INTERMODAL FREIGHT TERMINALS

In search of efficiency to support intermodality growth

Directorate-General
for Energy and Transport

EUROPEAN
COMMISSION

CONTENTS

This publication was produced by the EXTR@Web consortium on behalf of DG Energy and Transport. The information in this document has been collected by partners in the project on the basis of material provided by DG TREN and other project partners.

We would like to thank Professor Francesco Russo for contributing to the review of the manuscript.

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Manuscript completed by Marco Valerio Salucci, DITS , in May 2006.

Photos: courtesy of DigitalVision (cover details, cover background, p.8, inside backcover).

Printed in Belgium

FOREWORD

Due to growing freight traffic and an increasing imbalance in the use of the various transport modes and infrastructure, the transport system in the European Union is showing signs of inefficiency from a socio-economic point of view. Intermodality is an excellent policy tool that can support an overall transport systems approach aimed at a more balanced and efficient use of the available transport capacity.

The White Paper "European transport policy for 2010: time to decide"[a] lays particular emphasis on the need to shift the balance between transport modes towards those that are more sustainable by enhancing alternative modes to road, such as sea, inland waterways and rail, and eliminating bottlenecks in the multimodal corridors.

In the current modally-oriented freight transport system, any change of mode within a journey involves a change of system rather than just a technical transhipment. This creates costs that can make intermodal transport uncompetitive in comparison with uni-modal transport, particularly road transport.

Intermodal Freight Terminals (IFT) are the weakest links of the intermodal transport chain system and a major generator of costs. It is therefore necessary to study and investigate issues relating to these terminals, in order to improve their effectiveness and efficiency and make the intermodal freight transport more competitive and attractive.

1 DEFINITION OF THE SUBJECT

Intermodal Freight Terminals (IFT) or transfer points are places equipped for the transhipment and storage of Intermodal Transport Units (ITU). They connect at least two transport modes, which usually are road and rail, although waterborne (sea and inland waterways) and air transport can also be integrated. It is possible to find terminal companies and bodies handling both freight transport (eg. freight forwarders, shippers, transport operators, customs) and accompanying services (eg. storage, maintenance and repair): in this case IFT are also referred to as logistic centres or freight villages.

Terminals represent the nodal points of the intermodal transport network and their efficiency significantly affects the entire intermodal freight transport chain. Efficient intermodal transport requires infrastructure planners and managers across Europe to co-operate in establishing coherent networks of efficient transfer points, which are the weakest links in the current intermodal transport system and a major generator of friction costs.
These costs are generated through many factors. First of all, there is a lack of a coherent network of modes and interconnections between the modes in a number of high density corridors in Europe.

There is also inadequate access by rail, road or waterborne transport to existing transfer points, which can hamper the integration of these modes and transfer between modes.

Another factor is the lack or inadequacy of interoperability between modes and loading units. In fact, dealing with a variety of loading unit dimensions and different standards for transport means and infrastructure (often regulated differently by country and by mode) lowers the levels of interoperability between different modes, and produces congestion and inefficiencies at terminals.

Finally, present-day terminals, which are usually marked by a combination of heavy engineering and manual processes, are not managed efficiently with appropriate ICT technologies. The absence of a systematic network for data interchange along the entire intermodal transport chain is a source of high costs and service deficiencies. Existing modal-based information transmission systems require users to re-enter similar data at each interface, possibly according to different messages or EDI standards. The implementation of generalised systems for electronic communication between the different partners in the intermodal chain would mean that there was the opportunity to change operations at short notice along the journey. The absence of systems enabling tracking and tracing during the whole journey across modes, does not allow for a quick detection of errors and false routings.

2 RESEARCH NEEDS

Research projects carried out before the Fifth Framework Programme (FP5) have addressed many issues relating to the improvement of the efficiency of intermodal terminals. Some have focused on general aspects of the intermodal network and on tools or solutions for the effective integration of modes in the door-to-door transport chain. Others have looked at some on the improvement of technical operations and the information flows. The results have made it clear that it is necessary not only to further investigate and find solutions for issues already addressed, but also to direct research efforts towards new challenging issues.

First of all, it is essential to guarantee permanent concerted activities in the field of intermodal terminals in order to create and maximise synergy among intermodal transport RTD projects carried out at European and national level.

There is also a need for improving intermodal transport operations and the quality of the services offered, concentrating on the use of information technologies for terminal management purposes, focusing on the quality of inland terminals and investigating the opportunities for the integration of intermodal terminals in seaports and inland ports as well

as the enhancement of port operations. It is also necessary to develop and assess harmonised security and safety procedures for freight intermodal transport operations, since theft and damage to ITUs either inside terminals or during transport, reduces the attractiveness of intermodal transport.

