Current Challenges for Intermodal Freight Transport and Logistics in Europe and the U.S.

UCI-ITS-LI-WP-03-4

Konstantinos G. Zografos
Amelia C. Recker

1 Transportation Systems and Logistics Laboratory
Department of Management Science and Technology, Athens University of Economics and Technology
113 62, Athens, Greece, kostas.zografos@aeub.gr

2 Department of Computer Science, Department of Civil and Environmental Engineering
and Institute of Transportation Studies, University of California, Irvine, aregan@uci.edu

August 2003

Institute of Transportation Studies
University of California, Irvine
Irvine, CA 92697-3600, U.S.A.
http://www.its.uci.edu

Current Challenges for Intermodal Freight Transport and Logistics in Europe and the US

Konstantinos G. Zografos
Transportation Systems and Logistics Laboratory
Department of Management Science and Technology
Athens University of Economics and Business
47A Evelopidon & Lefkados 33 Str.,
113 62, Athens GREECE
+30210-8203673-5, fax +30210-8203684
kostas.zografos@aeub.gr

and

Amelia C. Regan
Computer Science and
Civil & Environmental Engineering
University of California
Irvine, CA, 92697-3600
949 824-1074
aregan@uci.edu

ABSTRACT

This paper addresses current issues and challenges related to the large scale implementation of intermodal freight transportation systems in the US and Europe as well as identifying open research issues and challenges. As congestion and environmental impacts continue to worsen, intermodal transportation will continue to increase in importance. Therefore, it is necessary to explore the barriers to large-scale implementation of intermodal freight transportation.
INTRODUCTION

Extensive research devoted to intermodal transport and logistics in the US and the European Union (EU), provides the opportunity to assess the current state of the art and identify issues that should be further studied. Experience accumulated through prior research can provide vital input regarding anticipated changes and trends in intermodal freight transport systems. Similarly, existing results and experience gained through research concerning the spectrum of changes, and consequences imposed by the rapid advances and application of Intelligent Transportation Systems (ITS) technologies on the operation and performance of intermodal freight and logistics, can be further explored.

The importance of intermodality for the efficient operation of transport and logistical systems and the benefits that intermodality can bring about in reducing external costs of transport have been recognized internationally (1, 2, 3, 4). In the near future intermodal freight transportation will become increasingly important, driven by congestion and environmental concerns, the changing requirements of global supply chain systems and the rapid advancement of Information and Communication Technologies (ICT). Furthermore, the substantial changes that have occurred or are currently occurring in freight transport systems regulations may dramatically impact the use and performance of transport systems.

The objective of this paper is to identify and present issues of common interest to EU and US researchers in the area of intermodal freight transport and logistics.

The rest of this paper is organised into seven sections. The next section presents a brief description of the research approach used while the third section describes the freight transport environment and its impact on intermodal freight transport. Section four discusses issues related to the impact of ICT on the provision of logistical and intermodal freight services. Section five discusses issues related to city logistics. Section six discusses topics related to the emergence of the third party logistics (3PL) industry, and section seven identifies research questions related to freight transport security. Finally, section eight provides the research conclusions.

RESEARCH APPROACH

The research approach followed for identifying open research issues in the area of intermodal freight transport and logistics is illustrated in figure 1. The basic assumption behind the proposed approach is that the socio-economic and technological environment prevailing in both the EU and the U.S. for the provision of logistical services determines intermodal freight service requirements. The intermodal freight transport requirements in turn determine the methods, tools, and concepts that should be available in order to plan, design and operate the intermodal freight transport system. It is clear that the existing EU and U.S. literature have already addressed a number of research topics, while a number of research issues of common interest are considered to be open.

The major research areas in which this research was focused are:

- Impacts and implications of e-business on the provision of logistical services, and the development of intermodal transport solutions
- Contribution of ICT on logistics and intermodal freight transport
- Impacts of the deregulation, ICT technologies, and 3PL concepts, on the provision of intermodal freight transportation
- Impact of the emerging technological environment on the development of efficient City Logistics concepts
- Impact of ICT on freight transportation security.
Figure 1: Research Approach

In what follows we present a brief discussion of the freight transportation and logistics environment as well as a justification for the research questions of common interest to EU and U.S. researchers.

