wide acceptance.

When the automatic identification does not have to be done over a distance other technologies are available e.g. Bar codes and Smart cards. The drawbacks of the bar code technology is its sensitivity to environmental conditions, the inability to update the data and the limited amount of data that can be handled. The Smart card has some important advantages: data capacity, update ability, security and ability to be used in harsh environments.

5.1.4.5 Terminal automation

In research projects, as well as in actual implementations, various handling processes carried out in the port are being automated. Some of these automations are large scale projects like the automatically guided vehicles (AGVs) of ECT-Delta terminal (Rotterdam), Thamesport and PSA's Pasir Panjang, while other projects (unfortunately gaining less attention) aim at making the most of traditional equipment by computer aided control systems e.g. MTL and HIT in Hong Kong.

The question on whether to automate or not remains an open issue both in terms of what ports should automate and in terms of what level of automation should be chosen. Since automation means capitalization of expenditures i.e. high fixed costs and low variable costs some see it mainly as an alternative for large volume ports. Others see automation as a possibility for low volume ports to offer round the clock service.

Automation can be an answer to problems with high land prices and difficulties in keeping and recruiting port workers. According to some experts automation is a must to keep down the vessel turnaround time as the size of the vessels increases. Furthermore automation is believed to lead to high reliability and productivity, with shorter ship turn-around times.

A drawback with some automated systems, e.g. certain kind of AGVs, is that the systems have a limited flexibility. Well managed straddle carrier systems can also show high productivity rates and some studies show that the performance achieved today with straddle carriers can be very difficult to achieve with AGVs.
So far automation has been done in the transfer between the yard and the ship-to-shore-crane but no terminal has yet introduced full automation of loading and discharging of the ships. Another area that has not yet been automated is the transfer of load units between the yard and road vehicles.

5.2 Establishment of visions for improved operations at the scenario ports

5.2.1 Objective and approach

5.2.1.1 Objective

The objective of WP700 is stated in the project programme: "To develop different scenarios to improve the situation as it has been described in WP300 with respect to information, administration, organisation and the related legal framework".

"Scenarios" are defined as descriptions of possible future ‘worlds’ or ‘aspects of the worlds’ based on signals which can be noticed at present. The EUROBORDER scenarios show possible future situations for port terminals and their external information exchange. The aim is to provide the management level of organisations involved in the transshipment process in port terminals with new ideas for their strategic planning.

5.2.1.2 Approach

Scenarios have been defined for terminals in four European ports (EUROBORDER scenario ports). In the scenario generation process, a continuous interaction has taken place with the different parties involved.

The ports involved are:
- Helsinki (Finland)
- Piraeus (Greece)
- Oslo (Norway)
- Bilbao (Spain)

Based on these trends and possible development, scenarios have been defined for each of the EUROBORDER scenario ports. The scenarios describe a possible future situation in which a series of changes and improvements has been realised and today’s problems are solved through different measures. The scenarios are related to all processes that belong to the scope of EUROBORDER: To the terminal handling and cargo administration as such and to the information exchange between the terminals and the parties related to the cargo flow.

The chapters related to the four scenario cases in deliverable 7 thus describe:
- Future plans of the specific port
- Expected development of the national transport market
- Informational, administrative and organisational context
- The scenario cases (incl. new procedures in terminal handling based on improvement measures)
5.2.1.3 Schoemaker methodology as a guideline

EUROBORDER has used a well established scenario development methodology, from Paul J.H. Schoemaker, as guidance for its own methodology development\(^2\). However, the starting point in EUROBORDER was different. In the "traditional" scenario development the upper management level is trained to think in long term development and to identify possible reactions. This enables the management to react more flexibly on possible future problems. In EUROBORDER the scenario development is related to alternative, future situations in which today's problems are solved. Due to this difference, the benefit that was drawn from traditional scenario approaches has to be seen in terms of using the main ideas in the steps to be followed.

Schoemaker's approach consists of ten steps, which describes a full scenario development process, i.e. a complete project. That means that his ideas do not only relate to the scenario generation work itself in EUROBORDER, but also integrates work in other workpackages. In the following, the relation of EUROBORDER to the different steps is described.

1. *Defining the scope* Definition of scenario scope (in terms of content) and the time frame. This step also includes the background information provided by WP300 and WP400, which established a view of the current situation.

2. *Identifying major stakeholders*, like organisation directly involved in terminal operations, terminal customers and other port related organisations.

3. *Identifying basic trends*, and

4. *Identifying key uncertainties*, These two steps have been handled together, i.e. what political, economic, transport market, societal, technological and legal trends are sure to affect the issues identified in Step 1 and what events with uncertain outcomes, will significantly affect the issues in Step 3. The trends and uncertainties have been identified on a global level and on a national, scenario port related level.

5. *Constructing initial scenario themes*. A first scenario "story" has been developed, describing the relevant procedures in the future scenario situation. This story was developed in a discussion process between the scenario generation responsibles at the sites and the relevant users.

6. *Checking consistency and plausibility*. The initial scenarios have been discussed and commented within the consortium.

7. *Developing learning scenarios*. The scenarios have been adapted and further developed based on the comments from step 6.

8. *Identifying research needs*, not applicable at this project stage, but an objective of the overall project.

9. *Developing quantitative models*, to describe the major quantitative aspects of the scenarios. This has been done in WP400, WP500 and WP600.

10. *Evolving towards decision scenarios*, original idea is not applicable as problem solving strategies are already part of the EUROBORDER scenarios. An iterative process between WP700 and WP800 gives feedback on the best possible solutions, though.

---

5.2.2 Main results

5.2.2.1 Summary
EUROBORDER has developed future visions for higher port efficiency and better customer service focussing on cargo handling in port terminals. A toolbox draws together the ideas from all scenarios. The most important ideas included in the scenarios are:

- Electronic data handling (EDIFACT, Internet, Extranet) for all information exchange
- Automation in the terminal access/exit area
- Improved terminal management systems (yard planning software, bay plan software)
- Business concepts based on cooperation with customers and other actors, even competitors
- Ensured space efficiency
- Improved terminal organisation (layout, pooling of resources, etc.)

The EUROBORDER scenarios are related to organisation, administration and information. Automation plays the main role in the scenarios, as for example information exchange between all parties by EDI/EDIFACT. For the management and control of the cargo within the port terminal better software tools are foreseen. Automatic identification of the cargo is an important part of the control. The guidance of drivers is also automated in some scenarios. For many of the scenario ideas like for the automatic identification different technical solutions can be found. The terminal operator and its customers have to decide, which technology is appropriate for them - based on their requirements and the state of technology development.

Picture 3: Terminal handling at the Mac Andrews terminal, Bilbao

The key to the integration of port terminals in the logistics chain is information for and on the internal operations. Cost-effective solutions for the information exchange internally and externally as well as automatic data capture have a key role. Detailed and real-time information is crucial to successful intermodal transport solutions, and such a success is crucial to the competitiveness of waterborne transport. The traditional situation where the port communicates with the ship’s agent is gradually changing into a situation where the port has to communicate with shippers, forwarders...
and agents as well as carriers (including the shipping line directly) and other ports up- and down- 
stream in the transport flow.

The specific scenarios are presented in the context of evaluation results in the following chapter. In 
the following the toolbox is described, which shows a compilation of the measures taken into 
account in the scenarios.

5.2.2.2 EUROBORDER toolbox

The EUROBORDER toolbox draws together and structures all improvement measures considered 
in the scenarios. The aim at all scenario ports is to reach higher competitiveness with a more 
efficient and customer oriented terminal performance. The toolbox is structured into four parts:
- Administrative functions according to an export/import procedure
- General organisational changes
- Infrastructure/equipment measures
- Supporting technology

The following text and tables at first generally present the toolbox and then show for the different 
scenarios, which measures/tools they include.

<table>
<thead>
<tr>
<th>Administrative functions in export/import case</th>
<th>Supporting technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>(the functions are explained in chapter 5.5)</td>
<td>(See also table 10)</td>
</tr>
<tr>
<td><strong>B1 Arrival Preparation</strong></td>
<td></td>
</tr>
<tr>
<td>1. Electronic forwarder pre-arrangement of customs procedure</td>
<td>EDI</td>
</tr>
<tr>
<td>2. (Electronic) pre-announcement of truck arrival to port terminal</td>
<td>EDI</td>
</tr>
<tr>
<td>3. Electronic pre-submission of formal documents to terminal</td>
<td>EDI</td>
</tr>
<tr>
<td><strong>B2/B9 Land access/exit control</strong></td>
<td></td>
</tr>
<tr>
<td>4. Automatic registration of ITU arrival/departure</td>
<td>Tags, OCR</td>
</tr>
<tr>
<td>5. Automatic damage control</td>
<td>Video cameras</td>
</tr>
<tr>
<td>6. Automatic entrance/exit control (gate)</td>
<td>Tags, OCR, Smart cards</td>
</tr>
<tr>
<td><strong>B3 Management of external vehicle transport</strong></td>
<td></td>
</tr>
<tr>
<td>7. Automatic provision of guidance in the terminal</td>
<td>VMS</td>
</tr>
<tr>
<td><strong>B4 Management of internal vehicle transport</strong></td>
<td></td>
</tr>
<tr>
<td>8. Tracking and tracing of internal vehicles and ITU</td>
<td>DGPS, tags</td>
</tr>
<tr>
<td>9. Automatic request of resources for transfer and transport</td>
<td>OBU, Yard management software</td>
</tr>
<tr>
<td><strong>B5 Management of parking and storing activities</strong></td>
<td></td>
</tr>
<tr>
<td>10. Automatic management of parking activities (of external vehicles)</td>
<td>Yard management software</td>
</tr>
<tr>
<td>11. Automatic management of storage activities</td>
<td>Yard management software</td>
</tr>
<tr>
<td>12. Automatic positioning of ITU</td>
<td>DGPS, tags</td>
</tr>
<tr>
<td><strong>B6 Sea exit/access control</strong></td>
<td></td>
</tr>
<tr>
<td>13. Automatic management of loading/unloading activities</td>
<td>OBU</td>
</tr>
<tr>
<td>14. Automatic damage control</td>
<td>Video cameras</td>
</tr>
<tr>
<td>15. Automatic tally control</td>
<td>OCR, tags</td>
</tr>
<tr>
<td><strong>B7 Post-administrative activities</strong></td>
<td></td>
</tr>
<tr>
<td>16. Electronic invoicing</td>
<td>EDI</td>
</tr>
<tr>
<td>17. Electronic status report on ITU arrival and departure</td>
<td>EDI</td>
</tr>
<tr>
<td>18. Automatic generation and electronic sending of formal documents</td>
<td>EDI</td>
</tr>
</tbody>
</table>
Table 7: Proposed administrative functions

The introduction of all above functions has both an organisational and an administrative dimension – by definition of the term "function". A change in terminal procedures (functions) is a change in the organisational structure of the terminal: Which activities are carried out by whom. At the same time it means a change in the day-to-day management of the goods flow (terminal administration).

<table>
<thead>
<tr>
<th>Organisational measures</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Alliances with other actors in the transport chain</td>
<td>• To strengthen the competitive power</td>
</tr>
<tr>
<td>21 Departmental integration</td>
<td>• Between different port terminal departments in order to increase efficiency</td>
</tr>
<tr>
<td>22 Separation of roles of the port as landlord, infrastructure provider, authority and terminal operator</td>
<td>• Enabling control, ensuring efficiency and flexibility (provision of infrastructure – and eventually also equipment – on terms which promote competitiveness)</td>
</tr>
<tr>
<td>23 Optimisation of work shifts</td>
<td>• for better use of existing resources/personnel</td>
</tr>
<tr>
<td>24 Longer opening hours – up to 24 hours</td>
<td>• To provide a better service to terminal customers</td>
</tr>
<tr>
<td></td>
<td>• To increase terminal capacity</td>
</tr>
<tr>
<td>25 Personnel training</td>
<td>• Preparing for the use of new technologies</td>
</tr>
<tr>
<td>26 Personnel transfer/reduction</td>
<td>• As consequence of organisational changes and introduction of new technologies</td>
</tr>
<tr>
<td>27 Privatisation</td>
<td>• To introduce stronger market forces into the port business</td>
</tr>
<tr>
<td>28 Decentralisation</td>
<td>• To give more responsibilities to the single port authority</td>
</tr>
</tbody>
</table>

Table 8: Organisational measures

<table>
<thead>
<tr>
<th>Infrastructure measure</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 Establishment of secure land side gates</td>
<td>• To enable control of vehicles and ITU crossing the terminal/port border</td>
</tr>
<tr>
<td>30 Building of additional land side gates</td>
<td>• To remove bottleneck at access/exit control</td>
</tr>
<tr>
<td>31 Separate gates for different kinds of traffic e.g. green lane/fast track</td>
<td>• To support the introduction of paperless procedures; gates for manual check-in will still be needed</td>
</tr>
<tr>
<td>32 Acquisition of new terminal equipment (automated vehicles)</td>
<td>• To increase the terminal’s handling capacity</td>
</tr>
<tr>
<td>33 Relocation of customs office outside port terminal</td>
<td>• To have less friction between terminal processes and customs processes</td>
</tr>
<tr>
<td>34 Relocation of parking area / terminal external parking area</td>
<td>• To have less friction between the ITU delivery/pick-up and the internal ITU transfer</td>
</tr>
<tr>
<td>35 Building of a completely new terminal</td>
<td>• To increase the port’s handling capacity</td>
</tr>
</tbody>
</table>

Table 9: Infrastructure/equipment measures
<table>
<thead>
<tr>
<th>ITS-Technology/equipment</th>
<th>Used for</th>
</tr>
</thead>
</table>
| 36 Integrated terminal management and information systems (MIS) | • Management and control of all terminal internal processes  
• Terminal networking |
| 37 Yard management software (including GIS) | • Management of storage area |
| 38 EDI – EDIFACT, Internet | • Electronic booking  
• Electronic status reports  
• Electronic invoicing  
• Electronic sending of documents (e.g. manifest) |
| 39 On Board Units (OBUs), GSM | • Communication with external vehicles (forwarder/transport operator), with internal vehicles and cranes (terminal operator) |
| 40 Radio Frequency Tags and transponders | • Automatic identification of ITU and vehicles throughout the terminal |
| 41 Smart Cards | • Automatic identification of drivers for authorisation of entrance |
| 42 Optical Character Reading (OCR) | • Automatic identification of containers (via container number) at land and sea side gate |
| 43 Video cameras, video stored pictures | • Damage control |
| 44 Variable Message Signs (VMS) | • Guidance of external vehicles |
| 45 DGPS – Differential Global Positioning System | • To position internal vehicles (and consequently ITUs) |
| 46 Simulation/optimisation model for port terminals | • Using computer software to test major strategic decisions |

Table 10: Supporting technologies

Each scenario for the different scenario ports is presented in a short version in the scenario evaluation chapter.