Research efforts are needed to continue to improve harmonisation and interoperability between transport modes, transport equipment and loading units. Technical specifications for transport means are often regulated differently by country and by mode. The incompatibility of the transport equipment for road, rail, short sea and inland waterway traffic raises transfer and handling costs and necessitates cumbersome transhipment techniques.

Furthermore new solutions are needed for the optimisation and rationalisation of transfer procedures and techniques. There is a particular need to integrate horizontal transhipment technologies in the intermodal door to door chain, because their technical features make them more suitable and economically convenient than the vertical ones for low traffic flows and small terminal operations.
With the enlargement of the EU and the corresponding development of the Trans- European Transport Networks (TEN-T) towards Central and Eastern European Countries (CEECs), it has also emerged that there is the need for research on the interoperability of the transport networks at the terminal at border crossings within the EU and towards CEECs in order to overcome technical and operational barriers. It is also necessary to assess the availability of intermodal transport means and suitable infrastructures.

Finally, it is vital to continue the development of integrated information systems and ICT technologies in order to make better use of existing capacity and infrastructures, through a more efficient organisation and management of the terminal operations.

3 RESEARCH PROGRAMMES

Issues relating to IFTs have been addressed by several projects carried out within the **Competitive and Sustainable Growth** and the **Information Society Technologies** (IST) programmes of FP5.

The programme **"Competitive and Sustainable Growth"** has supported research projects for the optimisation or improvement of the operations carried out in intermodal terminals under three key actions.

Key Action 2 **"Sustainable Mobility and Intermodality"** helped the EU to further develop and implement the objectives of the Common Transport Policy[b],[c], which promote transport sustainability, enhancing the efficiency and quality of transport systems and services, and improving safety and security. A major focus was to enhance intermodality by improving the integration between the different modes of transport in respect to infrastructure, operations, services, procedures and regulations. The key action defined a number of specific RTD objectives grouped under the following three main objectives: socio-economic scenarios, infrastructures and interfaces with transport means, and transport management. The research projects that studied issues relating to intermodal terminals, addressed the following specific objectives: quantitative tools for decision making[17], infrastructure development and maintenance[6],[8],[10],[11],[13],[18],[21], traffic management systems[5],[20], and transport and mobility services[1],[4].

The strategic aim of Key Action 3 **"Land Transport and Marine Technologies"**, was to support the land and marine sector to develop the technological infrastructure for the supply of future transport means and concepts in a sustainable manner. The research effort of RTD projects was considered and organised around the development of critical technologies

and their integration and validation around advanced industrial concepts. The key action's specific objectives were: efficient, safe and environmentally friendly ships and vessels; maximising interoperability and vessel performances; safe, efficient and environmentally friendly vessels and platforms; efficient interoperability and transhipment. A number of projects developed under this key action had an impact on the intermodal terminal operations[2],[3],[9],[12].

The general objective of Key Action 1 **"Systems and Services for the Citizen"** of the IST Programme, was to facilitate the wider use of RTD results obtained in the Telematics Applications for Transport programme of FP4 bringing them under a common architecture to ensure interworking, compatibility, user-friendly access, privacy, use of open standards and market take-up. Under the Cluster 1 "Mobility and Intelligent Infrastructure for Transport" some projects focused on issues relating to the improvement of the information flow in the intermodal transport chain and in terminals[7],[14],[15].

4 RESEARCH RESULTS

Policies, organisational aspects and network integration

This area covers issues ranging from territorial planningand location and financing of terminals, to the organisational aspects and integration in the TEN-T network, with a view to support planning and policy making at the EU level.

A thematic network on IFT

An important achievement of the research efforts has been the creation of a thematic network on freight transfer points[6],[13]. The main objective of the thematic network was to enhance the exchange of data and information and to create synergy in the European research effort related to intermodal freight transfer points.

The main results have been as follows:

- The improvement of knowledge of ongoing national and international projects in the field of transfer points across the EU and the exchange and dissemination of the relevant information and best practices.
- The creation of an online platform (www.eutp.org) of reference for ongoing and future projects on IFT.
- A best practice handbook that can provide support in identifying elements affecting construction and in correcting the operation of an intermodal chain of transport. It also provides a methodology for carrying out an analysis of strong and weak points of an intermodal transport chain, mainly focusing on transfer points.
- The identification of problems and bottlenecks in the field of IFT.
- Identification of priorities to improve the productivity of terminals and recommendations to the industry, transport operators, terminal owners and policy makers.

Quantitative tools for decision making

Research has defined and validated a methodology for the calculation of the real costs of intermodal freight transport, analysing three major trans-European door-to-door corridors, and developing a DSS[17].