FREIGHT TRANSPORTATION AND LOGISTICS ENVIRONMENT

The supply chain system encompasses activities dealing with the efficient and cost-effective flow of goods and information from a point of origin of raw materials to a final consumer. Freight transportation is a vital element of the organization and structure of any supply chain management system. A hierarchical relationship exists between supply chain and freight transportation systems. The hierarchical relationship between the supply chain and the logistical system leads to the hypothesis that changes occurring in the environment of the supply chain system not only affect the management of the supply chain system per se, but also they strongly influence the structure of the supply and distribution networks, which in turn influence the organization, structure, and use of the freight transport system.

Three main elements constitute the environment of the supply chain system. These are the technological, the political and the socio-economic environment. Changes in the environment of the supply chain system affect the way that supply chains are organized and operate.
The importance of the interactions taking place at the socio-economic, political and technological environment has attracted the attention of the scientific community and substantial research has been devoted to their analysis. Most of the literature has addressed the relationship between the configuration, organization, and management of the supply chain system and its environment. Cooper (5) described the factors influencing the restructuring of the supply chain system, i.e. global competition, environmental concerns, technology advancement and regulatory changes (i.e. in transport and telecommunication systems). Similarly, Coyle (6) argued that transport and telecommunication deregulation, global competition and technology advancement resulting from the socio-economic, political and technological changes set the new requirements for logistical services and change the organizational structure of business entities. Corrigh (7), and Meyer (8), examined the role of technological advancement, environment, global competition, and deregulation of transport and finance in impacting the development of the Supply Chain System. On the European side, through its research program, the European Commission identified changes in the organization of the Supply Chain System and their impacts on the physical distribution system as a result of changes in the supply system environment (9, 10, 11). O’ Sullivan (12) discussed the factors that influence the development of logistics in Europe, i.e. socio-economic, political and technological changes and the direction of their influence on the structure and organization of the European logistical system. The European Association of Logistics (ELA) and AT Kearney (13) in their fourth quinquennial European logistics study identified regulatory changes, global competition and technology advancement and integration as the three forces driving changes in the Supply Chain System.

The changes in the socio-economic, political and technological environment have substantially influenced the development of Supply Chain Management (SCM) trends like (14, 15):

1. Spatial concentration of inventory
2. Spatial concentration of production
3. Development of break-bulk/transshipment systems
4. Development of hub and spoke systems
5. Application of time compression principles
6. Postponement
7. Rationalization of the supply base
8. Wider geographical sourcing and distribution of goods
9. Concentration of international trade on hub port and airports
10. Vertical disintegration of production
11. Direct deliveries
12. Nominated day delivery and timed delivery systems
13. Reverse logistics

Recent studies (16) suggest that the emerging SCM trends will introduce substantial changes in the spatial organization of supply and distribution networks. The following trends are expected to influence the development of the freight transport system:

1. Geographical expansion of distribution networks, and an increase in long distance freight transport movements.
2. Change in the size and functionality of supply and distribution network nodes, i.e. development of break-bulk, cross-docking, or transshipment systems, development of reverse logistics process, development of light manufacturing and packaging, etc.
3. Increase in the development of hub and spoke networks.
4. Decrease in the size of consignments and an increase in delivery frequency.
5. Increase in vehicle utilization.
6. Concentration of international trade in hub terminals, i.e. ports and airports.
The emerging freight transport system trends demonstrate the importance and necessity of intermodal freight transport systems. In addition, new technologies, and organizational concepts, like City Logistics and third party logistics (3PL), have been introduced in order to cope effectively with the new freight transport demand requirements.

E-BUSINESS CHARACTERISTICS AND EMERGING REQUIREMENTS FOR LOGISTICAL AND FREIGHT TRANSPORTATION SERVICES

Electronic commerce enables corporations to form electronic relationships (B2B transactions) with their distributors, resellers, suppliers and other partners allowing them to form real-time connections with a globally dispersed base of partners (17). Changes in the spatial distribution of economic activities affect the spatial organisation and resource utilization of the freight transportation system in two ways:

1. Through changes in distribution patterns (e.g., direct deliveries, use of consolidation centres).
2. Through changes in the transportation/distribution system network configuration (e.g., the development of intermediate nodes like break-bulk/transhipment systems, the change of the size of transportation network links).

In business to consumer (B2C) transactions, the Internet provides new opportunities for managing demand, i.e. provision of services 24 hours a day and seven days a week.