### 5.3 Evaluation of probable impacts of the scenarios

#### 5.3.1 Approach

The following four types of assessment have been carried out, both in quantitative and in qualitative terms:

1. **Operational Assessment.** This type of assessment requires the quantification of the parameters of the functions of the port terminal in terms of time, quantities, cost in order to make comparison between the existing situation and the proposed scenarios.

2. **Socio Economic Assessment.** The socio-economic analysis is concerned with the economic and social results of the operational impacts. It calculates the socio-economic rate of return on the investment and gives the pay back period or the Internal Rate of Return on the investment.

3. **Market Analysis.** An examination of the size of the market and the roles of the different organisations in the development of this market.

4. **Legal and Institutional Analysis.** This analysis explores and assesses the conflicts with the existing legal and institutional framework.
5.3.2 Main results

Different organisations are involved in the scenarios. In addition to the terminal operator, other players as the road haulier, the ship’s agent or the forwarder might also need to decide on investments and implementations. The evaluation has shown, though, that the terminal operator is the party with most costs and benefits. Important quantitative evaluation results are shown below.

### Operational results: Time savings/efficiency improvements

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Finnish Scenario</th>
<th>Greek Scenario</th>
<th>Norwegian Scenario</th>
<th>Spanish Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput time of truck reduced</td>
<td>-30% to -45%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yard control routines reduced</td>
<td>-30% to -85%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal equipment handles more ITU</td>
<td>+30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative preparation of transport</td>
<td>-66% to -100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Economic results**

| Pay back period (PBP) for IT technology    | 3-6 years        |                |                   |                  |

*) Note. Some processes are automated by EDI which means that time is reduced to 0.

<table>
<thead>
<tr>
<th>Impact Aspect</th>
<th>Finnish Scenario</th>
<th>Greek Scenario</th>
<th>Norwegian Scenario</th>
<th>Spanish Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Customer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased container throughput per day</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced storage costs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced chain total time</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Transport Comp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced truck throughput time</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Transportation of more containers</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Shipping Agent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced unload/load time</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Reduced personnel</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

### Table 11: Main quantitative evaluation results from EUROBORDER

Other important results from the analysis are:

- The terminal operator has to carry most of the investments, but also receives most of the profits. However, supporting investments by the customer are a prerequisite.
- The terminal size (economies of scale) plays a major role for the profitability of investments in small and medium size ports (SMPs)
- It might be profitable for a port terminal to train the personnel of small companies/customers that do not have training resources in order to establish the necessary know-how outside the terminal.
- It would be more efficient, if the terminal operator prepares the vessel’s bayplan on behalf of the ship’s agent
- Automatic Identification has to be integrated with Electronic Data Interchange (EDI)
- Road hauliers can reduce total number of lorries for pick-up and delivery, when the
access/exit procedures are automated

- Investment into new heavy handling equipment substantially increases space efficiency and might be feasible for SMP’s as an alternative to terminal extension or relocation

5.3.3 The Finnish scenario evaluation

5.3.3.1 Scenario characteristics
The Finnish scenario has been developed based on discussions with members of a Finnish user group. The proposed future scenario implies a full automation of current information handling by utilising advanced technologies. The Finnish partners have developed very detailed spreadsheets for operational and economic evaluation, that can easily be used by ports and port users to test the effects of large investments.

The Finnish scenario focuses on:

1. Advanced information systems:
   - yard management systems
   - EDI based communication, port terminal as an information node
   - automatic identification of drivers, vehicles and load units (smart cards, tags, optical character reading etc.);

2. Administrational changes:
   - new task division between port terminals and port authorities
   - new task division between port terminals and shipping lines
   - landlord organisation structure and privatisation of the port (authority);

3. Organisational changes:
   - teams committed to objectives which can be measured
   - persons with high IT knowledge taking more responsibility
   - integration of the planning of yard, bay plans and internal vehicle use.

A major question is the dependencies between the terminal size (TEU) and the benefits of possible investments: If it makes sense for small terminals to invest into the state-of-the-art of telematic systems.

5.3.3.2 Main findings
The introduction of the most efficient tools would increase the operational efficiency of a port terminal by approximately 30 percent. This means for example that

The main findings of the economic analysis are
- the pay back time in terminals handling 100,000 TEU/year is approx. 6 years
- the pay back time in terminals handling 300,000 TEU/year is approx. 3 years
- the major costs and benefits remain with the terminal operator
- costs and benefits are relatively small for other organisations, but the difference is positive
- computer based yard management systems are significant investments for small and medium size port terminals
- investments in training of the port terminal's personnel are usually significantly large.
The acceptable pay-back period depends on many different issues such as national and regional transport policies, competition, number of other alternatives etc. and thus it has to be decided case by case.

### Picture 4: Current gate control procedure at the Finnsteveterminal

#### 5.3.3.3 Operational analysis

The following table shows the different steps of the Finnish operational analysis.

<table>
<thead>
<tr>
<th>Step Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Establishment of the reference and future scenarios</td>
</tr>
<tr>
<td>Export operation / reference case</td>
</tr>
<tr>
<td>Export operation / scenario case</td>
</tr>
<tr>
<td>Import operation / reference case</td>
</tr>
<tr>
<td>Import operation / scenario case</td>
</tr>
<tr>
<td>2. Definition of operation times for sub-procedures</td>
</tr>
<tr>
<td>Operation times per one load unit</td>
</tr>
<tr>
<td>3. Definition of operation times per procedure and organisation</td>
</tr>
<tr>
<td>Operation times per procedure</td>
</tr>
<tr>
<td>Operation times per organisation</td>
</tr>
</tbody>
</table>

*Table 13: Steps in the operational analysis*

#### Quantitative results of the operational analysis

The estimation of the operation cost for each sub-procedure (time cost of one minute, operational cost per sub-procedure and organisation) was done for each organisation. The results are presented in a user friendly spreadsheet. In a last step of the operational analysis the estimated times for the execution of sub-procedures were calculated together per procedure and per organisation to
compare reference and future cases. From the results, differences in execution times can be seen per load unit. After analysis it can be seen how much faster one load unit passes through the port terminal.

Based on the operational analysis it is estimated that the introduction of the most efficient tools would increase the efficiency of a port terminal approximately 30 percent. This means for example that

- the throughput time of a truck can be reduced down to 15 minutes
- the yard planning routines can be done 30 percent faster
- the number of load unit movements performed by internal equipment during a working shift can be 30 percent higher.

**Qualitative results of the operational analysis**

If the terminal is effective it provides the required service level for both sea and shore side customers. Scenarios were studied in order to find the most powerful tools to support this goal. The most efficient tools identified in the study are:

- Computer based yard management system
- EDI based communication with the terminal’s customers
- Driver, vehicle and load unit identification

**5.3.3.4 Organisational analysis**

These discussions show that the introduction of computer based yard management systems causes organisational changes in the terminal operator's organisation. The introduction of the system requires an extensive training program of staff-members.

Moreover it might be profitable for the terminal operator to make the vessel's bay plan on behalf of ship’s agent. Thus the terminal operator would have much better control of the cargo flow by connecting the planning of the vessel's bay plan and the terminal’s yard plan. The Finnish User Group believes that the port authorities should concentrate more on their role as landlord while the operational responsibility should be taken care of by the terminal operators. For example one of the operators will be responsible for the gates in the future.

The introduction of EDI is very difficult to control as it affects several organisations. These organisations have to be committed to using the EDI system and sending information accurately and on time. Training of persons using EDI might also turn out to be a problem. Rather small companies (e.g. road transport companies) operating in the logistics chain might be in a key position to send essential information to the port terminal but these companies do not have training resources. For this reason it might be profitable for a port terminal to train the personnel of these small companies. The situation is very similar when introducing the driver identification system. The personnel of the port terminal have to learn to use the new technology and new procedures as well as the port's external users. In some cases external organisations might be too small or under-motivated to carry through the required investments in equipment and training.
5.3.3.5 Socio - Economic analysis

The following table shows the different calculation steps in the economic analysis

<table>
<thead>
<tr>
<th>4. Basis for operation cost</th>
<th>Cost for one minute per organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Operation cost</td>
<td>Operation time [min] \times\ operation cost [ECU/min]</td>
</tr>
<tr>
<td>6. Operation cost per procedure and organisation</td>
<td>Operation cost per procedure</td>
</tr>
<tr>
<td></td>
<td>Operation cost per organisation</td>
</tr>
<tr>
<td>7. Investment cost</td>
<td>Investment cost per organisation</td>
</tr>
<tr>
<td>8. Load unit volumes</td>
<td>Load unit volumes per organisation</td>
</tr>
<tr>
<td>9. Investment analysis, Net Present Value Method</td>
<td>Cash flows generated by the investment per organisation</td>
</tr>
<tr>
<td></td>
<td>the baypack time of the investment per organisation</td>
</tr>
</tbody>
</table>

Table 14: Steps in the socio-economic analysis

Quantitative results of the socio - economic analysis

The Finnish Scenario's economic analysis was carried out using the results of the operational analysis.

From the economic analysis it can be seen how much cheaper one load unit passes through the port terminal. The results of this analysis is shown in the following table. It can be noted that the road haulier and the terminal operator profit most from the improvements.

<table>
<thead>
<tr>
<th>Costs per load unit (in Ecu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forwarder</td>
</tr>
<tr>
<td>Export case</td>
</tr>
<tr>
<td>Reference scenario</td>
</tr>
<tr>
<td>Future scenario</td>
</tr>
<tr>
<td>Import case</td>
</tr>
<tr>
<td>Reference scenario</td>
</tr>
<tr>
<td>Future scenario</td>
</tr>
</tbody>
</table>

Table 15: Economic effects on a port terminal and its customers

The future scenario requires substantial investments in equipment and training. These investments were defined and estimated for each organisation. Cargo volumes are a key factor when considering profitability of the proposed investments. The result of the quantitative economic analysis using the Net Present Value Method is shown in the investment analysis. The profitability of the investment was studied by comparing the discounted cash flows generated by the investments and the invested capital for each organisation. The economic analysis shows that computer based yard management systems are significant investments for small and medium size port terminals and that investments in training of the port terminal's personnel are usually significantly large.
One of the goals of the economic analysis was to study the possibility for differently sized ports to introduce new technology. The sensitivity analysis studied the investment possibilities of port terminals handling 100,000 TEUs resp. 300,000 TEUs per year. The following figures present the results of the investments analysis.

![Economic analysis (Net Present Value Method)](image)

**Figure 2: Results for terminal with 100,000 TEU/year**

The above figure shows the cumulative calculation of investments (made during year 0) and cash flows generated by the investments. The analysis is made for a port terminal handling 100,000 TEUs per year.

![Economic analysis (Net Present Value Method)](image)

**Figure 3: Results for terminal with 300,000 TEU/year**

The above figure shows the cumulative calculation of investments (made during year 0) and cash flows generated by the investments. The analysis is made for a port terminal handling 300,000 TEUs per year.

The pay back time of the investments made by the 100,000 TEUs-port terminal is about six years. The pay back time of the 300,000 TEUs-port terminal is about three years. Terminal operators profit most. Quick benefits (though small) occur also for driver and ships agent. This comparison shows that the port terminal has to handle a certain volume in order to be able to provide the required service quality at reasonable costs. However the general value for critical size is very hard
to define. The investments made by other organisations are relatively small. This is important since it might be that other organisations are not so willing to invest to improve the efficiency of a port terminal. Frequently, external organisations view it as the port terminal’s duty to finance all the necessary investments even outside the port terminal.

**Qualitative results of the socio-economic analysis**

From the economic point of view sophisticated computer based yard management systems are considerable investments, in most cases costing millions of ECUs. The cost comprises mainly:

- software for yard management, internal vehicle control and load planning
- training of the personnel.
- IT infrastructure

It is very difficult to define a general minimum size (TEU/year) for the investment to be economically interesting. This limit would probably vary considerably in different countries. The investment calculation has to be done separately for each port terminal.

The introduction of EDI based communication has an impact on many organisations in the logistics chain. These different sized companies have very different interests and capabilities to develop and invest in EDI based communication. This factor is slowing down the introduction of wide scale EDI solutions in Short Sea Shipping.

In order to be taken into use, EDI based communication needs a strong organisation which realises what kind of benefits it can gain by using EDI. The organisation should also have a sophisticated internal information system (e.g. computer based yard management system) in order to be able to utilise the benefits of EDI. It should plan the details for EDI based communication and even finance the development for the other smaller organisations. In order to get the EDI development and integration work done, a port terminal might support the smaller organisations like transport companies in the form of planning of the use of EDI, training, financing the development of EDI and/or financing the costs of telecommunication.

Automatic driver identification without the support of EDI based information concerning the load units to be picked up or delivered was found to be an economically weak solution if considered separately. The system can only identify the driver and check if the driver is allowed to access to the port terminal. The automated access control should have EDI support in order to be profitable. This means that the terminal operator receives information via EDI concerning the load unit which the driver is going to deliver or pick up. Since the number of containers equipped with transponders is very low, investments in transponder based unit identification were found to be economically weak. The Finnish User Group believes that optical identification of load units and vehicles could be profitable.