This analysis has allowed the identification of those cost items that play a major role in determining the performance of intermodal services, thereby leading to recommendations on priority actions to reduce those costs. After having identified terminal and transhipment operations as one of the major cost drivers, the implementation of a policy package has been simulated with the DSS. This package featured the elimination of rail-rail transhipment (interoperability), a 15% improvement of manpower productivity in terminals, and a 33% cut in capital costs. The aggregated result has been a 6% reduction in total resource costs (average value for the three corridors analysed).

Research has also developed the **TRAPIST Terminal Simulation System** (TTSS)[21], which is a valuable planning tool for terminal managers and for planners and designers of ports and terminals, since it provides support in establishing the most suitable terminal layout, allocating resources for changed operational requirements and reducing the probabilities of accidents on the terminal by reducing the numbers of encounters.

Another software tool named ExTip provides valuable support in selecting the more appropriate transhipment system, relying on an inventory of technologies, a variety of rail operating forms, and using a number of selection criteria[13].

Financing IFTs

The construction of new IFTs should be decided on the basis of a common policy at European level, which takes into account the freight flows all over Europe identifying the main nodes. There is not a common financing scheme for the freight terminals in the European Union. An example of best practice is the PPP scheme adopted in Germany[6]. Financial aids are given to either the national railways Deutsche Bundesbahn (DB) or to private companies. The financial aid involves grants of 80 % and 20 % of subsidised loans. DB must keep the terminal open for public use for 20 years. The private operator must keep the terminal open for 5, 10 or 20 years depending on the part of their own financial engagement. The more the company finances itself, the shorter the obligation to keep the terminal open for public use. The local ministry gives the financial aid. The German government allocates a certain amount of money each year. Today, the terminals owned by DB and operated privately are the Ubf München-Riem – Fa UBM and Ubf Einsiedlerhof – Fa Steiner. There are also private terminals with private operators such as Terminal Eurokai in Hamburg and terminal BASF in Ludwigshafen. The aid is used for the Intermodal Terminal and its infrastructure: cranes, ground, and tracks but not for the operations.

Improving intermodal transport between the EU and the CEECs

The existing intermodal transport system linking the present EU countries and the CEECs have been examined. The major intermodal bottlenecks in the system were identified, and policies that the EC might implement for reducing the negative effects of the bottlenecks were recognised and prioritised[11].

A significant number of the major bottlenecks identified concern accessibility, capacity and operations carried out in IFTs. High priority bottlenecks are limited opening hours, shortage of IFTs, insufficient terminal capacity, lack of appropriate combined-transport equipment, and finally long marshalling time due to short tracks and a limited number of tracks. The following high impact policies, which target high-importance bottlenecks and have good feasibility for implementation, have been suggested: to introduce funds for replacing obsolete handling equipment, to set standards for combined-transport equipment, and to introduce funds for restructuring terminals.

Key technical, operational, administrative and documentary parameters influencing the terminal performances have been identified on the basis of their impact on terminal operating costs, terminal management and transit time, and safety and environment[10].

Safe and secure intermodal transport

A thematic network for international co-operation and information exchange regarding safety and security for intermodal freight transport has been created[19]. This is in response to the international need for further harmonisation of intermodal safety and security standards as well as the need for seamless information exchange between transport modes and between the multiple stages in the transport supply chain.

A cluster on secure data transmission and hosting has been organised to examine the procedures and standards needed for secure data transmission during the freight process from origin to destination. It has explored the opportunities for establishing an international freight data exchange standard to develop, in particular, a common language or dictionary of terms applicable to both maritime and land transport. Risks on safety and security on intermodal transport originated by data transmission and hosting have been identified as well as the measures to minimise them. Existing operating freight data exchange systems (in ports, logistics platforms, freight villages, airports) have been analysed and a synthesis of the existing situation, identification of gaps and proposals for additional measures (e.g. creation of an international data exchange standard) have been produced.

Research has also analysed how the latest regulations related to safety and security (the IMO ISPS code and the US Container Security Initiative) can affect the competitiveness of the ports operations and of the performance of intermodality[16]. It concludes that the application of the security initiatives did not provoke the much feared disruption in the logistic chain. This was based on the experience of the logistic chain actors in general since the introduction of the new security regulations. Despite the demanding standards of some measures and the initial difficulties experienced, the stakeholders showed an important capacity to adapt to the new challenges. General improvements in communications, electronic document submission and investments in training made a smooth transition possible. Regarding who should pay for security investments and costs, the position of the stakeholders is divided between those with the higher investment in security hardware items (ports and terminal operators), who claim that they should be paid by all chain stakeholders, and the stream of logistic operators up and down the chain (shipping lines, shippers, forwarders, etc), who claim that each stakeholder must only bear his own security costs.

Infrastructure, transport equipment and transfer means

This area deals with the innovation and development of terminal infrastructure, technology, transport means and loading units.