However, trends related to freight transport demand are vague, as the implications of e-commerce in B2B and B2C transactions have not accurately been determined. On the one hand, the direct delivery of information reduces physical transportation requirements. On the other, tangible goods are delivered in smaller consignments in size and weight but in increased transport distances (18). As far as the demand for different modes is concerned, demand for air and road transport (the fastest transportation means) is expected to increase (17). Furthermore, the changing demand for freight transportation is influenced by the need for improved service quality. Thus, over the last years there has been a continuing shift from relatively slow modes of transportation like water and rail to faster and higher cost modes.

In addition, the on-going dematerialization of the economy that is linked to information technologies has led to the replacement of heavy industries in Europe by service industries. A service-oriented economy requires a high capacity transportation system that is fast and reliable.

Therefore, considering the characteristics of ideal intermodal transport systems, i.e. the exploitation of the competitive advantage of each mode along the entire door-to-door movement of goods, it becomes apparent that intermodalism is of specific relevance in the emerging logistical and business environment.

The spatial concentration of production and inventory, the globalization of markets, and the advancement of ICT technologies and electronic commerce have contributed to the creation of geographically dispersed logistical networks, which in turn generate demand for long-haul transportation services. Therefore, there is a need for global, reliable, efficient and cost-effective transportation services. The importance of transfer points and terminals is crucial for the provision of long-haul transportation services.
Domestic intermodal freight transportation is on the rise in the US. There has been a steady climb of about 5% per year for more than a decade (19). Of concern is the ability of the intermodal transportation system to meet the rapid throughput needs of information technology enhanced businesses. Nonetheless, considerable evidence suggests that intermodal systems will become increasingly efficient, due to electronic and mechanical technology improvements (20, 21).

Summarizing the issues identified above, the following questions related to the implications of e-commerce on the development of the intermodal freight transportation system arise:

- Are the demand requirements for freight transport services imposed by e-commerce compatible with intermodal freight transport?
- How will the emerging patterns for the spatial organization of supply and distribution networks affect the development of intermodal transport?

The emerging trends for the provision of logistical services are generating new requirements for freight transport services. The freight transport demand requirements are characterized by:

1. Longer transportation distances.
2. Development of break-bulk and transhipment systems in order to keep the transportation/delivery cost of small sized orders low,
4. Concentration of international trade at large ports and airports.

These new requirements for the provision of freight transport service are expected to influence modal splits and the use of intermodal transport services. Therefore, it is important to study:

- The implications of the emerging requirements for logistical services on: i) modal split, and ii) the development of intermodal transport solutions.

INTELLIGENT TRANSPORTATION SYSTEMS TECHNOLOGIES AND FREIGHT TRANSPORTATION DEVELOPMENT

Intelligent Transportation Systems (ITS) provide ample opportunities for increasing transportation system performance and capacity through better management, control, and use of resources. The integration of information provided by Advanced Traveller Information Systems (ATIS) and freight and fleet management information provided by Automatic Vehicle Location/Identification (AVL)/(AVI) systems with vehicle routing/scheduling software, may provide substantial potential for reduction in vehicle operating costs. Furthermore, Intelligent Transport System (ITS) technologies allow the efficient flow of freight information along the entire transport chain increasing the efficiency of freight transport en-route and facilitating modal transfers. The development of identification technologies facilitate further logistics information exchange and acquisition and allow the fast and accurate tracking and tracing of shipments leading to substantial benefits, i.e. i) time savings, ii) increased level of service, iii) better utilization of resources, and iv) better supply chain integration. In addition the provision of real-time information increases flexibility and responsiveness.

Substantial research on both sides of the Atlantic has been devoted to interoperability and standardization issues related to loading units, information systems, etc. with an emphasis in interconnecting systems in order to support the different functionalities of the various transportations modes (4, 21).
Although the impact of ITS technologies is potentially dramatic there is little consensus on how these technologies affect the performance of the freight transport system. The following research questions need to be further studied:

- **What are the major barriers in implementing successfully the emerging ITS technologies in freight transportation/distribution systems?**
- **What are the major criteria for assessing the impacts of the introduction of ITS technologies on intermodal freight transportation systems?**
- **What types of methodologies should be used in order to assess the impacts of ITS technologies on freight transport operations?**

The provision of answers to the above stated questions requires the development of methodologies that can consider the following characteristics (22):

- Multiple and sometimes ill defined and conflicting objectives expressing the values, needs, and aspirations of the various stakeholders (shippers, carriers, providers of warehousing services, terminal operators, transportation infrastructure owners and operators, integrated logistics service providers, and public agencies) involved in and affected by the planning and operation of intermodal transport facilities.
- Lack of a clear decision making structure regarding the appraisal of intermodal freight transportation networks.
- The existence of a hierarchy of objectives and goals for the management of intermodal freight transportation network.
- The assignment of priorities to different objectives by the various stakeholders.
- The simultaneous consideration of both quantitative and qualitative criteria which sometimes are difficult to quantify or measure.