**5.3.3.6 Social impact analysis**

The Finnish Scenarios are aiming at increasing the efficiency of ports and port terminals and thus also the efficiency of Short Sea Shipping. The scenarios outline the need for better educated and trained port terminal personnel. In particular, knowledge of IT technology is needed. New job descriptions will include the use of IT technology. Due to the more challenging work an increase in job satisfaction is expected. Improved yard management will lead to the reduction of unnecessary load unit movements in the yard. This will improve efficiency and also reduce accidents. The control of hazardous goods is already taken care of by the PortNet system and is considered to be on a high level. Safety and security of goods will be improved by introducing...
driver identification. Driver, load unit and vehicle identification also has significant meaning for the whole logistics chain since the same devices can also be used in hinterland terminals.
5.3.4 The Spanish scenario evaluation

5.3.4.1 Introduction
The Bilbao case evaluation analyses the following:

- operational issues and impacts
- the socio-economic implications for the users
- legal and institutional issues

In order to perform the above mentioned analyses, two different types of scenarios were produced:

- The current situation scenario (reference case) which incorporates current practice of operations and current infrastructure configuration of the terminal under study
- The short-term evolution scenario, which incorporates the adoption of several measures which aim at curing the deficiencies of the current situation.
- A long-term, new terminal development from the “green field” approach, without the current limitations of space and terminal layout.

5.3.4.2 Current situation background
The MacAndrews terminal serves currently 123,000 TEUs. During the past years an annual growth of demand 10% is reported and some times even up to 13%. This trend is estimated to continue. Extrapolating this trend in the future, in 5 years the demand will rise to 198,000 TEUs/year and in 10 years to 320,000 TEUs/year.

![Projected annual throughput in TEUs](image)

*Figure 4: Container traffic trends for MacAndrews Terminal*

Several problems are experienced in the terminal which are to a large extend related to the lack of space and capacity limits. Congestion is a problem in the Mac Andrews terminal today. This is due to disorderly traffic, i.e. unregulated circulation and parking of trucks, to limited opening hours of the terminal and working hours of the customs office and to a lengthy check-in procedure. Space is limited so that it is difficult to organise the traffic better in the terminal. On the administration level, communication between the terminal, its customers and customs is lacking. The situation
will get worse in the future, if the growth experienced during the last years continues. The two scenarios aim to enable an increase in cargo transhipped via the MacAndrews terminal.

5.3.4.3 Two scenarios analysed

**Short-term scenario**

For the short-term scenario, the study proposes a set of measures comprising only “smart” interventions. By this is meant that no large scale infrastructure projects will be proposed; instead the study mainly focuses on telematic measures in order to facilitate information flow in the terminal, along with measures that will influence some aspects of physical flow (identification of containers, easing of peaks).

Among the recommended interventions, the following can be judged in numerical terms and within the scope of this study:

- Longer opening hours, a measure that lies within the organisational domain
- Enhanced customs service which includes electronic clearance and extensive use of EDI technology (a measure within the communications and informational domain)
- Accelerated check-in which includes the installation of entry gates, pre-announcement of container arrival, and AEI equipment at entry gates for automatic identification of entering lorries / units. This measure incorporates interventions in informational, communications and slightly in the infrastructural domain

**Long-term scenario**

In the long-term (green field) scenario, the study has proposed a draft lay-out of a new terminal. The term “new” refers not only to the placement of the terminal in the Bilbao area, but also to:

- The operations as a whole. One obvious difference will be that the terminal will incorporate different handling / storage system (straddle carriers instead of transtainers). The most radical change will be the transformation into an automated terminal where most activities related to data acquisition and decision making will be automated and assisted by an integrated management and control system.
- The communication and information flow. All data will be available in real time, to everyone concerned.

The port of Bilbao started from 1992 an ambitious programme for port expansion outside of the river of Bilbao area. The programme includes a vast constructing project in order to gain some extra 350 hectares of land surface with 8 kilometres of new docks. The project is carried out in phases. The first phase includes the construction of one pier at Santurtzi, adjacent to the existing piers at the Santurtzi docks (which include MacAndrews terminal at *Muelle Reina Victoria Eugenia*).

Paperless operations will allow faster interaction between the terminal and its customers, since all formal documents will be transmitted electronically and on time. Apart from this, physical flow will not be hindered by the lack of on-time information flow. The only constraint in the physical flow will be the speed of the straddle carriers and the cranes.

Automation will mean that the involvement of human factor will be minimal, thus minimising the possibility of errors. The introduction of an fully automated management system will help in quick and accurate decision making in everyday operations. The allocation of resources will be optimal, and the idle times will be minimised allowing better utilisation of equipment.
5.3.4.4 Main findings

As a main outcome from the Bilbao evaluation, some interesting conclusions have been obtained:

- Telematics do help in eliminating the inconveniences created by lagging or erroneous information flow. However, the introduction of telematics requires that the actions taken will address the problems of a terminal in a global manner instead of spotting only part of the problems.

- There is an upper limit to the positive effects of the introduction of telematics, that of the spatial and infrastructural capacity of the terminal. When every possible resource is exhausted, a major intervention in infrastructure is unavoidable.

- The establishment of a new infrastructure gives the opportunity of a radical change in the operations scheme. The transition to a automated and paperless terminal will be beneficial both to the terminal operator and to its customers.

5.3.4.5 Operational Analysis

5.3.4.5.1 Introduction

The operational analysis in the Spanish case was carried out based on a simple simulation model which presents the concept of terminal operations as a network of queuing systems:

From the “waterfront” side ships deliver or pick containers, served from the gantries. The gantries in turn required to be served by the transtainers which either provide or take the containers to the storage area. From the “hinterland” side, lorries after the check in procedure, wait to be served by the transtainers. Wagons also wait in front of the transtainers in order to pick or deliver containers. The arrows in the figure 3 do not represent physical flows; they represent streams of “customers”, in this case lorries or containers going from one “server” to another.

![Figure 5: The terminal operations queue network](image-url)
5.3.4.5.2 **Short term scenario**

The measures proposed for the short-term scenario have several impacts on the performance of the terminal. Some of them can be evaluated directly into definite numerical indices, while other impacts can only be evaluated in qualitative terms.

In this short-term scenario, all the proposed operational measures are jointly adopted: The terminal is accessible for 16 hours, electronic clearance is possible, while half of the lorries are able to check-in in zero time. Each of these measures has been evaluated separately in order to estimate the impact of each specific measure, the cohesion between the measures and to investigate possible incremental effects from the adoption of such measures.

The simulation gives interesting results about this prospect: All indices show drastic improvement. The time spent by both the truckers and the terminal are reduced. These promising findings are the results of a uniform capacity increase of all the facilities of the terminal leading to the acceleration of many transactions.

![Figure 6: Capacity and demand in the short-term and the long-term prospect](image)

**5.3.4.5.3 The long term prospect**

The most obvious outcome from the “green field” scenario is the capacity augmentation. The implementation of the “green field” will mean that for the foreseeable future neither the infrastructure (size of storage area, quay capacity etc.) nor the operations will hinder the terminal to cope with the demand.

The infrastructure capability is the result of the ample storage space. Even with streamlined operations the current terminal will be completely saturated in the year 2002. After this year there will be a need for a more fundamental change in the terminal. The new lay-out has the expandability to meet very increased demands; it provides a storage space of 8.16 ha which in turn gives a maximum effective storage capacity of 6530 TEUs. This means that the annual throughput that can be handled rises to 477000 TEUs.
5.3.4.6 Economic Analysis

The operational/organizational interventions have implications for the relevant body involved, in terms of investments, operational cost reduction and short/medium term business potential. The economic assessment constitutes an evaluation tool to compare the benefits against the costs and prove the viability of the measures proposed.

5.3.4.6.1 The cost/benefit analysis for the short term scenario

The implementation of the short-term scenario will result in definite measurable costs. More specifically the following measures will have a direct economic impact:

- The expansion of land-access hours from 12 to 16.
- The introduction of EDI to transactions between the terminal and the customers
- The installation of AEI at terminal gates.

Expansion of land access hours from 12 to 16 will not result in an increase in payroll. Indeed, currently, the terminal operations take place in round-the-clock shifts, since ship traffic is handled continuously. So the personnel allocated for the operation of cranes, platforms and transtainers will not be affected by the expansion of the land access hours. On the other hand, the introduction of EDI, will facilitate document handling, increasing the productivity of existing shifts of administration personnel.

Introduction of EDI. EDI is currently used for a limited number of messages (bayplan), so there is no need for procuring EDI software. However, the wider application of EDI will require the development of additional EDI messages. In order to integrate the information obtained via EDI with that already available by NAVIS, the development of an interface between the existing Management information system is required. Some additional investment will be made in training and maintenance.

Installation of AEI. For the AEI application we adopt a transceiver/tag solution. The hardware needed will be two transceivers with the accompanying computer hardware (ISA cards and industrial PCs). A minimal software development will also be needed. A summary of all the investments for the introduction of these technological solutions is presented in the table below. The figures included are based on relevant data regarding installation of AEI and EDI in port of Piraeus.

<table>
<thead>
<tr>
<th>Technological applications</th>
<th>Investment cost in ECUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDIFACT messages</td>
<td>10000</td>
</tr>
<tr>
<td>Integration with NAVIS</td>
<td>4286</td>
</tr>
<tr>
<td>Training</td>
<td>20000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>10000</td>
</tr>
<tr>
<td>AEI transceivers (2)</td>
<td>10750</td>
</tr>
<tr>
<td>ISA cards</td>
<td>6200</td>
</tr>
<tr>
<td>PC</td>
<td>1000</td>
</tr>
<tr>
<td>AEI software</td>
<td>2000</td>
</tr>
<tr>
<td>Total investment</td>
<td>ca 65000</td>
</tr>
<tr>
<td>Annual expenses</td>
<td>10000</td>
</tr>
</tbody>
</table>

Table 16: Investment cost for MacAndrews terminal for the short-term scenario
The analysis for the short-term scenario shows that the investment is profitable from the first year that in effect, i.e. from the year 2000. The revenues at year 2000 will surpass the losses of the year 1999 due to the investment. From this point onward the new system is profitable with increasing rate until the year 2002 when the capacity ceiling of 175,200 TEUs is reached.

![Graph showing net present values for the short-term scenario](image)

*Figure 7: Net present values for the short-term scenario*

### 5.3.4.6.2 The cost/benefit analysis for the long-term prospect

The exact calculation of the green-field scenario costs is well beyond the scope of this study. It requires very detailed information about cost allocation. The issue of the concession charges involves questions about the general transport policy and the financial pursuits of Port of Bilbao.

In order to give an outline of the financial results, the Net Present Value of the investment was calculated as the result of two parameters: Initial investment and annual additional costs. These two parameters represent negative flows while each year there are additional inflows due to increased demand / capacity, as shown below.
These figures give the margin values for the combination of annual expenses and initial investment for which the NPV is zero. Beyond this margin and for less annual expenses and initial investment the NPV becomes positive while towards the opposite direction the results become negative.

Of course if the initial investment is low, there is the possibility to amortize it with larger annual running costs. The inverse holds true: if the initial investment is large, small running costs are required in order to amortize the investment.

The analysis shows that the longer the required payback period, the wider are the margins for investments and running costs.
5.3.4.7 Legal and Institutional Analysis

**Port system**
The relevant Spanish legal framework comprises of recently issued Laws. The most important is the Law of State Ports and Merchant Marine (27/1992). This Law opts for a decentralized management scheme and follows a more liberal approach for the port development policy.

The measures proposed in the short and green field scenarios comply with the general guidelines of the Ports and Merchant Marine Law and are consistent with the objectives posed (minimization of costs and self-financing).

**EDI**
The introduction of EDI imposes some questions about the authenticity of dispatched messages, the reliability, the liability, questions that for the case of paper communication have been resolved for years. A Ministerial Order of 27 July 1995 facilitates the sending of some documents (Import/Export Manifest) to Customs according to the EDIFACT standard. It is estimated that further spreading of EDI requires a legal base to be provided.

Ente Público Puertos del Estado is participating in the PORTEL company which aims at introducing the use of EDI throughout the port community, through the operation of an EDI dispatching and handling network.
5.3.5 The Greek scenario evaluation

5.3.5.1 Scenario characteristics

The Greek scenario is mainly a container-import scenario with focus on information exchange and organisation. The future 1 scenario introduces measures for the enhancement of the operations inside and outside the terminal and is closely related to the plans of the port of Piraeus. The future 2 scenario is an ideal future scenario describing a situation under significant technological and procedural changes. The following lists give an overview over the changes in both scenarios. The evaluation has shown, that a further development than planned by the port authority would be much more beneficial.

**Future 1**
- Increase in entrance gates (from 2 to 10), Semi-automatic
- EDI
- Improved manual entry control procedure
- Video cameras for damage control (still also manually)
- Parking area separated from storage area
- Better control of ITU and vehicles throughout the terminal, by radio communication straddle carrier - yard managers regarding all ITU movements
- New MIS for improved management and control

**Future 2**
- Increase in entrance gates (from 2 to 10), Automatic
- EDI
- Automatic access control
- Automatic damage and seal control (video)
- Automatic management of parking, storing and loading/unloading activities
- Parking area separated from storage area
- Full control of resource, ITU movement in the terminal (automatic identification, OBU)
- New MIS
- Yard management software
- Guidance of external vehicles

For the evaluation it has been distinguished between three cases looking at impacts on different organisations:

1. **Containers Delivery/Collection – Road transport company case**: This case studies the operational performance of the port terminal during the delivery of a container to the terminal by a lorry of a road transport company and subsequent collection of another container by the same lorry.

2. **Containers Import – Port authority case**: This case studies the operational performance of the terminal during the import of containers via the terminal. This is the basic port related case of the Greek operational analysis and examines in detail the containers handling by the terminal resources (human and equipment).

3. **Containers Transhipment- Shipping company case**: This case studies the operational performance of the terminal under the transhipment of containers via the terminal.
5.3.5.2 Main findings

- Both scenarios are financially justifiable.
- For the terminal operator’s investments the NPV is greater than zero in the sixth year of the investment in the future 1 scenario while in the future 2 scenario NPV becomes greater than zero between the fourth and the fifth year of the investment.
- The unmanned terminal operations, as described in the Future 2 scenario, substantially reduce the containers’ total turnover time.
- The electronic transmission and handling of formal documents gives significant benefits for the involved actors, such as reduction of the paperwork and human resources, significant time savings, etc.
- The recommended telematics solutions can substantially increase the resource utilisation and reduce human involvement.
- More efficient port terminal operations may have significant effects for the total transport chain from consignor to consignee.
- The implementation of the future 2 scenario would increase the number of containers that one lorry can transfer to the terminal.
- It is assessed that the total number of lorries required to transfer containers could substantially decrease.
- The future 2 scenario is beneficial for all parties involved.