Innovative technologies for IFTs

Research has produced an assessment of the situation regarding new technologies in intermodal transport, from the terminal operation point of view[13]. The technologies considered covered different modes (road, rail and waterborne with inland waterways and short sea shipping), and the following different areas were investigated:

- innovative technology in transport means and equipment;
- innovative technology in transhipment techniques;
- innovative technology in load units;
- information technology and telematics systems (inside the terminal).

The study found that there are still margins for the improvement of the attractiveness of combined transport. Most of the factors are related to the improvement of the quality of service, while others are directly linked to cost saving connected to a better utilisation of terminal capacity.

Expanding the capacity of terminals

In existing terminals there are often problems of space and traffic constraints because it is not possible to expand to the surrounding areas, especially for ports inside cities. A full-scale prototype system, which is a dedicated rail track connecting a port yard to a peripheral inland depot, operated by electrically-powered, automated shuttles, has been studied and validated[2]. The vehicles run as an autonomous shuttle or in a "convoy mode" without any mechanical link between the shuttle trains. The hinterland depot accepts freight from road vehicles and transfers it via the automated shuttle to the port where it is transferred to ship. Each shuttle carries up to six container units and runs either on a dedicated railway line or on a concrete pathway. Further increases in the rate of freight transfer will be obtained by the use of improved container and lifting equipment.

Increasing the speed of intermodal operations

Two major bottlenecks of the intermodal transport chain are the cost and the time required for the mode change in intermodal transfer terminals. Research efforts have been focused on new techniques or systems that can reduce this cost and time. In this context two prototypes for rail-road operations, a CargoSpeed rail-wagon and a transfer mechanism have been developed, constructed and demonstrated. The system can reduce the costs for road/rail intermodality and increase the speed of the operation at combined terminals, resulting in up to a 50% reduction in the economic break-even distance for intermodal freight movements. The estimated reduction of costs of the complete system in comparison to common techniques is at least 30%.

Innovative horizontal transhipment techniques

A feasibility study has been carried out to investigate the technical and operational possibilities of horizontal transhipment technologies[8]. The study has produced an updated inventory of operational horizontal transhipment systems existing in Europe. A survey on more than 60 systems invented within

the last 25 years has shown that no more than 20% of all invented systems are in service today. On the basis of the results of the study, innovative transhipment systems have been developed and prototypes to be used for the demonstration were validated in a virtual environment using virtual terminals and trains. Three practical demonstrations of the technology were carried out.

- The Hungarian demonstration (Bosch Rexroth Budapest) was based on the development of the RST 100 automatic storage facility turning the operations from manual to fully automated. The RTS 501 Re-loader has been assembled in the Budapest Freeport area and successfully demonstrated its ability to move containers horizontally. The use of orthodox rail tracks as the basis for this technology demonstrated its potential to be used in shunting yards and sidings.

- The Austrian demonstration (RCA) has been assembled in the Vienna Northwest freight terminal area. The equipment was assembled in 2002 and demonstrated during winter and spring in order to validate its capabilities in all weather conditions. This equipment can be used in urban areas where site constraints, such as the lack of available open spaces, prevent the use of traditional terminal cranes.

- The Swiss demonstration was focused on the NETHS horizontal transhipment system. The system could operate in manual, semi-automatic and fully automatic modes.

Development of new concepts

A project was carried out to study the feasibility and develop viable concepts for combined air/rail cargo transport[4]. One finding is that there is definitely a market potential for fast train transport of cargo, and that facilities throughout Europe can be developed to serve as multi-modal transhipment points. A number of interesting concepts for terminals and overall systems have been produced, as well as a detailed procedure for their validation. A concept design scenario based on a pilot study of a train between Amsterdam Airport Schiphol and Fraport, has been developed and tested with a simulation.

An innovative waterborne transport concept for inland/short-sea operations has been developed, which accommodates various types of cargo units, and enables faster cargo

handling and better use of cargo space[12]. This concept can replace current fragmented and traffic-jam-sensitive road, rail and waterborne transport. This system optimised for inland / short-sea operations provides a door–to-door waterborne solution, positive effects on quality of life, reduced pollution and noise, reduced number of accidents, improved utilisation of infrastructure, and improved mobility of goods.

New Automated Guided Vehicle (AGV) devices to automate loading and unloading operation of RoRo ships and terminals with a 500 TEU/h capacity, and new RoRo and Ropax ships specifically designed for the AGV automation, have also been developed[9]. The high handling capacity of the systems under consideration reduces loading and unloading time as well as waiting time by the berth. Forming a column of up to 10 AGVs it is possible to simultaneously handle up to twenty 40' containers or forty 20' containers, whose weight can reach a total of 800 tons. The set of RoRo ships are designed to

satisfy a wide range of speed (10-55 knots) and cargo volumes (80-1500 TEU). This wide range of vessels can address market demand and satisfy current and potential requirements of the Short Sea Shipping (SSS) and of the intermodal freight transport in a competitive way.