The necessary prerequisites for developing such a framework are: i) a thorough understanding of the processes that take place in intermodal freight transportation both at terminals and on transportation links ii) a good grasp of the legal and institutional environment within which intermodal freight transportation operations take place, iii) a careful identification and analysis of functions influencing the performance of intermodal freight transportation systems, iv) the determination of the impacts of the ITS applications on intermodal transportation operations, v) the prioritisation of the ITS applications and vi) the implementation of the new system.

- **How can the opportunities offered by Information and Communication Technologies be explored in order to support a seamless intermodal transport system?**
- **What standardization and harmonization activities are required to facilitate the efficient flow of information along the entire transportation and supply chain?**

**CITY LOGISTICS**

Urban freight movements generate a number of negative social, economic, and environmental impacts. An efficient urban freight system is of crucial importance for the development of urban economies. More than ever, businesses base their locational decisions on the performance and efficiency of the available transportation system.
In order to plan for an effective and efficient urban freight transportation system, the driving forces shaping the needs and requirements for freight movements should be identified and analyzed. The demand for freight movements should be considered in the context of issues related to urban environment like congestion, pollution and accessibility. The rational organization of urban logistics has been proposed as a measure for reducing urban freight transport externalities.

City Logistics is the process of optimizing urban logistics activities by considering the social, environmental, economical, financial, and energy impacts of urban freight movements (23, 24). City Logistics aims at encouraging intermodal transfers at terminals located in relatively under-developed areas close to urban centres (25). The terminals should be developed by interested parties in a cooperative manner (3). City Logistics concepts, i.e. freight villages have been developed and operate in Germany and Switzerland, as well as across the Atlantic (for example the Metropolitan New York freight village, the rail-truck intermodal terminals in the metropolitan Chicago area, and the Alameda Corridor in Southern California). The implementation of these concepts provides an effective and efficient solution to urban freight transport problems including traffic congestion, regional competitiveness, and quality of life.

City Logistics involves the development of partnerships and alternative ways of cooperation between the parties involved in the supply chain and the distribution/transportation functions in the urban environment. These forms of cooperation can generate a significant reduction in vehicle kilometres, number of trucks used, and vehicle kilometres driven empty and can increase vehicle productivity.

The preceding discussion suggests that there are a number of issues related to the implementation of City Logistics concept that should be further discussed:

- How can urban and interurban freight transportation/distribution networks be integrated?
- How can City Logistics concepts fit with the emerging requirements for logistical services and the promotion of intermodality?
- How can ITS contribute in the development of the City Logistics concepts?
- What are the barriers for implementing the City Logistics concept?
- What are the criteria for assessing the socio-economic impacts of City Logistics?
- How can alternative City Logistics concepts be implemented?

Researchers in the US have paid relatively little attention to city logistics to date. Nevertheless, there is a growing consensus in the research community that shared use of urban freight terminals and shared use of drop boxes for express package delivery services should be investigated and probably implemented in severely congested urban areas (26, 27, 28).

**FREIGHT TRANSPORTATION LEGAL/INSTITUTIONAL FRAMEWORK – 3PL INDUSTRY**

The large scale deregulation of the freight transportation industries in the US has led to major changes in the supply side of logistical services (6, 29). For example, there has been a simultaneous increase in the number of carriers and the consolidation of both the size and reach of the largest carriers. There have been changes in modal splits and the services provided by large logistics companies, many of which emerged from large successful carriers (truck, rail, air cargo) now extend beyond warehousing and transportation.
Transportation deregulation in Europe – on a similar scale – is much more recent, it actually started during early 1990s and despite the substantial effort devoted by the European Union Member States the results to date are not as significant as in the US. The results of a recent study (SULOGTRA) of the legal and institutional changes taking place within the EU Member States suggests that the legal and institutional framework governing the various transport modes in European Union Countries is characterized by the following major trends (14, 15, 16):

- Harmonization and convergence with the general EU policies and guidelines governing the various transport modes.
- Movement from a tightly regulated transport market to a deregulated market, allowing fair and free competition among the transport service providers.
- Introduction of Private Sector investments, under a variety of Public Private Partnership schemes, for the development of the infrastructure.
- Separation of infrastructure ownership and operations.