5.3.5.3 Operational analysis

5.3.5.3.1 Cases assessment

Effects on road transport companies

Within the first case, the study is focused on the total number of containers that a specific transport company can transfer to/from the terminal and its required capacity for various demand levels. Furthermore, the average time that the lorry of the road transport company remains within the container terminal, in order to deliver the container to be exported and collect the container to be imported has been investigated.

The following table presents the results of calculations in terms of benefits and disadvantages between the three scenarios from the road transport companies point of view.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time that the lorry remains within the terminal</td>
<td>-6%</td>
<td>-82%</td>
<td>-81%</td>
</tr>
<tr>
<td>Total time required for the lorry to complete the whole assignment</td>
<td>-5%</td>
<td>-45%</td>
<td>-43%</td>
</tr>
<tr>
<td>No of containers that one lorry can transfer to the terminal per shift (13-hours)</td>
<td>0%</td>
<td>+67%</td>
<td>+67%</td>
</tr>
<tr>
<td>Total no of lorries required by the transport company to transfer x export containers per shift (13-hours)</td>
<td>0%</td>
<td>-40%</td>
<td>-40%</td>
</tr>
</tbody>
</table>
Table 17: General benefits and disadvantages between the three scenarios from the road transport companies point of view

The table above demonstrates the superiority of the advanced scenario compared to the other, through the dramatic reduction in the service time required for the completion of the containers delivery/collection process. These time savings contribute to the increased effectiveness of the transport companies fleet assignments through the minimization of their stay in the terminal.

The unmanned access control of the future -2 scenario gives a substantial advantage against the other two manual or semi-automatic procedures. This is more evident against the Future - 1 scenario that the introduced formalised, however necessary, control at the entrance leads to an extra time penalty. The big gains for the Future - 2 scenario have been achieved at the stowage area control and particularly in relation to the customs control, which for EU containers can substantially be speeded up.

The prime advantages from the introduction of a full scale telematic solution are related to the efficient and errorless undertaking of the terminal operations. Human errors and deficiencies from the manual operations can lead to substantial delays, which occasionally may reach the 100% level.

**Effects on the port authority**

The study conducted in the specific case is focused on the average time required for a pre-specified number of containers to be imported through the container terminal. Furthermore, how this time affects the total number of containers that the port authority can handle, has been further investigated, considering that all other parameters beyond the terminal do not interfere with the transfer. The emphasis is put on the resources required to undertake a specific assignment.

The following table is broken down to the various procedures of the whole scenario. The table provides the percentage reduction/increase in the time required between the three scenarios for the port authority case, in order to detect the operations where time-savings can be realised.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Import preparations</td>
<td>-66%</td>
<td>-66%</td>
<td>0%</td>
</tr>
<tr>
<td>Sea entry control</td>
<td>+11%</td>
<td>-22%</td>
<td>-30%</td>
</tr>
<tr>
<td>Stowage area control</td>
<td>-17%</td>
<td>-85%</td>
<td>-81%</td>
</tr>
<tr>
<td>Parking area control</td>
<td>-17%</td>
<td>-17%</td>
<td>0%</td>
</tr>
<tr>
<td>Land exit control</td>
<td>0%</td>
<td>-100%</td>
<td>-100%</td>
</tr>
<tr>
<td>Total terminal</td>
<td>-25%</td>
<td>-78%</td>
<td>-71%</td>
</tr>
</tbody>
</table>

**Table 18: Functional presentation of the time-savings/losses for the port authority**

The administrational procedures prior to the vessel arrival as well as the stowage area activities constitute the main determinants concerning the performance of the designed scenarios. The current manual handling and communication of the formal documents between the shipping company and customs clearing agents and the port authority and customs respectively add a significant time penalty in the total turnover time. The recommended telematic solutions dramatically reduce both the duration of the individual activities and the human resources requirements.

The other major operational element of the stowage area control is very much influenced by the time savings obtained because of the automatic control of the collection/placing procedure, the real time positioning of the containers and the electronic clearance of the imported units, particularly those coming from EU countries.
The resources utilisation constitutes the main operational cost for every port terminal. Thus, the relevant analysis undertaken has showed that though the organisational measure of establishing an exclusive parking area has required additional resources to function, the total resources occupation has been reduced under the future-2 scenario. This increases the port terminal operational capacity with direct effects to the terminal performance under increased level of demand.

**Effects on shipping lines**

In the third case the focus is given to the parameters, which affect the in-terminal operations undertaken by the agent of the shipping company for container transhipment. Additional emphasis is put on the transport of the containers from the loading/unloading area to the stowage area and vice versa. The analysis focuses on the benefits or disadvantages for the shipping lines which result from specific changes between the current and future scenarios.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unloading preparations</td>
<td>-66%</td>
<td>-66%</td>
<td>0%</td>
</tr>
<tr>
<td>Sea entry control</td>
<td>+11%</td>
<td>-22%</td>
<td>-30%</td>
</tr>
<tr>
<td>Stowage area control (import)</td>
<td>-20%</td>
<td>-40%</td>
<td>-25%</td>
</tr>
<tr>
<td>Loading preparations</td>
<td>-66%</td>
<td>-66%</td>
<td>0%</td>
</tr>
<tr>
<td>Stowage area control (export)</td>
<td>-14%</td>
<td>-29%</td>
<td>-17%</td>
</tr>
<tr>
<td>Sea exit control</td>
<td>+17%</td>
<td>-33%</td>
<td>-43%</td>
</tr>
<tr>
<td>Total terminal</td>
<td>-45%</td>
<td>-55%</td>
<td>-17%</td>
</tr>
</tbody>
</table>

Table 19: Functional presentation of the time-savings/losses for the shipping lines

According to the analysis performed, the most time-savings have been achieved at the loading preparation procedures and for the Future-2 scenario. The reasons behind this result have been described in the import case conclusions and are mainly related to the computerised approach both for data handling and communication. Apart from the "preparations" the rest procedures demonstrate similar operational performance. In case that both the manual positions confirmation as well as the recovery of a faulty locational referencing are taken into account the stowage area becomes the number one factor concerning the obtained time and cost savings.

More results concerning the operational evaluation of the three cases can be found at the Evaluation deliverable.

**5.3.5.3.2 Exception handling**

The Greek partner also investigated how the scenarios would be influenced by unforeseen events. The following situations have been analysed:

- Time penalties under various inefficiency situations,
- Port terminal performance for higher demand levels as assumed,
- Introduction of a 24-hours service (working hours),
- Lower adoption of electronic data management
  the port terminals influence in the total transport chain.

Several reasons can cause delays for the transport company within the terminal. The analysis was made for a specific company which requires approximately one hour to reach the terminal. Two delay-situations (30% delay, 90% delay in the current situation) were compared with the situation without delays. The analysis shows that both future scenarios are the more beneficial to transport companies the bigger the delays are.
### Table 20: Comparison of time penalties under various inefficiency situations

<table>
<thead>
<tr>
<th></th>
<th>Future 1 - Current</th>
<th>Future 2 - Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without delay</td>
<td>30% delay</td>
</tr>
<tr>
<td>Time that one lorry remains within the terminal</td>
<td>-6%</td>
<td>-6%</td>
</tr>
<tr>
<td>Total time required for the lorry to complete the whole assignment</td>
<td>-5%</td>
<td>-4%</td>
</tr>
<tr>
<td>No of container that one lorry can transfer to the terminal</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total number of lorries required by the transport company to transfer 200 export containers per shift (13 hours)</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

A 50% higher increase in demand as assumed would lead to a bottleneck situation in terms of required number of parking places. The current system would get in a situation with a need of 164 parking places. In the future 2 scenario with its advanced telematic system the need of parking places sums up to 32. This is a very important issue under the space limitations experienced by all ports. For the port authority, a higher demand would lead to bottlenecks at the land exit control and the import preparation. In the future 2 scenario the port authority is able to manage higher demand due to automatic exit control and the advanced IT.

The 24-hours service would have direct benefits to the transport company. While the number of containers that one lorry can transfer almost doubles in the future 1 scenario and doubles in the future2 scenario, the total number of lorries required decreases accordingly.

Lower adoption of electronic data management (20% instead of the assumed 100%) would lead to lower time savings of the port authorities in the future 1 scenario. Most of the time savings would be shifted to the future 2. Time savings in the port influences the total transport chain. The reduction of the containers handling duration would decrease the total transport time from 16,5 days to 15,2 days (future 1) resp. 15,13 days (future 2). The competitive position of the port of Piraeus can be improved under both future scenarios.

### 5.3.5.4 Economic analysis

#### 5.3.5.4.1 Economic analysis from the transport companies point of view

The economic analysis from the transport company’s point of view examines the economic benefits /disadvantages mainly in terms of:

- increased number of transferred containers
- reduced number of required lorries
- opportunity cost

The Net Present Value Method shows that in the future 2 scenario is economically justifiable, since the NPV is greater than zero even from the first year of the investment. A transport company that interacts with the port terminal enjoys significant economic benefits without investing a great amount of money for the implementation of the scenarios.
5.3.5.4.2 Economic analysis from the port terminals point of view

The calculation of the cost of the human resources, cost of the equipment and the time cost for the equipment and the personnel involved in the three EUROBORDER scenarios has been made for the calculation of the running costs. The future scenarios in order to increase the port terminal operational capacity, require additional resources (human resources and equipment). Therefore, the overall running costs of the future 1 scenario is increased by 43% compared with the current situation. The running cost of the future 2 scenario will increase by 29%. The calculation of the time required within the scenarios showed that the service time decreases by 25% while the required time in the future 2 scenario decreases by 78%.

The Net Present Value method shows that the pay back period for the future 1 scenario is approximately six years. An underlying assumption is an increase in container handling of 15% per year. The discount rate is 10%.

![Figure 10: NPV results from the application of the future 1 scenario in the port terminal](image)

By summing up the values of the NPV for the future 2 scenario, the NPV becomes greater than zero between the forth and the fifth year of the investment. Calculating the difference in the profit between the current situation and the future 2 scenario, the port terminal increases its profit in the first year of the investment by 3,067,800 ECU.

![Figure 11: NPV results from the application of the future 2 scenario in the port terminal](image)
5.3.5.4.3 Economic analysis from the shipping company’s point of view

The main economic benefits that the shipping company has due to the introduction of the two future scenarios are:

- the reduction of their personnel which leads to significant economic gains and
- the reduction of the time required, mainly for the loading / unloading procedures, which leads to the reduction of the time that the ship stays at the port, the main concern of the shipping company.

The comparison of the two future scenarios with the current situation also shows that the cost savings are very high compared to the scenario’s implementation costs. This makes the implementation of the scenarios interesting and applicable to the Greek shipping companies.

5.3.5.5 Legal and institutional analysis

The legislation concerning the proposed scenarios varies. The proposed scenarios require either juridical and / or institutional changes in the legislation.

The following table shows areas for new legislation which are required for some parts of the scenarios. These areas are also generally applicable for the other test sites.

<table>
<thead>
<tr>
<th>Solutions</th>
<th>New legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDI</td>
<td>• authentication</td>
</tr>
<tr>
<td></td>
<td>• uniqueness of documents</td>
</tr>
<tr>
<td></td>
<td>• storage of electronic data</td>
</tr>
<tr>
<td></td>
<td>• reliability of EDI networks</td>
</tr>
<tr>
<td></td>
<td>• liability and insurance</td>
</tr>
<tr>
<td>AEI</td>
<td>• electronic signature</td>
</tr>
<tr>
<td></td>
<td>• safety of data</td>
</tr>
<tr>
<td></td>
<td>• storage of data</td>
</tr>
<tr>
<td></td>
<td>• confidentiality</td>
</tr>
<tr>
<td></td>
<td>• PIN</td>
</tr>
<tr>
<td>Optimisation of working shifts and Reduction / transfer of personnel</td>
<td>• customs legislation</td>
</tr>
<tr>
<td></td>
<td>• labour legislation / agreements</td>
</tr>
</tbody>
</table>

Table 21: Legislation required for some parts of the scenarios

5.3.5.6 Social impact analysis

Within the social impact analysis, the social results of the operational impacts of the Greek EUROBORDER scenario are assessed. The development of the EUROBORDER scenarios should provide significant benefits not only for the port terminal but for the society as a whole. An investment of public money should not only contribute to the improvement of a specific sector of public life but to the society as a whole.

The main benefits for the Greek society expected from the introduction of the EUROBORDER measures are similar to those defined in the evaluation methodology and can be summarised into the following categories:

- increased transport efficiency
- increased efficiency of the port
- increased safety and security of the operations
- wider economic benefits.
5.3.6 The Norwegian scenario evaluation

5.3.6.1 Scenario background
The major bottleneck for the Port of Oslo for the coming years is lack of capacity for container handling because of limited land areas, limited possibilities for expansion, sub-optimal organisational and administrative structures and little use of IT-technology. Especially the problem of a too small terminal area will get even larger in the future. Additionally operations are restricted due to noise and pollution affecting nearby residential areas.

The work in EUROBORDER is closely related to the development of a new strategic plan for the port. In this work, Oslo Port Authority (OPA) is assessing the current situation in the whole port in coherence with the forecast for the growth in general cargo traffic for the period to year 2020. The following figure shows the forecast for containers handling until 2020.

Figure 12: Expected development of container import and exports in Oslo Port

The projected growth will be far outside the capacity of the existing terminal and planned extensions/land reclamation. It is not likely that significantly more land will be available in the future other than areas already included in existing plans.

The Oslo port test site developed several scenarios for solving the main problem containing:
- short term improvements
- increase of space efficiency ("future scenario") and
- extension of the terminal area ("alternative scenario")

The main strategy in Oslo is to enhance the space efficiency in the terminal. Space efficiency is defined as the total number of containers going through the terminal in a year divided by the area of the terminal (TEU/sq.m/year). It will be affected by the handling system, storage pattern, dwell time and peaks in traffic.
The "future scenario" focuses on
- the introduction of new handling technology,
- new management and information systems and
- a new organisation in order to achieve improvements.

The alternative to solve the capacity problem would be to build a completely new terminal. This "alternative scenario" has also been analysed.

5.3.6.2 Main findings

- The space efficiency can be clearly improved by investment in new handling systems. Especially an investment in rail mounted gantries would increase the space efficiency by 160%-310%.