Research has also analysed and assessed the transportation of semitrailers by road and in intermodal transport in order to find solutions for increasing the percentage of semi-trailers transported by rail[18]. A new semitrailer system (**SAIL** semitrailer), consisting of an innovative RoRo system, a cranable semitrailer, and a cranable swap body and chassis, were developed and successfully tested in a corridor that represents the main flow of semitrailers in intermodal transport in Europe. A scaled model simulating the innovative and cost efficient transhipment of the new **SAIL** semitrailer has been created. With these improvements the use of semitrailers in intermodal transport is expected to grow with a possible increase in the percentage of semitrailers transported from the present 10% to 20%.

Information and communication systems

This area concerns issues ranging from data collection strategies and standardisation, to innovative ICT technologies used to increase terminal efficiency.

Improving the management of container terminals

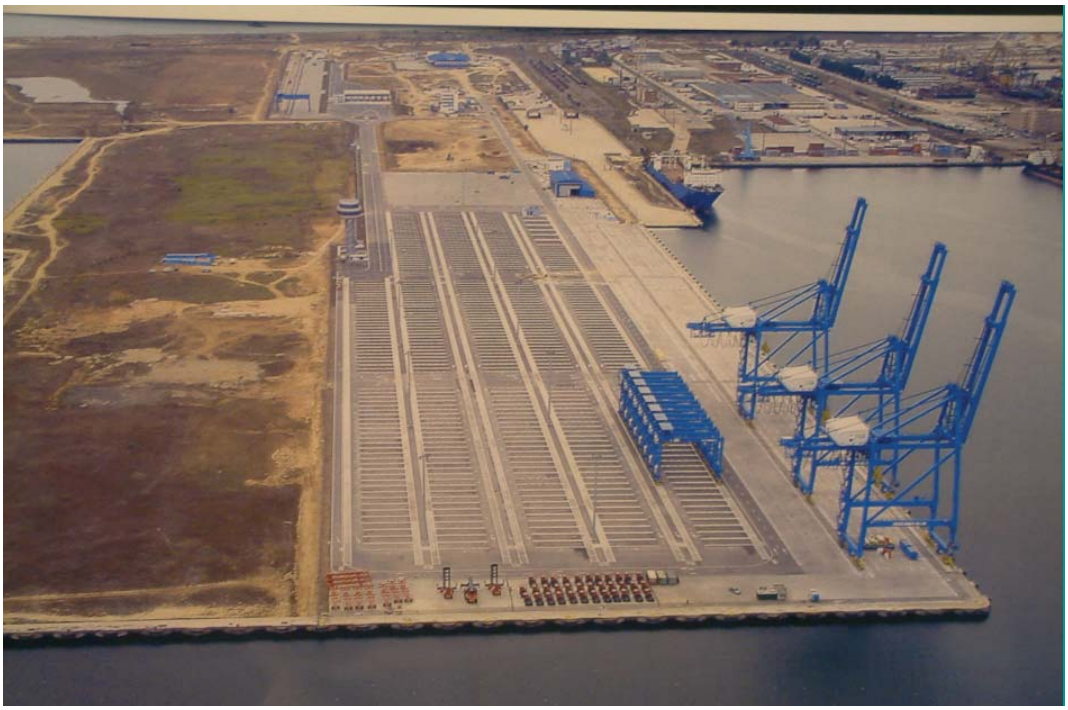
A system to automatically track the containers inside a terminal from the reception to the delivery at the gate has been developed[14] and the prototypes tested in a number of trials[15]. The efficiency of terminal operations are improved by the possibility of continuously and automatically updating the terminal operating system database with the position of each container handled by this system. This is regarded as an essential starting point to perform every optimisation of the yard operations that is one of the major concerns for each terminal operator. The different benefits produced by this type of technology are the reduction of the average time for container handling, the increase of terminal productivity, a better level of service for terminal customers, an improvement of the working conditions and quality of work for terminal workers, and finally a general cost reduction of the operational costs due to the decrease in re-handling operations.

Exploiting and integrating ICT

The availability, quality and timeliness of information can significantly improve the efficiency of the activities carried out in IFTs. reliable expected time of arrivals and unloading information can help receiving terminals to provide information to forwarders and truckers, enabling them to arrive on time at the terminal. A number of projects have focused on the improvement of the availability, accessibility and integration of information in the intermodal chain.