The emerging changes in the organizational structure of supply chains and the deregulation of the freight transport system provide fertile ground for the development of third party logistics (3PL). The term third party logistics (3PL) was initially used in the late 1980s as a description of outsourcing logistical activities. The term has been also used to describe “strategic alliances with service providers” and “logistics service providers” in particular. Contract logistics is also used to refer to outsourcing of logistical activities (30, 31). However, third party logistics can be “narrow in scope” and limited to one type of service only (i.e. transportation) (31).

In Europe there is a great variety among third party logistics companies and the services provided (32). At the higher level there are the largest 3PL companies, which provide several value-added logistical services to almost every significant market in Europe. These services vary from labelling in different languages to product assembly, inventory storage and management, and transportation. At this level European companies compete with their U.S.-based competitors like UPS Worldwide Logistics, Ryder Integrated Logistics, etc. and although no 3PL operating in Europe has a dominant share of market, the European owned 3PL companies have a commanding presence (32). The European market particularities create significant challenges to be met by the 3PL providers. In France, Netherlands and Germany sophisticated outsourcing services are required, with an emphasis in technology and SCM integration. In the Mediterranean countries, where infrastructure is not so well developed the focus of logistical services is on transportation and warehousing, while in eastern Europe, where the transportation and telecommunication infrastructure is underdeveloped, basic transportation and logistical functions are required (32). At the lower level there are the international freight forwarders. These are asset-based operators that perform trucking, warehousing, customs brokerage, and packing services, usually with a specific geographical or/and commodity focus.

Between these two extremes a new type of European 3PLs has emerged out of other types of freight-service providers, such as terminal operators, providing complex logistics services for the retail and manufacturing industries. Furthermore, another quickly expanding class of European 3PLs has developed out of large state-owned institutions such as the national railroads and postal authorities.
The US has seen similar development of 3PLs. Some 3PLs grew out of the shipper's agents and freight brokerages that existed under regulation. The term freight broker applied to ICC (the US Interstate Commerce Commission, the regulatory agency responsible for freight transportation) licensed truck brokers that handled general commodity freight. These brokers acted primarily as marketing agents and load matchers for smaller trucking companies while shippers' agents were intermediaries who bought intermodal capacity from railroads and then sold this to shippers (33). Until very recently most 3PL companies were affiliated with a parent transportation or warehousing company, many operating as subsidiaries of that company. Based on the ownership of transportation equipment or warehouse facilities, 3PL providers were historically divided into two categories: asset-based and non-asset based (34). Today, the majority of 3PLs are non-asset based companies. These tend to be either management or knowledge-based consulting companies. Rather than handling the physical distribution themselves, these companies mainly focus on strategic or tactical level activities.

The rapid growth of international trade activities has been followed by the birth of strategic channel intermediaries, such as foreign freight forwarders, non-vessel-owning common carriers, trading management companies, customs house brokers, export packers and port operators. Several recent studies have addressed the issue of growth in the 3PL market and other freight intermediaries in detail (35).

Lieb and Peluso (36, 37) and Lieb and Randall (38) discuss insights gained from a multi-year survey of chief executive officers of the largest 3PL providers in the United States. Key findings reported in the paper are the following: most of the companies surveyed are autonomous subsidiaries of companies in the transportation and warehousing business; most have significantly increased their international operations in the past few years; most are increasingly forming strategic alliances with other 3PL companies as well as companies primarily involved in warehousing, trucking, freight forwarding, and customs brokerage. Similarly, Leahy, Murphy and Poist (39) examined the determinants of successful third party relationships from the provider perspective. More recently, Sankaran and Charman (40) performed an exploratory study of the effectiveness of 3PL contracts as well as the process by which buying firms purchase services. All of these studies predict that this already formidable industry will continue to see significant growth in the years ahead.

The deregulation of the transportation system, the development of third party logistics services and their influence on the implementation of intermodal freight strategies needs to be further understood by addressing the following questions:

- What is the relationship between third party logistics providers and intermodal transport development?
- What are the institutional/regulatory barriers on national and international level in implementing intermodality?
- To what extent is public-private cooperation necessary to promote and implement intermodal transport at a satisfactory level?
- What types of incentives should be introduced in order to increase the integration of the different transport modes?
- How can the introduction of ITS technologies contribute to the efficient provision of 3PL services in an intermodal freight transport environment?