- An important result for the Oslo test site is, that an increase in efficiency goes along with a "monopolization". For the Ormsund terminal it shows that much higher efficiency can be reached with only one terminal operator (today two).

- Operational costs for the "future scenario" are at least 4% lower than for the "alternative scenario".

- The "future scenario" has the additional benefit that area close to the city centre can be released for non-port activities.

- Terminal productivity is twice as high in the "future scenario" as today.

- Increase in space efficiency: Today: 0.8 TEU/sq.m/year
  Alternative: 1.78 TEU/sq.m/year
  Future: 3.85 TEU/sq.m/year
5.3.6.3 Operational analysis

5.3.6.3.1 Short term improvements
To improve the current situation in the short term the following key points are evident:

- One management team for the terminal should be formed based on a tendering process (today two terminal operators). The team should take charge of the yard, acquire sufficient of the yard handling equipment for the operation and be responsible for all aspects of activity on the terminal.
- Safety should be improved. The terminal should be fenced and unauthorised persons should be excluded. All personnel working on the site should wear protective clothing i.e., high visibility vests and hard hats as well as reinforced shoes.
- A Yard Management System (YMS) should be acquired. This will require that the yard is formally laid out for container stowage and a grid reference code is introduced which will give a unique reference for each stacking position in the yard.
- It is expected that these short term measures could boost the throughput of the terminal by between 30 and 50%. The short term improvement would probably make the terminal able to meet the immediate demand for more capacity, while other and more radical measures are planned and implemented to meet the future capacity increase.

5.3.6.3.2 The future scenario
The future scenario is one possible solution to meet the demand for handling capacity in year 2007. During this period the cargo is estimated to increase from 85,000 to 165,000 TEUs. In 2007 60% of all containers will be 40-foot containers. The remaining 40% will be 20-foot containers. The short term improvements are considered as the first part of the "future scenario". The "future scenario" is part of a new development plan for the Oslo port and can be effective in short time. The Norwegian "future scenario" focuses on
- the introduction of new handling technology,
- new management and information systems and
- a new organisation in order to achieve improvements.

The implementation of the future scenario will increase the space efficiency in the Ormsund terminal from today’s 0.8 TEU/sq.m/year to 3.85 TEU/sq.m/year in the year 2008.

Introduction of new handling technology
The Norwegian scenario implies a total change in the cargo handling system. A comparison between the handling system which is in use today (see following table) and alternative handling systems shows that the space efficiency can be improved considerably.

<table>
<thead>
<tr>
<th>Handling equipment</th>
<th>Height of container stack</th>
<th>Comparative Efficiency</th>
<th>Space Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLT's / Reach Stackers</td>
<td>3</td>
<td>100% (today)</td>
<td></td>
</tr>
<tr>
<td>Straddle Carriers</td>
<td>2</td>
<td>140%</td>
<td></td>
</tr>
<tr>
<td>Straddle Carriers</td>
<td>3</td>
<td>210%</td>
<td></td>
</tr>
<tr>
<td>Rubber tyred / Rail mounted Gantry</td>
<td>2</td>
<td>160%</td>
<td></td>
</tr>
<tr>
<td>Rubber tyred / Rail mounted Gantry</td>
<td>3</td>
<td>230%</td>
<td></td>
</tr>
<tr>
<td>Rubber tyred / Rail mounted Gantry</td>
<td>4</td>
<td>310%</td>
<td></td>
</tr>
</tbody>
</table>

Table 22: Comparison of space efficiency for different handling systems
The stacking system which makes best use of yard space are rail mounted or rubber tyred gantries (RMG/RTG). RMGs have the advantage of being electrically powered and hence quieter and less polluting. The terminal tractors serving the RMGs are diesel driven. Moreover RMGs are easily automated. The disadvantage of RMG is that if they are required to access a box at the bottom of a stack, it takes more time to remove the higher boxes. The implementation of RMGs can almost double the existing capacity.

**New management and information systems**

The introduction of new telematics systems is a vital part of the scenario. This measure enables and supports the capacity increase. Other scenario parts are automatic identification at gate, automatic damage control, automatic positioning and EDIFACT-based communication with the customers.

To get optimal effect from the investment in handling equipment and to reduce dwell time to a minimum it is a necessity to implement IT-technology for
- yard management
- generating loading lists
- generating bay plans
- giving consignees automatic notice of arrival

**A new organisation in order to achieve improvements**

Organisational consequences of the future scenario in order to get maximum benefit are
- one operator engaged on a tender base and on short contract
- the port takes the responsibility for investments in heavy handling equipment and technology.

Presently two operators share the terminal area. They lease the land from the port and provide the handling equipment themselves, apart from the container cranes which are provided by the port. Present system with two operators on fairly short contracts (5 years) maintains a necessary degree of competition between the operators. Investments in the RMG-system are huge and additionally it would require only one operator. If the RMG costs were carried by a terminal operator, it would be necessary to give him a long term contract (>10 years). The limited competition in this situation could jeopardize the competitiveness of the port. Therefore the Oslo Port Authority aims at providing also the handling equipment (the RMGs) in order to be able to give short term contracts to an operator selected through a tendering process.

**5.3.6.3.3 The alternative scenario**

In the "alternative scenario" the handling operations, information and administration systems are the same as in the "Short Term Improvement". To enhance the capacity in the terminal, additional land area is necessary to meet the projected demand. To match the capacity in the "Future Scenario" additional 45,000 sqm. is necessary. Due to longer internal transport it is also a need for more handling equipment to maintain the handling capacity. At least two heavy forklifts will be needed. The implementation of the alternative scenario will increase the space efficiency in the Ormsund terminal from today’s 0,8 TEU/sq.m/year to 1,78 TEU/sq.m/year in the year 2008.
5.3.6.4 Economic Analysis

5.3.6.4.1 Scenario Implementation Costs

Future Scenario:
The total investment of the future scenario sums up to 88 mill. NOK. The operational costs for manpower and equipment amounts to 13 mill. NOK per year. The following table gives a more detailed overview over the operational costs of the future scenario.

<table>
<thead>
<tr>
<th>Investments year 2000 in mill. NOK</th>
<th>Operational costs in mill. NOK/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMG-crane</td>
<td>40</td>
</tr>
<tr>
<td>Operational costs RMG cranes (incl.salary)</td>
<td>4,5</td>
</tr>
<tr>
<td>Rail, foundation etc.</td>
<td>25</td>
</tr>
<tr>
<td>Other terminal handling equipment</td>
<td>17</td>
</tr>
<tr>
<td>Operational costs other terminal handling equipment (incl.salary)</td>
<td>8,5</td>
</tr>
<tr>
<td>Container management system</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

*Table 23: Investments and operational costs for future scenario*

At maximum capacity an income per square meter of NOK 521 is expected in 2008. This requires that 3,85 TEU/square meter/year can be handled.

Alternative Scenario:
The total investment of the alternative scenario sums up to 78 mill. NOK. The operational costs for manpower and equipment amounts to 14,6 mill. NOK per year. The following table gives a more detailed overview over the operational costs of the alternative scenario.

<table>
<thead>
<tr>
<th>Investments year 2000 in mill. NOK</th>
<th>Operational costs in mill. NOK/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land reclamation</td>
<td>45</td>
</tr>
<tr>
<td>Operational costs manpower</td>
<td>11,6</td>
</tr>
<tr>
<td>Forklifts</td>
<td>7</td>
</tr>
<tr>
<td>Operational costs equipment</td>
<td>3</td>
</tr>
<tr>
<td>Toplift trucks (existing)</td>
<td>24,5</td>
</tr>
<tr>
<td>Terminal tractor (existing)</td>
<td>1,1</td>
</tr>
<tr>
<td>Container chassis (existing)</td>
<td>0,4</td>
</tr>
<tr>
<td>Total</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>14,6</td>
</tr>
</tbody>
</table>

*Table 24: Investments and operational costs for alternative scenario*

Investment in land reclamtion or other extensions is estimated to NOK 1500/sq.m. At maximum capacity there is expected an income per square meter of NOK 250 in 2008 provided that 1,78 TEU/square meter/year can be handled.
5.3.6.4.2 Cost/Benefit Analysis

The Norwegian partners worked out spreadsheets which show the direct efficiency of investments for the two scenarios.

**Future scenario vs. alternative scenario**

As can be seen from the table above the two scenarios have very similar total costs. In the future scenario the investment costs are higher than in the alternative case. The operational costs are higher in the alternative scenario, though. The pay-back time for both scenarios is 20 years and both reach their maximum handling capacity (165,000 TEU) in 2008 which means that further investments would have to take place to enable the handling of the increasing cargo flow.

For the Oslo Port Authority, the main conclusion from the analysis is that it is profitable to invest into new heavy equipment, whether land is available or not. In any case the future scenario can compete with the alternative scenario. Moreover, in the situation of the city port Oslo, land area close to the city centre has a non-quantifiable value which was not taken into account in the economic analysis. Increasing the space efficiency of the existing terminals means that area today reserved for port expansion is available for non-port activities. This is important in discussions with the city council, which would like to use parts of the port’s space for city expansion and fosters plans to move the whole port to an area outside the city. As the Oslo port authority wants to keep its central position, a capacity increase has to be managed without taking up more space.

<table>
<thead>
<tr>
<th></th>
<th>Handling capacity per year in TEU</th>
<th>Terminal area in sqm</th>
<th>Annual revenue/sqm in NOK</th>
<th>Space efficiency in TEU/sqm/year</th>
<th>Pay-back period in years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
<td>85,000</td>
<td>44,000</td>
<td></td>
<td>0,8</td>
<td></td>
</tr>
<tr>
<td>Future scenario</td>
<td>165,000</td>
<td>44,000</td>
<td>521</td>
<td>3,85</td>
<td>20</td>
</tr>
<tr>
<td>Alternative scenario</td>
<td>165,000</td>
<td>89,000</td>
<td>250</td>
<td>1,78</td>
<td>20</td>
</tr>
</tbody>
</table>

*Table 25: Comparison of efficiency and economic indicators of Norwegian scenarios*

5.3.6.5 User Acceptance and Market Analysis

The users of the Port of Oslo, in this context meaning shipping lines and cargo owners, are suffering under the existing conditions. Both shipping lines and cargo owners are in need of more capacity and more space. From these users any action to improve the current situation is met by a positive attitude. Furthermore, the expectation of lower service costs and port’s tariffs as well as reduced dwell time due to improved efficiency secure a high user acceptance.

As shown in the figure above the demand for container-handling lo/lo will increase the next 10 years with 6-7% p.a. This means that the demand will increase to 165,000 TEUs during a 10 year period. The planned capacity in the future scenario will match this demand efficiently, without a costly and politically difficult port expansion.
5.3.6.6 Legal and Institutional Analysis

Legal analysis
The Port Authority as landlord must comply with the national and local regulations governing the planning and building process. The result is a long lasting planning and building period and great difficulties to meet the requirements from the transport and shipping industry on time. The second law and regulation is the local health regulations concerning the health effects in the terminal and in its surroundings.

The regulations will affect the future scenario to a lesser degree than the alternative one. The planning committee of the city must most probably grant the implementation of the new RMG-crane. The process will take less than 1 year. For the alternative scenario the implications are much larger. A plan must be made and an environmental impact assessment would be required. The plan would then have to be submitted to the city planning department to be prepared for political decision on different levels before the final decision in the city council. The whole process would take 3-4 years.

Strategic assessment
The Port Authority will have to consider whether to give the operator chosen for the terminal a long lease contract and let him do the investments or to take investments by the Port itself. The last alternative will require the Port Authority to reconsider the border between infrastructure, which is already the responsibility of the Port, and handling equipment which is financed and operated by the terminal.

The implementation of new stacking equipment as in the future scenario requires a new order in the port. To make use of the potential of the investment it is no longer acceptable to have more than one operator in the terminal. The operator is then responsible for the efficient utilisation of existing resources.

5.3.6.6.1 Conclusions
The analysis and the assessments show that implementing the future scenario is the only responsible thing to do. The implementation of the future scenario gives a high cost/benefit ratio and should even be implemented without the actual space problems. It will give the maritime industry the demanded capacity in the quickest way possible and to the lowest operational price. The future scenario will be part of the new strategic plan for the port of Oslo. From an environmental point of view the change from mainly diesel driven equipment to electrical is a major step ahead to improve the local environment and reduce the exhaust emissions. The area which is not used for port expansion now can be a potential to future port or city expansion.
5.4 User feedback

5.4.1 Approach
Interviews have been carried out at the end of the project in order to get a feedback from the organisations the EUROBORDER work is related to. A questionnaire had been developed for this purpose, which focused on two areas of EUROBORDER results: The toolbox, as comprising all improvement measures suggested by EUROBORDER scenarios, and the proposed areas for further R&D.

The user validation of the toolbox looked at the question, to which extent the proposed measures are taken into account in the operations or in the strategic planning of the interviewed organisations.

The validation of the proposals for R&D tried to assess, how important the interviewees see R&D in these areas. The list which was presented to them comprised a wide range of issues which are important for the future development, mixing private business development with areas for involvement of ministries/authorities and with real tasks for R&D. The feedback has resulted in the list for further R&D in chapter 6. Please see chapter 6 for more information.

About 20 interviews have been carried out in Greece, Spain, Germany, Sweden and Finland. The user feedback gives a picture of the applicability of the ideas in small and medium size ports. The interviews were mainly held with port authorities/terminal operators as the primary addressees of the EUROBORDER work.

5.4.2 User feedback on the toolbox
The part of the questionnaire related to the EUROBORDER toolbox tried to assess to which extend the users already consider the proposed measures. For each of the measures included in the toolbox (see chapter 5.2) it asked:

- Do you use it today?
- Do you consider it in your strategic planning?
- Do you find it not feasible in your situation?
- Have you never heard of this possibility for improving efficiency?

A first impression of the results from the interviews is that the actors close to a 100 per cent are familiar with all the different measures in the EUROBORDER toolbox. That complies with the fact that all measures used in EUROBORDER are solutions that can be found in the market or have at least been tested in large terminals. EUROBORDER aims to support the introduction of measures in small and medium size terminals in Europe.
Organisational measures Infrastructure measures Supporting IT-technology Administrative functions

Figure 13: User feedback on toolbox

The diagramme shows that port terminals are constantly making organisational and infrastructure improvements. These are areas, where shortcomings have a quick and direct influence on their operations and the economy: If there is no sufficient transfer equipment and if staff is not educated well, capacity and internal efficiency will be low. IT technology and the connected administrative improvements are on the other hand soft factors. IT raises efficiency but the terminal operations will not be in danger, if IT improvements are not made.