A fully-integrated operational platform which provides services to efficiently manage intermodal door-to-door freight transport has been designed, developed and tested in pilot cases, and a **European Freight Data Communications Network** has been set up[7] that is accessible from all points along the supply chain and for all users through Internet connection. It provides applications for operational functions, such as track and trace and monitoring of the door-to-door journey, and all the e-commerce and insurance functions of a door-to-door freight transport chain, such as e-document transfer and e-payment.

Particular attention has been given to using ICT to increase the efficiency of intermodal door-to-door transport chains, in which



shipping plays a major role. One project has demonstrated how to accomplish this, developing a transport chain management system available as a web-based application on the Internet[5].

An open virtual network, based on a broad European approach, linked actors in logistic chains along the Danube corridor by interconnecting existing ICT systems via a **Common Source Logistic Database** (CSL.DB), interactively related to traffic management systems[1]. Web based client applications, advanced EDI solutions and innovative telematic technologies were integrated, demonstrated and evaluated within four real-life business demonstration scenarios. The use of these IT-systems proved to be a crucial factor to guarantee high quality service.

Benefits gained from the research

Solutions for the optimisation and improvement of the operations carried out in intermodal terminals have been provided. Techniques for integrating horizontal transhipment in the intermodal door-to-door chains have been analysed and demonstrated[8]. A practical demonstration of a complete intermodal transport process using an innovative concept of a semi-trailer has been carried out along with the simulation of the transhipment operations in a terminal [18].

Other projects have produced tools for the terminal managers, planners and designers of ports and terminals. A terminal simulation system was developed for the strategic planning of IFTs[21]. The simulation of the implementation of a policy package to reduce the costs generated by terminal operations has been carried out with a new developed DSS[17]. A thematic network on IFT has continued to enhance the exchange of relevant data and information[6]. A best practice handbook has been produced to allow those involved at the level of transhipment terminals and transfer

points, to identify the elements affecting the construction and to correct the operation of an intermodal chain of transport[13]. Major bottlenecks and key parameters affecting the performances of terminals in the intermodal transport chain between the EU and the CEECs were identified, and an assessment and ranking of policies to remove bottlenecks has been carried out[10],[11].

New concepts and systemshave been developed, aimed at reducing costs and time required for the mode change in IFT[3], as well as efficiently connecting a port yard to a peripheral inland depot so as to increase its capacity in terms of space available[2].

An innovative waterborne transport concept for inland/short-sea operations has also been designed, which accommodates various types of cargo units, and enables faster cargo handling and better use of cargo space[12]. Furthermore, systems based on optimised loading/unloading operations and on ships specifically designed to make the whole cargo handling cycle more economic, have been designed[9].

Finally a number of projects have focused on the improvement of the information flow in the intermodal transport chain and in terminals[1],[5],[7],[14],[15],[20], as well as on security issues[16],[19].

5 EUROPEAN **POLICY IMPLICATIONS**

Research dealing with IFTs under FP5 has produced results and recommendations which can help decision makers to define appropriate policies for intermodality development[6].

Although in 1997 the European Commission proposed to include ports and terminals in the TEN-T, at present it is only the ports that have been included. The issues concerning how to integrate terminals into the TEN-T network should be addressed by future research projects, as well as the study of effective financing schemes for the construction of new terminals, taking into account examples of best practice such as the Private-Public Partnership (PPP) financing scheme adopted in Germany. It will also be useful to develop tools to help decision makers to efficiently evaluate whether it is better to build a new terminal or to extend an existing one.

Research efforts should also be directed to better integrate inland waterways into intermodal transport and door-to-door transport chains. The White Paper[a] stresses the fact that inland waterways and SSS are a real competitive alternative to land transport and can play a major role in shifting the balance between modes of transport. Promoting the use of inland waterways will strengthen the efforts to achieve sustainable mobility. The main tasks to perform are the integration of vessel operations with port operations, the improvement of the service portfolio of ports, an increase in the efficiency of inland waterway transport through a highly integrated logistics network and supply chain, the combination of traffic management with logistics operations in order to improve quality of service, and the use of extended electronic data communications for intermodal door-to-door service.

There is also a need to address the organisational aspects of the logistics chain in order to integrate the actors in a more effective way, as well as to further investigate the issues relating to the interoperability in terminals at borders between EU and Newly Associated States (NAS) and CEEC.

The lack of harmonisation and standardisation is a major obstacle for intermodal transport, and affects the interoperability between systems. It relates to both hardware technologies (load units, rolling road and rolling rail equipment, transhipment devices, terminal layout and design, etc.) and information technology (telematics, information systems, electronic data exchange, etc.). Research should find proper ways to implement the harmonisation of the many different national laws and regulations as well as standardised technologies at European level.

It would also be useful to investigate which are the key success and failure factors for the implementation of innovative technologies, not only from the technical and economic point of view, but also from the socio-economic one.