The above diagramme reflects this difference. It also shows, though, that improved management and control using IT technology is becoming more important. Many of the interviewees consider these measures in their strategic planning.

Figure 14: User feedback on organisation and administration
The organisational measures in the EUROBORDER toolbox are to a great extent in use today or being considered in the strategic planning. Most of the interviewed organisations have a business cooperation in some way with other organisations. Changes related to the internal structuring of work and to employees (training of staff, staff transfer) have in many cases already been realised or are subject to constant development and optimisation. Staff training is constantly being done by almost 80% of the interviewees.

In most cases changes have already taken place between the port authority and the terminal operator. At most of the interviewed terminals the port authority is the landlord and not involved in the handling. Very few are thinking about further changes and more than 30% are content with the way the roles are divided. "Longer opening hours" is an organisational issue which is important in strategic considerations. Privatisation and decentralisation is a topic only at very few of the interviewed ports and terminals.

The administrative functions of the EUROBORDER toolbox are considered to a very varying degree. The main issue in the current development are the functions involving electronic information exchange and the introduction of EDI (EDIFACT messages). Automatic access/exit control at the terminal’s land and sea side is an important issue for strategic planning. Automatic procedures also find their way into the control of internal vehicles and freight within the terminal. Still, most interviewees did not find them applicable to their situation.

Many of the proposed infrastructure measures have already been realised by the interviewed terminal operators and port authorities. This is especially true for the establishment of secure land side gates, the separation of gates for different kinds of traffic and for the acquisition of new terminal equipment, which naturally is taking place frequently. The building of additional land side gates is to a high degree not found applicable. This complies with the fact that many ports are situated in city areas which makes space a scarce resource.
Most interviewees also do not see the relocation of the Customs office outside the port terminal as important. Often it was commented that it is very convenient to have the customs office close by – for quick problem solving. Many interviewees consider or have already realised a new terminal layout or even a complete new building to ease terminal bottlenecks and increase the terminal capacity.

![Information technology](image)

**Figure 16: User feedback on IT**

For the technology suggestions, there is a difference between the interviewed ferry and container terminals. The small and medium size ferry terminals need less support in the terminal internal control. Therefore issues like yard management software and On Board Units for the communication with internal vehicles are not considered important. They are regarded as very important, though, for the current and future container handling.

The issue which is currently occupying all organisations is the EDI development. Some of the interviewed organisations have realised first EDI-links with their major customers. More is to come, but the development is a difficult one which requires a large amount of coordination and work. RF tags or smart cards are under consideration by many organisations. This is also true for video stored pictures which facilitate and automate damage control.

OCR, VMS and DGPS are technologies that to a great extent are not found feasible in today’s situation of the organisations. This is due to different reasons. For vehicle guidance (VMS), for example, the interviewees see no major need for automation. OCR is not yet reliable enough.

When considering the suggestions for efficiency improvements raised by the toolbox it can be said that the interviewed organisations are quite up-to-date and have constantly realised changes in the area of organisational and infrastructure measures. Some of them for example also have an ISO 9002 certificate. The picture is different when it comes to automation of administrative and control procedures. Technologies and possible procedures can even be unknown to the interviewees. First steps might have been made, a lot is considered in the strategical planning, but it can be expected that it will take a long time until changes are realised on a large scale. This partly depends on
technology and price development. It is also due to the fact that many organisations in the port and along the transport chain would have to cooperate.

A comment from an interviewee reflects the situation of SMPs. One of the terminal operators said that many of the features presented in the list would be nice to have, but would at the same time be an "overkill" and not appropriate in its situation. It was also commented, that it is not so easy to reduce the number of personnel in an automation process: "A certain amount of persons is needed to run the terminal. They might as well work." The interconnection between terminal procedures has to be taken into account in an automation process. To automate single functions might not make much sense, if the same amount of personnel is still needed to carry out other tasks.

5.4.3 User feedback on R&D needs
The feedback on the R&D part of the questionnaire has been structured into three groups in order to simplify the presentation. The grouping was made for organisational issues, IT development and other issues.

The interviewees were asked to range the importance with figures from 5 (high) to 1 (low). For the presentation of results, answers in
- 1 to 2 are classified as "low"
- 3 is classified as "medium" and
- 4 to 5 are classified as "high".

The interviewees could also state "no opinion" if they had not thought a point raised in the questionnaire before.

For many of the issues further development is regarded as highly important. On average more than 40% are of the opinion, that the ideas for R&D are of high importance. The percentage for medium and low importance is about 20% each. An interesting result is, that 20% of the interviewees had "no opinion" to the ideas for further development. This reflects the big variety of issues raised and the fact that they covered many development areas which not necessarily had a direct link to national and European R&D: In some cases it might have been difficult to answer. It also reflects that R&D work is far away from the daily operations. Not many thoughts are spent on this area. As for the toolbox part, the answers which are presented below reflect the areas that would be of direct benefit to the interviewees.

The organisational areas for further R&D are regarded as quite important. Many interviewees emphasized the need for improving the situation in city ports (high importance > 60%). Training and education of personnel is an area of constant consideration and development (high importance > 70%). The division of work between different organisations and their cooperation is also seen as an important area for development (high importance > 50%). This includes division of responsibilities between port authority and terminal operator as well as the cooperation between several companies working in the same area.
The interviewees see very little importance for special organisational measures related to technology development in small/medium size ports. One interviewee commented for example, that the technology transfer between large and small ports (in terms of exchange of information) is taking place to a sufficient amount.

In the area of information and communication technologies, the interviewees clearly identify the need for further development and further R&D. In the presentation of results, several questions have been drawn together: All questions related to EDI/EDIFACT, all questions regarding automatic identification (addressed as AEI), the Internet/Extranet and smart cards.

As could be seen in the previous chapter, most interviewees see the need for a better control of the cargo status and therefore are in some way occupied with AEI/AVI technology. The standardisation of identification technology was rated as highly important by more than 70% of the interviewees. More than 40% also saw legislation in the area of AEI/AVI as an area in which more development is needed. EDIFACT is being used by most of the interviewees, so they know the shortcomings and more than 50% see a high need for improvements and further development.
Two issues are considered to be of fairly little importance: OCR and smart cards. Both areas are probably regarded as far away from directly benefitting terminal operations. Only about 30% of the interviewees see them as important areas for future R&D. More than 20% stated “no opinion”.

The answers to the questions regarding "other" issues show a limited interest. Less than 20% of the interviewees see computer models of port procedures as important. Again, in this area the direct benefit would be low, as simulation/optimisations models only support strategic planning. The deviations in the use of terminology are not seen as a major problem either. The integration of ports into the system architecture for intermodal transport, which is needed for technology development, is seen as important by about 35% of the interviewees. Of higher interest for their business would be a clear view of their customers decision criteria for Short Sea Shipping compared to the other transport modes. More than 40% of the interviewees see a high need for R&D on decision criteria, to find out how they could better influence their competitive situation.

Figure 19: Other important areas for development

5.4.4 Conclusions from the user validation

The results clearly reflect the business needs of the interviewees. They are, for example, far advanced when it comes to organisational, infrastructure and equipment development in order to become more efficient. These areas have a very direct influence on the operations, with personnel and equipment as core of the operations. The interviews related to the toolbox also show, that advanced IT technology and the related improved administrative procedures have been taken into use only to a limited extent. However, these soft factors for terminal efficiency are considered by a lot of the interviewees in their strategic planning.

The main topics identified for future R&D are the training and education of personnel, improved operations of city-ports, the further development of automatic identification (standardisation!) and of EDIFACT. Very little importance was given to the development of special organisational concepts for the introduction of advanced IT into small and medium size ports, to the development of improved port computer models, to a common European terminology and to Optical Character Reading.
5.5 Developing a functional view of the port terminal and its interactions

5.5.1 Introduction
In WP 400 a functional model of a port terminal was developed. The purpose of this modelling was manifold. The main purpose was to develop a common understanding of port terminal functions as a framework for problem analysis and scenario evaluation. Another purpose was to provide input for the development of the NeuComb Port Terminal Model, i.e. the simulation and optimisation tool.

5.5.2 Approach
The modelling was based on input from the bottleneck and problem analysis and on the experiences of the project participants. To support the modelling the project arranged a number of workshops with project members. It was considered as especially important to have port professionals represented at these meetings.

All models depend on a modelling language (and are indeed languages in themselves). Frequently such modelling languages consist of standard building blocks and have predefined rules or grammars for how objects can be combined. There exist computerised tools for supporting modelling in such languages. Modelling languages range from formal mathematics to graphics. The choice of language depends on the purpose of the model and of the type of descriptions to be developed. Frequently different modelling languages are needed to describe various aspects of the particular system that is modelled.

Different modelling languages were considered for the functional model. With regard to the purpose of the modelling it was found that the best alternative was to use verbal descriptions and simple graphics. The only instance where a more formalised formulation was needed was in the NeuComb Port Terminal model. This would be a mathematical model, which could not serve the other purposes that the functional model had to meet.

5.5.3 Main Findings
The most obvious result of this workpackage is the models themselves, which are reported in Deliverable 4.2. Models were developed at different levels of aggregation. Two graphical models are given below: a functional view of export operation and an example of the related information flow. Besides this result, other important conclusions were also made in the development of the models. These conclusions concern both system properties of the port and aspects of the modelling as such.
**EXPORT CASE**

**Physical flow and handling**

A1. Land gate arrival
A2. Land gate entrance
A3. External vehicle transport
A4. Transfer
  A4.1 Loading
  A4.2 Unloading
A5. Internal vehicle transport
A6. Storing
  A6.1 Parking
  A6.2 Stacking
  A6.3 Warehousing
  A6.4 Stripping
  A6.5 Stuffing
  A6.6 Shifting
A7. Sea exit
A9. Land gate exit

**Administrative activities**

B1. Arrival preparation
  B1.1 Transport booking
  B1.2 Loading preparation
B2. Land access control
  B2.1 Check-in
  B2.2 Damage Control
  B2.3 Entrance Control
B3. Management of external vehicle transport
  B3.1 Provision of guidance
  B3.2 Control of position
B4. Management of internal vehicle transport
  B4.1 Requesting of resources for transfer
  B4.2 Requesting of resources for transport
  B4.3 Monitoring of location and identity of vehicle and ITU
B5. Management of parking and storing activities
  B5.1 Requesting of resources for storing
  B5.2 Positioning of ITUs
  B5.3 Confirmation of storing activities
  B5.4 Confirmation of customs inspection
  B5.5 Preparing for export
B6. Sea exit Control
  B6.1 Tally control
  B6.2 Damage control
B7. Post-administrative activities
  B7.1 Reporting
  B7.2 Invoicing

**Resource management activities**

C1. Resource planning
C2. Resource notification
C3. Resource deployment

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*Figure 20: Functional level (export case)*
The objective was to develop a general model that should apply to any port. This might seem like an impossible task, knowing the large differences also between ports of similar size serving similar
markets. The work showed that general models can be developed at two different levels of abstraction but that there is a system (port) specific level between these two.

At an aggregated level the port can successfully be modelled as performing certain functions in a logistic system, e.g. transhipping between different modes of transport. At a detailed level it is also possible to develop models of various sub-processes that are performed in many ports, e.g. discharging a vessel.

The port-specific level, where it is not possible to develop general models, is the level describing how these sub-processes are combined in order for the port to perform its function on the aggregated level. On this port-specific level there is a large number of possibilities to combine the sub-processes for performing the same aggregated function. Even if it is possible to create models on this level, they are therefore not general but merely examples.

It appears that much of the differences in port-performance can be attributed to this port-specific level. There are a number of factors constraining the options for combining processes at this level. These factors may to a large extent be regarded as being determined by informational, organisational and administrational issues in the port. Realising this, the relevance of the overall approach of the EUROBORDER project becomes evident.

Another systemic property is the complexity of port terminals. There is a vast number of possible system states for even a small terminal. The complexity arises on a global level seen over time i.e. when the system is in operation and propagates from one state to another. Any attempt to capture this complexity in partial or static models is therefore deemed to fail. The complexity cannot be dissected. Still, in order to understand the difficulties in determining the optimal way of running a terminal, it is important to understand this complexity.

In terms of conclusions from the modelling as such, some experiences were learnt from modelling the relation between the cargo, the transport resources and the information. The ambition was to develop an integrated model from which one could easily see how the flows and processes in the system were related. While contributing to such a model, we did not manage to fully meet the requirements. Neither were we able to find any other model meeting our requirements reported in the literature.

In the modelling process important characteristics of the system were discovered and interesting ways of approaching the problem of an integrated model were found. Together with the models that were developed this represents important findings for future modelling work.

The following characteristics were found to make an integrated model difficult to develop:

- While the cargo flow follows one chain through the port, the resources move freely between several different "cargo chains"
- For the cargo one may speak of a flow from the gate to the sea, but for the resources it is more relevant to speak of vehicle cycles.
- A vehicle cycle may be a cycle in time but not in space.
- The time scale is radically different for the information flow and the physical flows.
- Often electronically stored information is not sent away from a node, but duplicated to the next.
- Stored information can often be immediately retrieved at any time to a networked location.
- There is not only one type of information but many different ones overlapping each other and forming a grid or network more than what may be called a flow.
• There is not just one information flow but as many flows as there are different information types.
• To a large extent the exchange of information is made on an ad hoc basis through informal communication channels.
• There are by far more actors involved in the information flow than is the case with the physical flows.
• The administrative processes and the related exchange of information is less structured and more difficult to model than the physical flow and the exchange of information that is made only for the purpose of directing the flow according to a given plan.

5.6 Developing a simulation and optimisation software for terminal procedures

5.6.1 Introduction
Evaluating the consequences of alternative changes in a port can seldomly be made by real life experiments. Such experiments are usually far too expensive, and additionally ports operate in a competitive environment where disruptions in the business procedures cannot be accepted. Furthermore, the changes in the port may require changes also by other organisations, which is not reasonable to demand for experimental reasons.