Furthermore, it is necessary to develop a reference centre for freight terminals with a centralised availability of knowledge, harmonisation and standardisation of business processes in order to improve the use of resources by means of advanced information and communication technologies. This will improve the effectiveness and efficiency of IFT, which will provide a higher level of quality of services with reduced costs. Tasks might include the use of the concept of 'Portal' as a means to integrate information systems, to develop an internet site, which offers a set

of tools and services to establish electronic links with terminals, ports, shipping lines and logistics in order to develop a web based platform with interfaces to all parties. It might also be useful to carry out an analysis of how to integrate the different organisational structures of data of the various actors in IFTs, as well as identifying who should be responsible for their integration. Since big actors have the power to dictate rules and formats, it is necessary to find a way to harmonise them which can benefit all the actors, if possible.

New efficient tools to improve the logistics chain management and the trackability of vehicles and freight or **ITU** should be developed and the potential of the e-industry should be studied, analysing how it would improve business and commerce. It might be useful to investigate effective and secure ways of sharing information, processes and resources, such as **CPFR** and **VMI**, as well as the supply chain visibility and transparency in order to improve the level of control of the freight flow and enhance the level of service.

Finally, it has been found that costs and benefits in **EDI** are not balanced. The main issue to be addressed is to determine whether the information provider or the information user should pay for the investment and running costs. Research shoud be carried out to define and validate financing mechanisms for the implementation of **EDI**.

6 FUTURE RESEARCH DEVELOPMENTS

One of the tasks performed by the **FP5** thematic network on freight terminals[6], together with experts from transport industry, research and public authorities, has been the definition of the top priority areas for future projects.

They have identified the following areas.

- **The European intermodal terminal network.** It is necessary to improve the knowledge at European level of the intermodal terminal network and to integrate the terminals in the TEN-T. Also a systematic collection of data and information on freight terminals and OD freight flows is needed. Research should also be carried out to identify effective financing schemes for intermodal terminals and to improve interoperability in railway border terminals. Technological innovation in the field of inland waterway corridors is also necessary.

- **Security in terminals and along the chain.** Starting from the achievements obtained by the SIT thematic network[19], further research should be carried out on integrated and harmonised security regulations for freight transport, determining who should pay for these standardised procedures.

- **Technological innovation applications.**

- **Improvement of the co-ordination and collaboration between actors.**

- **Quality of services.** Liberalisation of transport markets, the implementation of common safety and security measures, and the creation of interoperable networks have a direct impact on the quality of services. In the liberalisation process, open access should be granted to SMEs in intermodal terminals.

- I**CT applications.** ICT technologies are a key factor for the improvement of the effectiveness and efficiency of terminal operations. Main issues are standardisation of technologies, harmonisation of information, regulations on security and confidentiality in e-commerce.

The general objective 3 "Re-balancing and integrating different transport modes" of the **Sustainable Surface Transport** work programme of the Sixth Framework Programme, addresses most of these issues. The objective of one task "Intermodal freight transport systems, technologies and strategies" is to bring to the attention of the different users the most promising innovative concepts, best practices, business models and strategies for the enhanced planning and operation of intermodal transport and freight terminals.

One research project is addressing issues relating to the incompatibility between the different available technologies and transhipment equipments, as well as the standardisation and interoperability of transport technologies[22]. Other projects are developing new intermodal loading units suitable for the trimodal transport of bulk and packaged goods at road, railway and inland waterways[24], and more efficient RoRo vessels[23].

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[7] GIFTS, Global intermodal freight transport system, 2001-2004

[8] IN.HO.TRA., Integration of Interoperable Intermodal Horizontal Transhipment Techniques in intermodal transport operations, 2000-2003, *http://www.inhotra.org*

[9] INTEGRATION, Integration of sea land technologies for an efficient intermodal door to door transport, 2002-2005

[10] INTERFACE, Improvement of intermodal TERminal Freight operAtions at border Crossing tErminal,2002-2005

[11] INTERMODA, Integrated Solutions for Intermodal Transport between the EU and the CEECs, 2001-2003, *www.intermoda.org*

[12] INTERMODESHIP, The Intermodal Ship, 2002-2006

[13] ITIP, Innovative Technologies for Intermodal Transfer Points, 2000–2004, *www.eutp.org/en/itip*

[14] MOCONT, MOnitoring the Yard in CONtainer Terminal, 2000-2001

[15] MOCONT II, MOnitoring the Yard in CONtainer TermInal - TrIals, 2002-2003

[16] REALISE, Regional Action for Logistical Integration of Shipping across Europe, 2002-2005, *http://www.realise-sss.org*

[17] RECORDIT, Real Cost Reduction of Door-to-door Intermodal Transport, 2000-2002, *http://www.recordit.org*

[18] SAIL, Semi Trailers in Advance Intermodal Logistics, 2000-2002, *http://www.tfk-hamburg.com/sail*

[19] SIT, Safe and secure Intermodal Transport, 2003-2005

[20] THEMIS, Thematic Network in Optimising the Management of Intermodal Transport Services, 2000-2004, *http://www.themis-network.org*

[21] TRAPIST, Tools and Routines to Assist Ports and Improve Shipping, 2002-2004.