Therefore, it is desirable to conduct the experiments in a model environment instead. Earlier changes were often evaluated by using standard tables over time, space and resource requirements for various port processes. Evaluation could also be made by making a mathematical model of the port and apply various mathematical operational research tools.

Both these methods required large simplifications, and the scope of the analysis was limited to certain variables. Such methods could often only deliver a steady-state solution, but for the port it could be very interesting to study how the system would evolve over time, with different queues growing and decreasing in the system.

Consequently it is of interest to have a tool for evaluating changes in the port which can handle the complexity of the real system. With computerised tools it is possible to get a closer match between the real world and the model. Computer modelling of port terminals is not a novelty. Simulation of port facilities has been used for decision support for many years now.
The most intricate part of developing a model of a port is to describe the program logic. While the physical structure of the port can be fairly easily described, the rules and decisions governing the movements of cargo and resources in the system are seldom easily formulated.

A computer model can be built by programming in a general purpose programming language, a simulation programming language or using simulation packages. Some simulation packages are user friendly and it is fairly easy to build at least a simple model. But these packages have their limitations when it comes to the difficult problem of the model logic. Simple decision rules, such as “first come first served” or choosing the shortest queue, are standard features. But when it comes to making complicated decision depending on several factors, the programs require that the users write new subroutines, which then are called by the main program. In addition, the simulation packages are very expensive and aimed for the market of simulation experts rather than for port operators occasionally needing to simulate their production system.

### 5.6.2 Approach

The primary objective of WP500 was to develop a computerised tool that could be used for evaluating the effects of changes in the port terminal. Furthermore, the project aimed at being able to do these evaluations in a more advanced way than simulation according to simplistic decision rules.

In contrast to the material flow in a manufacturing industry, in a port terminal a detailed pattern of cargo movements can not be decided in advance. This is mainly due to the uncertainty about when and what cargo will enter and leave the terminal. In a port terminal, therefore, cargo and resources continuously have to be routed in the terminal. For systems of any considerable size this is seldom made in an optimal way.

When evaluating changes that can be made in the terminal it is of interest to know how well the system can perform with this configuration, given that the cargo and resources where routed in the best possible way. If this was possible the evaluation could be freed from effects stemming from poor management, and the “true” consequences of the changes could be evaluated.
EUROBORDER therefore aimed at developing a computer model that could route the cargo and resources in an optimal way. This requires that not only the current state but also the expected outcome of the on-going processes and later scheduled activities be considered in the decision. Naturally, even if this optimum is optimal in the model it may not be the optimal solution in the real world since any model is a simplification of the reality. In addition to this novel optimisation functionality it was decided that it should be possible to run simulations with more simplified decision rules such as first come, first served. The primarily usage of this simulation mode is to calibrate the model.

In order to create a model it was necessary to have a thorough understanding of the system to model. Building a good model is a matter of being able to determine what matters of reality are important for the problem at hand and what parts can be discarded.

The development of the EUROBORDER NeuComb port model followed two trails in parallel. One part of the work was concerned with analysing the port system in order to decide what kind of elements and relations should be included as well as deciding an appropriate level of detail for the modelling. This was done through cooperation of WP500 members in WP400, involving both theoretical modelling and study of port systems in practice. The other part of the work concerned the formulation of the mathematical optimisation problem. There was a strong interdependency between these two activities.

Figure 23: The screen window while running the model

The next step, which also ran in parallel with the other two, but commenced later, was the translation of the mathematical model to a computer model. This work included the detailed formulation of the program algorithms carrying out the optimisation and the formulation of the program structure and flow chart. After this stage it was possible for an initiated person to run the computer model. For the ordinary user, though, the model was too difficult to handle. The last step
of the basic development phase, therefore, was to build all the necessary modules of an improved user interface and incorporate the model in a user friendly computer program or "tool".

5.6.3 Main Results
EUROBORDER succeeded to develop a mathematical formulation of an "optimal" decision strategy for the simultaneous routing of cargo and allocation of resources in a port terminal. New about this tool is the combination of algorithms that have been used for the optimisation module. They enable a parallel optimisation instead of a serial. Furthermore, this strategy has been formulated in such a way that it can be incorporated in a "modest" computer environment. A computerised tool, The NeuComb Port Terminal Tool, which runs in Microsoft Windows environment, has been developed. The tool is not a commercial product but a research tool. Optimisation of the program code as well as the integration of additional functionalities would be necessary before the tool could be commercialised.

The simulation and optimisation software enables port terminals to analyse the differences in efficiency for
- pooled vs. unpooled terminal equipment
- dedicated cargo areas vs. handling and storage of cargo without distinction of cargo types
- terminal infrastructure and layout changes
- changes in the number of terminal equipment
- delays due to incomplete information

![Results](image)

*Figure 24: The result window with the aggregated results for the whole system*

The NeuComb tool represents a new development in primarily three senses. Starting with the model formulation the port has been modelled in a new way as three superimposed networks. Then a combination of good optimisation algorithms for all networks in the model has been developed. The three superposed networks are the physical, information and resource networks that are all handled in the same model. The availability of information has been introduced into the nodes in terms of a delay function. Both this model formulation and the combination of optimisation algorithms are new.
There is also a development in the way the model has been computerised. The NeuComb tool works with parallel optimisation instead of serial. To our knowledge this is the first time that such a tool that works in this fashion has been developed.

As mentioned above the computerised tool based on the mathematical NeuComb Port model was developed in two stages. In the first stage the computer program was basically a shell for running the model. With this program it was possible to obtain theoretically interesting results which contributed to increased understanding of the logistics system. It proved, however, that the results as such were very difficult to interpret. In order to understand the result of the program both a good understanding of the program logic and the logistics of the system were needed.

Furthermore, while the results were theoretically interesting they were not the kind of results that the users wanted or were used to handle. Therefore a second version of the tool was developed. In order to produce the results the users wanted and in the requested format this version of the program needed be constrained in certain ways. As a result of this necessary trade-off the second version is further away from calculating the optimal solution according to the original mathematical formulae. On the other hand the model now gives much more detailed results and is therefore of greater value for the users.

The NeuComb Port model runs in four different modes, depending on the objective (goal function) and decision rules. These for modes are time or cost simulation and time or cost optimisation. The tool was designed with the primary objective of incorporating the "optimal" decision rules. As a consequence it is less suited to handle the "simulation" decision rules, and it takes much longer time to run than a tool primarily designed for using simpler rules for decision making.
5.7 The port in the total transport chain

5.7.1 Objective
The objective of WP600 was to provide a basis for assessing what impact changes in port terminals would have on the overall cost and performance of the whole transport chain. Therefore the modelling in WP 600 extended outside the port terminal and included the whole transport chain from origin to destination.

The calculations were concentrated on generalised cost represented by out of pocket cost and time consumption. These are just two of several factors influencing choice of transport alternative. There are several other factors, such as frequency, punctuality and reliability, affecting the choice of mode and route for freight. These factors are more difficult to quantify in terms of ‘costs’, and were not included in the case studies. Therefore, the results of the case studies do not give a complete picture of the impact of improved port performance on the choice of transport alternative.

5.7.2 Approach
Four networks were developed for analysing the effects of the EUROBORDER scenarios on transport chains. The analysis was restricted to a few relations and cargo types for each network. The networks are based upon a few real-life transport chains involving the Norwegian, the Spanish and the Greek scenario ports in EUROBORDER. Each of the ports included operates under different conditions, and serve different parts of the freight market. These differences were important in the process of deciding what products and routes/corridors to focus on in the network models.

The following models were build:

- The Norwegian case study focuses on freight between Mid Norway (Trondheim) and North Italy (Milan).

- The Greek case study consists of two networks: The first network focuses on multimodal transport between representative cities in the West and Central Europe (München, Paris, Berlin) and the Greek /Balkan area. The second network studies Piraeus as a hub of transport between Europe and the Black Sea countries (former Soviet republics) and the Far East. Additionally to the Port of Piraeus, the Greek models also include the Port of Thessaloniki.

- The Spanish study focuses on freight between Northern Spain and UK.
The analysis of the networks was based on the calculations of the generalised costs for the various cargo movements from origin to destination city. The consortium used a general spreadsheet software and built up a large number of tables for the calculation of generalised costs (out of pocket costs and time costs).

To make sure that the necessary data could be obtained, the network selection was made in dialogue with forwarding agents that agreed to deliver cost and time data. The selection process included to identify:

- which scenario-relevant origin-destination (OD)-relation(s) and cargo group(s) to focus on
- the main alternative routes and modes for shipments on these relations
- data sources for cost, price and time consume on the different parts of the network

Data was collected which described the total transport chain and the scenario ports. In addition, data on other nodes and links in the network was collected when this was available. Data was gathered on freight flows, prices, time consumption and other network characteristics.

### 5.7.3 Main results

The results for the four networks are here presented in brief, followed by overall conclusions. It has to be noted that there are large differences between the cases and that the percentages of the generalised costs share of ports in the intermodal chain are therefore not comparable. They give indications, though.
5.7.3.1 Results from the Greek Transit case study

Comparison of the alternative transport chains between Paris and the Balkan cities showed that the chain via Thessaloniki was best of the intermodal chains. For the relations to Belgrade and Craiova, the land based modes - road and rail - were competitive. On the relations between the German cities and the Balkan cities, the intermodal alternatives could not compete with the road and rail alternatives in terms of generalised costs.

The ports represented about 3% - 9% of the total generalised cost in the intermodal transport chains included in the Greek Transit case study.

5.7.3.2 Results from the Greek Transhipment case study

For the Black Sea - USA / West Europe relations there were generally little difference in total generalised cost. The cost and time in the various ports were very similar. The differences in total generalised cost were mainly due to differences in sailing distance for the various alternative routes.

Figure 27: The Greek Transhipment case
For the Black Sea - Far East relations, the findings indicated that the alternatives including ports situated near the Suez channel were most favourable with regard to total calculated generalised cost. Again the time and cost in the ports showed only modest variation - the difference in total generalised cost was mainly related to differences in sailing distance for each alternative.

In the transhipment network the port cost constitute a relatively large part of the cost of the transport chains modelled. (Between 13% and 25% for the different chains.) This is due to that, since a wide variety of origins and destinations are included under USA, West Europe and Far East, the respective intermediate points of Suez channel and Gibraltar were considered as end points instead. These costs are therefore not comparable to the other cases.

5.7.3.3 Results from the Norwegian case study

Despite high values of time, the time cost tended to be of limited importance compared with the ‘out of pocket’ cost. The fastest alternatives were the most expensive ones, and the generalised cost of import was 10% - 18% more expensive than the corresponding export. The ports represented 1% - 5% of the total generalised cost of the intermodal transport chains included in the study.

![Figure 28: The Network for the Norwegian case study](image)
5.7.3.4 Results from the Spanish case study

The Spanish network consisted of two transport chains via the port of Bilbao; one between London and Madrid, the other between London and Barcelona. Here, the port costs (Bilbao and Felixstowe) constituted approximately 25% of the generalised transport costs of the waterborne alternative. In total the generalised costs for the direct road transport is approximately 85% of the alternative via Bilbao. However, the sea alternative included distribution in London which the road alternative did not. It has to be noted, though, that the waterborne alternative is actually taking place. The reason might be discounts which were not possible to get information on or that the delays in the ports due to bad weather were calculated too high. In addition, the cargo values of time applied were probably too high, adding extra cost to the most time-consuming alternatives, namely the intermodal transport chains.

![Network diagram for the Spanish case study]

Figure 29: The network for the Spanish case study

5.7.3.5 Summary

Any comparison of the port’s role in a transport chain from door-to-door has to consider the real prices paid for the transport(s) and the handling involved, as well as the service provided by the players in the chain. The prices are normally a well-kept secret and methods for quantification of service levels are missing. Hence, it is not to be expected that far reaching conclusions can be drawn. Hence, the result of the EUROBORDER exercise can only be used to indicate that:

- Costs are only one of the parameters describing the choice of mode and route
- Cargo value in relation to service parameters as frequency, reliability, security, customer relation etc. plays a major role in the selection of mode and route

The conclusion is that it might be as important for waterborne transport to adjust its service levels to cargo value and logistics requirements as it is to reduce costs.

Complaints about the high level of cost in ports come from various players in the transport market. However, these players may be involved in only a minor section of the transport chain, and not the
complete door to door chain. This is especially true for transhipment as illustrated by the Greek case. If a port is to be attractive as a hub for transhipment it must be situated close to the main transport corridors. Even within these limitations there are normally several ports competing in prices and service levels. The possible changes are illustrated by the analysis of the scenario for Piraeus, which showed that through the proposed organisational, administrative and informational improvements it would be possible to improve Piraeus ranking as a transhipment port within a cluster of competing Greek ports.
6 EUROBORDER conclusions

6.1 General remarks

In discussions on the need for development in the port industry, a common argument is that there is little need for specifically promoting development. As "proof” of this, examples are given of the successful implementation of a particular technology in a port. Our experience shows that this argument conceals the real problem. While it is absolutely true that there exist good examples, particularly in the larger ports, it is likely true that these solutions are not implemented throughout the industry, and especially not in the small to medium sized ports.

The reasons for this are manifold. Increasing world trade automatically results in increasing volumes handled in the ports. In spite of competition, many ports have a strong position on their market which gives at least some of them a fairly comfortable economic situation. Even if the ports are commercial entities acting on a competitive market, many of them carry a burden of "old” rules and administrative procedures which influence their interest in and even possibilities for seeking new solutions and new markets. The division of competence between the players in the port also plays a role in the development process. What responsibility does the landlord have for the efficiency of the terminals, what role does the shipping line have in relation to its customer for terminal handling and how does this impact on the terminal?

This situation is especially affecting the development of the port’s role in the intermodal transport chain. One can argue that waterborne transport has always been a link in such a chain, although without being much involved in its organisation. Modern logistics, however, demands more from the port than just the transhipment between land and sea, from a commercial and technical viewpoint.

Modern intermodal transport solutions demand customer orientation, which require an understanding of the customer’s goals and an ability to provide services adapted to the transport operations up- and downstream the port. Flexibility and customisation are needed based on standard procedures.