[22] INTERMODE-TRANS, Specific Support Action for pan-European stakeholders and users sustaining integrated pilot technologies for increasing the efficiency of intermodal transport, 2004-2006

[23] LOGBASED, Logistics-based design, 2004-2007

[24] TRIMOTRANS, Development of new intermodal loading units and dedicated adaptors for the trimodal transport of bulk materials in Europe, started in 2005

LIST OF **ACRONYMS** AND **GLOSSARY** OF TERMS

AGV	Automated Guided Vehicle
CEC	Commission of the European Communities
CEEC	Central and Eastern European Countries
CPFR	Collaborative Planning Forecasting and Replenishment
DSS	Decision Support System
EC	European Commission
EDI	Electronic Data Interchange
EU	European Union
FP4	Fourth Framework Programme
FP5	Fifth Framework Programme
FP6	Sixth Framework Programme
HORIZONTAL TRANSHIPMENT	The transhipment between transport vehicles, buffers and storages, mainly horizontal in two dimensions
ICT	Information and Communication Technologies
IFT	Intermodal Freight Terminal
INTERMODAL TRANSPORT	The movement of goods in one and the same loading unit or road vehicle, which successively uses two or more modes of transport without handling the goods themselves in changing modes. By extension, the term intermodality has been used to describe a system of transport whereby two or more modes of transport are used to transport the same loading unit or truck in an integrated manner, without loading or unloading, in a [door to door] transport chain.
IST	Information Society Technologies
ITU	Intermodal Transport Unit
LIFT-ON-LIFT-OFF (LOLO)	Loading and unloading of intermodal transport units (ITU) using lifting equipment
LOADING UNIT	Container or swap body
MULTIMODAL TRANSPORT OPERATOR (MTO)	Any person who concludes a multimodal transport contract and assumes the whole responsibility for the performance thereof as a carrier or a transport operator.
NAS	Newly Associated States
OD	Origin Destination
PPP	Private-Public Partnership
ROLL-ON ROLL-OFF (RORO)	Loading/unloading by the vessel's doors/ramps by a wheeled means of conveyance
ROPAX	RoRo vessel which carries both passengers and cargo
RTD	Research and Technology Development
SEMI-TRAILER	A non-powered vehicle for the carriage of goods, intended to be coupled to a motor vehicle in such a way that a substantial part of its weight and of its load is borne by the motor vehicle. Semi-trailers may have to be specially adapted for use in combined transport.

SHORT SEA SHIPPING	Movement of cargo by sea between ports situated in Europe as well as between ports in Europe and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe.
SSS	Short Sea Shipping
SME	Small and Medium Enterprises
SSS	Short Sea Shipping
SWAP BODY	A freight carrying unit optimised to road vehicle dimensions and fitted with handling devices for transfer between modes, usually road/rail. Originally, such units were not capable of being stacked when full or top-lifted. However, many units can now be stacked and top-lifted and the main feature distinguishing them from containers is that they are optimised to vehicle dimensions. Such units would need a UIC approval to be used on rail. Some swap bodies are equipped with folding legs on which the unit stands when not on the vehicle.
TEU - TWENTY-FOOT EQUIVALENT UNIT	A standard unit based on an ISO container of 20 feet length (6.10 m), used as a statistical measure of traffic flows or capacities. One standard 40' ISO Series 1 container equals 2 TEUs.
TRAILER	A non-powered vehicle for the carriage of goods, intended to be coupled to a motor vehicle, excluding semi-trailers
TRANSPORT OPERATOR/ CARRIER	The person responsible for the carriage of goods, either directly or using a third party

Intermodal Freight Terminals are places equipped to handle the transhipment and storage of Intermodal Transport Units. They are also the weakest link in an intermodal transport chain. Prior to the EC's Fifth Framework Programme, research projects highlighted many issues, including the need for improvement in this area.

This brochure studies the projects carried out under this Framework Programme that focussed on IFTs and provides an overview of the results available at the time of going to press.

Among other issues it looks at the opportunities for the integration of intermodal terminals in seaports and inland ports. It offers some solutions for improving interoperability between transport modes and for the optimisation and rationalisation of transfer procedures. It also addresses problems noted at terminals on border crossings within the EU and towards CEECs, as well as looking at issues relating to the integration of information technologies into intermodal door-to-door systems.