EUROBORDER concludes that port terminals must position themselves as an integral part of intermodal transport chains (hinterland-port-sea-port hinterland). Issues related to physical handling do not seem to be a problem, but there is a big uncertainty when it comes to information handling (internally, but especially externally). Problems arise from the diversity of customers and their needs, lack of standards and lack of trained staff.

Having said this, EUROBORDER finds it possible to generalise on what we see (given the objectives of the project) as the three most important key issues for ports to consider in order to improve their performance. We make this generalisation based on the finding that these key issues are not due to characteristics innate only of the ports studied but are inherent in any system performing the same tasks as these ports. The key issues, or the tree I:s of successful port business are:

- interaction - to actively to define a role and a business strategy
- integration - to coordinate investments and operation to exploit synergies
- information – to manage the intermodal transport tasks and contribute to the overall goal
6.1.1 Interaction

Ports must interact with the other parties in the transport chain, rather than just react to the external forces acting upon the ports. By being an interactive node, the port can influence how the customer formulates its requirements on the port’s services. If the port only reacts, it will be in a less favourable position in terms of trying to influence the customer’s requirements. Being an interactive node, the port can even take the lead and help its customers to find efficient transport solutions.

When interacting with external parties, the port must be prepared to act several stages upstream and downstream the transport chain. Communicating via intermediaries, introduces a risk that information is distorted or even lost. The port must be aware, though that to communicate directly with its customer’s customer can be a delicate matter. However, to an increasing extent shippers want to have transparency of the logistic chain, and want to be reassured that they are using good logistics solution. Therefore it is likely that it will be less controversial for the ports to have direct contacts with the shippers in the future.

6.1.2 Integration

In order to co-ordinate resources in the best possible way and exploit synergy effects, ports should strive to integrate their operations. It is especially important that information is made available throughout the port on what is going on in the various parts of the terminal and on the whereabouts of the terminal equipment. It may be far easier to handle the various parts of a disintegrated system, as the complexity rapidly increases in an integrated system. The costs, in terms of sub-optimisation and lost synergies, for achieving this simplicity can however be devastating. Therefore, the ports must find ways of dealing with the complexity of an integrated system instead of avoiding it.

Integration is a key word also for the customer relations. By forming partnerships and alliances with their customers, the ports and the partners alike can benefit from increased mutual adaptation of their interrelated processes. In a partnership integration of the information systems are easier to achieve and both parties can benefit from an improved exchange of information. Often, the port’s customer can benefit from investments in the port. But especially if the shipper has no immediate alternative to using the port, the port may be reluctant to make these investments. However, in the long run both the port and its customers will benefit from finding the best possible transport solution. By forming partnerships and long term agreements (interaction) the willingness can increase of both the port and of its customers to invest in their mutual relations.

6.1.3 Information

Information is the means for achieving both integration and interaction. As for terminal integration this can only be achieved with access to updated information throughout the system. Ports should therefore make use of the possibilities of the new information technology. Technologically, it is today possible to automatically capture, and in real-time exchange, much of the information needed to co-ordinate the various processes in the port. Furthermore, a selection of decision support systems is available for various planning problems and operational management. (But terminal management systems for RoRo operations is an area calling for improvement.) As any business, ports and terminals should also use IT for "office automation" in order to reduce the administrative costs.
The ports should also be aware of the importance of information as a customer service weapon. For one thing the information is just as important for integration with external parties as for integration within the terminal. But in relation to external parties the information exchange plays more roles. With improved exchange of information the customer can stay informed about what is happening to the cargo, which increases the customer’s sense of control. Efficient exchange of all the information related to a business transaction can also make it easy for the customer to do business with the port. Manual paperwork is costly. With IT these transaction costs can be substantially reduced.

The exchange of information that is needed for being an interactive node in the transport chain is of a different kind. To a large extent this is a matter of creating good customer relations by exchanging less structured information through informal channels. The port needs to have an "intelligence" function that at an early stage picks up signals on the customer’s transport needs and requirements. The port also needs to react to these signals and initiate a discussion with the customer on how they together can find good solutions.

The lack of standards is a major problem which hampers investments and punishes the advanced. It is true that EDIFACT is available, but the messages are expensive to implement, there are often different versions in use and the sea transport environment uses other messages than the land transport business for the same purpose. The latter problem arises mainly in RoRo-operations, where the port terminal normally interacts with a wider variety of clients than in the LoLo-case, where the line agent is the major contact.

Shippers and carriers of all modes are mainly focussing on standards for their own activities and too weak an interest is shown for standardisation across the modes. The fragmented structure of the transport business and the great number of small actors make an intermodal focus difficult both when promoting a standardisation strategy and implementing an adopted standard. A typical example of the first issue is the lack of a numbering scheme for all types of intermodal transport units (ITU). The containers all have their BIC\(^3\)-numbers, the swap-bodies will soon follow, but nothing is yet available for the semi-trailer, which is the most frequently used ITU in European short sea shipping.

Many of the small actors along the transport chain also have problems with understanding the need for the new information technology. It does not help, as in the EUROBORDER scenarios, to show that the terminal profits from the investment. Only when (as in Bilbao or in Piraeus) it can be shown that the local distributor is able to make more runs per day and lorry will there be an interest in investing in the new technology. Then appears a problem which the terminals also have, which is the lack of staff familiar with the new technology. That is the reason why Finnish port terminals are considering to start to train their clients as well as their own staff.

The case studies of EUROBORDER show that the port terminals are giving priority to the introduction/improvement of management systems to improving financial as well as operational performance. However, yard management systems for LoLo-terminals are expensive to acquire, implement and run. As demonstrated by the Finnish case in the DGVII project EUROBORDER, the costs represent a heavy burden on small terminals. The situation is different in the RoRo case where the problem is less complex and the involvement of the RoRo-operator often is bigger. Still, even here there is an increasing need to control the accesses and to know what is in the terminal and where it is.

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\(^3\) Bureau International des Conteneurs
6.2 Port prices in the intermodal perspective

EUROBORDER has found through analysing a number of real cases, that the port costs constitute a rather small part of the total cost for a transport from door to door. Due to restrictions of the chosen network modelling approach, it has not been possible to fully assess the impacts of the proposed changes on “the port’s attraction as a node in the intermodal transport chain”. The quantitative analysis based on generalised costs shows that even if price and time are important, these two factors alone do not explain the choice of a transport solution. The quality of service provided (reliability, flexibility, security, etc.) is equally important. In the case of a transport from Trondheim in Norway to Munich in Germany the port costs in the waterborne alternatives were approx. 5% of the total, which was substantially less than the cost differences between the alternatives transport routes. However, even small changes in the port fees could be important which was demonstrated by the Greek case where alternative transshipment ports were compared for a few specific routes. The implementation of the future scenario was assessed to reduce the costs enough to change the ranking of Piraeus from third to first.

This indicates that:

• Intermediaries, only undertaking a part of the total transport, where the port costs constitute a high relative portion, might drive the discussion of high port costs.
• Ports need to inform the shippers about the relative magnitude of the ports costs.
• The situation is different between system transports and other unitised multimodal transport of general cargo.

6.3 Output

Fine-tuning individual port processes, e.g. the inspection of damages, may achieve improvement of port performance. More importantly though, port performance may be improved by changing the actual way the processes are performed. The total system performance to a large extent is not only dependent on how the individual processes are performed, but on how they are combined and interrelated. This complexity does not encourage specific recommendations and EUROBORDER has therefore focused on tools and processes which can be used for creating and assessing individual solutions. All measures or tools aim at one or more of the three main areas for competitiveness in intermodal transport: Cost competitiveness, time competitiveness and quality competitiveness.

The table on the next page gives an overview of the output of EUROBORDER, the reason for using it and the potential impact of such a usage.
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<td>A &quot;tool box” containing measures for improving information, administration and organisation</td>
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In the EUROBORDER project several tools which can help the port to enhance Interaction and Integration as well as improving the management of Information have been identified. These tools are not any new revolutionary solutions, requiring a lot of extra development or being too complicated to implement. Instead these tools are available today, and are used in large "best practice” port terminal. But, they have not yet been implemented throughout the industry, and especially not in the small to medium sized ports.

In order to promote the SMPs’ awareness of these tools, EUROBORDER has brought them together in a "tool box”. Furthermore, EUROBORDER has developed scenarios describing how these tools can be used. The effects of using the tools according to the scenarios, have then been investigated and evaluated.

The results from the feasibility assessment show that for example, the terminal operator can strongly benefit from IT investments in automation of access/exit control, improved monitoring and control of terminal handling, incl. yard planning systems (container terminals) and electronic handling of all customs information (pay-back period 3-6 years). The terminal´s customers benefit as well but not to the same extent. The bigger the terminal, the higher the benefits (economies of scale can be realised).

It was also concluded that EDIFACT implementations are very important, but time consuming and expensive - needs to be supported by national and European harmonisation. As a consequence Internet solutions are developing rapidly and getting a lot of attention. In order to promote IT development and create a wide user community, it could be profitable for the terminal operator to train its customers and to co-operate with other ports to create uniform solutions possible to handle in an economic way by the customers. Information to the ports and their customers about IT options and experiences (“success stories”) could be a way to start the development.
The introduction of IT can lead to changes in the involved organisations and also in the distribution of tasks between the players (e.g. terminal operator makes the bayplan). Similar effects can be expected by privatisation, decentralisation, new provisions in lease contracts from port authority to terminal operators.

The EUROBORDER study of port terminals shows that there is a lot to do if the ports are to function as efficient nodes in modern logistics chains. Having said that, one should remember that these requirements are not satisfied by any terminal today, which has to work under similar conditions. Given the size of the operations, the diversity of clients, the fact that the port constitutes a national border and the need to operate cost-efficiently and profitably, the port terminals could serve as good example of what has to be achieved by all nodes in a deregulated, sustainable, intermodal transport system.

### 6.4 EUROBORDER and the Trans-European Networks (TEN)

The Transport-TEN comprises transport infrastructure, traffic management systems and positioning and navigation systems. Transport infrastructure covers road, rail and inland waterway networks, seaports, inland waterway ports and other interconnection points. The traffic management systems and the positioning and navigation systems are to include the necessary technical installations and information and telecommunication systems to ensure the harmonious operation of the network and efficient traffic management.

The work developed by EUROBORDER matches the specific goals and interests of the Transport-TEN policy. EUROBORDER shows that there are definite possibilities to improve port performance and thus the integration of Short Sea Shipping in the European transport system.

### 6.5 Further research and development (R&D)

The port community involved in EUROBORDER has given their opinion on the "tool box" (c.f. chapter 5.4) and at the same time they were asked to assess the need for further R&D related to the issues addressed by the tool box. The main R&D-topics were the following:

1. **Improving terminal efficiency**  
   Much of the attention of the terminal operators is already focused on this issue, as can be seen from the comments to the tool box. However, competition and increasing demands for handling and storing capacity as well as technical development highlights the need for better understanding of the interaction between terminal lay-out, selection of handling equipment and introduction of automated procedures for information handling and data capture. "City ports", i.e. ports limited by a surrounding city, present an especially interesting case due to their lack of space, congested access routes on the land side and environmental restrictions. In such cases relocation is often discussed as an alternative, which then has an impact on infrastructure demand and the pattern of co-operating terminals in the whole region. The decision to stay or to relocate has socio-economic impacts as well as consequences for all parties involved.

2. **Developing and implementing feasible communication systems.**  
   Answers from the users indicate that this is a topic which has a high priority in present strategic planning. EDIFACT is well known, but difficult to implement. How to select the "right" solution among available systems based on EDIFACT, internet or extranet? How to handle the impact of systems already in use by customers and partners? How to select migration paths from simple E-mail, GSM and variable message signs to fully electronic systems for on-line information exchange, internally and externally, between stationary
and mobile units. What is the potential of standardisation, future technology development and legal harmonisation.

3. The use of technology for automatic identification
This is a technology which is presently not in use but considered potentially highly relevant. It is given priority as a topic for R&D, standardisation and legislation. An efficient use of the technology depends on a well functioning information and communication system. On the other hand the introduction of an automatic identification system can favourably improve the benefits of an electronic information system and quality control along the intermodal transport chain.

4. Training
Freshly employed staff, customer requirements, changes in organisation and introduction of new technology imply a constant need for training. However, training needs are considered especially high in order to introduce the new information technology. New methods need to be explored in order to reach all persons affected within the own organisation and with the client’s. Knowledge is lacking internally and externally which hampers the introduction of efficient electronic information exchange.

In addition to the areas mentioned above, the EUROBORDER consortium has concluded that there is a need for further R&D related to:

5. Attitudes to change
Competition is fierce between ports, however there are differences due to the role of the port (import, export, transshipment) and ownership. Even if the port is a limited company, its owner(s) may have nationally or regionally motivated goals to pursue, which have a tendency to influence the activities of the port and the demands on its economic performance. When – as in many cases - the volumes handled also increase more or less automatically, due to trade development in general, inefficiencies might be difficult to discover. Performance indicators are used, but on levels, which make action-oriented comparisons difficult (c.f. ”functional modelling” below).

6. Functional modelling
It is true that every port has its own character, but it is also true that this character is constituted by a set of functions, which on a certain level can be characterised as generally applicable. Lack of a common understanding and acceptance of these functions makes information exchange and definition of responsibilities more complicated (internally and when out-sourcing) and hinders comparisons of efficiency between ports. An other aspect is that software tools need to be customised to a degree which makes them unnecessarily expensive.

7. Systems architecture
Commonly accepted data modelling and systems architecture facilitate the creation of interoperable systems. Borders to other systems and subsystems must be defined. The port’s cargo information handling system must be possible to integrate with other similar systems in the intermodal chain.

8. Software tools
Management tools for yard and bay planning are big investments for SMPs, in purchase, installation, training and use. Besides reducing these costs (c.f. functional modelling) there is a need to develop modules which can support the automated procedures made possible by the new information technology. Additionally, simulation and optimisation tools must
be further developed and used in the search for not only the most efficient handling equipment, but also for improving organisation and information handling.

9. Promoting the business’ interest in standardisation

Lack of standardisation in communication and information handling has been identified as one of the major obstacles against a rapid development in this sector. However, the transport industry is not very active in standardisation which makes development slow and biased towards the opinions of the technology providers. The big ports and other big players in the transport chain have the power to define their own specifications. The small and medium sized ports and other minor players have much more to gain from standardisation, but they normally have neither the expertise nor the resources.