SECURITY IN FREIGHT TRANSPORT

The global transportation environment necessitates dramatic changes in the organization and performance of the freight security function. New systems, skills, and technologies are required in order secure cargo during its flow along the supply chain. The new challenges in cargo security include (41):
• The rise of sophisticated fraud and theft in the freight transportation system.
• The low rate of introduction of new security systems.
• The need for new innovative technological solutions for securing cargo.

The emerging requirements for freight transport, i.e. increase in speed, volume and on-time delivery leads the transportation industry to focus on the implementation of integrated information systems in order to improve the provided services. Nevertheless, the high complexity of the intermodal system and the use of inadequately protected electronic systems and internet web sites provides criminals, who use successfully the new technologies, with detailed cargo trucking information at a low risk. Therefore, it is imperative to develop and integrate new security systems, techniques and equipment appropriate for the different critical security points (i.e. web sites, information systems of terminals and transfer points, etc.), optimizing in this way the role of security in the supply chain management, while contributing to corporate' financial benefits.

Considering the key points of the brief introduction on the emerging freight security issues, it is necessary to further explore how freight transport security can be improved. The following questions may provide a starting point for this discussion:

• What is the role of government and industry in improving the effectiveness of the cargo security process?

The efficiency of the global economy is heavily dependent on the efficiency of the freight transportation/logistical system. Therefore it is on the best interest of industry to work together with government in order to develop and establish the necessary security practices and procedures that will ensure the secure and efficient flow of goods worldwide.

A number of programs to promote security within the global intermodal transportation system have been initiated. Following the terrorism act of 11th September, 2001, the U.S. has been more active than Europe on this respect. Specifically the U.S. Customs Service has announced two new programs: the Customs-Trade Partnership Against Terrorism and the Container Security Initiative. These programs involve government and industry around the world in order to develop security partnerships that enhance the intermodal transport system with the minimum impact on efficiency and reliability. A similar program has been developed between U.S. and Canada, the “Smart Border Accord”, where Customs officials from the two countries place their own inspectors in each other’s port. Other security initiatives and programs with cyber-security relevance in the U.S. include: i) the Electronic Supply Chain Manifest (ESCM) operational test, ii) Transaction Worker Identification Card, iii) Surface Transportation Information Sharing and Analysis Center, iv) Port Security Grants Program, v) Tracking Industry Anti-Terrorism Operations Center, vi) Operation Safe-Commerce (42).

• What are the areas where innovative security systems and technologies should be introduced?

Major emphasis should be placed in containers since the majority of freight is transported using containers. The implementation of security systems and procedures requires substantial effort in moving containers from inbound vehicles to staging areas, areas where security inspections can occur, and outbound vehicles. Therefore, it is important both to develop and introduce technological solutions supporting the pre-screening of containers and identify those that security checks should be performed, as well as to develop models and algorithms, and decision support systems in order to optimize the processes required for implementing the security inspections.
However, significant efforts are underway towards solving some of these safety-related issues. According to Cho (43), several US initiatives have emerged to address security (including terrorist) concerns. One is the US Customs Service's 24-hour rule, which requires cargo manifests at the port of call 24 hours before the cargo is loaded. Container tracking tests are also being conducted. In addition, various ports are using trackside scanners to read cards on cargo containers, biometric smart cards to track identities of truckers and cargo handlers, electronic seals for ship containers that send automated alerts via transponders and warn when a container has been tampered with without authorisation, and seals on rail containers that can be read by devices along the route.

In addition due to the fact that different technologies are required, effort should be also allocated in the effective coordination and deployment of these technologies (44, 45).

Still, a great deal of testing remains to be done, and a global set of standards needs to be agreed upon. Researchers agree, however, that such initiatives are preliminary at best – much more development and testing is needed before an international or even national safety standard will emerge.

- **How cargo security system performance can be improved across the entire intermodal transport chain?**

Technology has the potential to support the introduction of advanced security practices in the freight transportation/logistical system operations. More specifically Information and Communication Technologies (ICT) can be used in order to support the acquisition, processing and communication/dissemination of data/information between the different actors, terminals, and transportation modes. These data can be used either to optimize the various processes, i.e. terminal space allocation, loading/unloading plans, etc. or to provide services that expedite the inspection process i.e. pre-screening of containers. Bar codes, Global Positioning Systems (GPS) and Radio Frequency Identification Devices (RFID) increase the level of visibility all along the supply chain, increasing in this way the efficiency and effectiveness of the decision making process (46). Substantial contribution in the performance of security systems is provided by the cargo scanning systems which can actually detect the specific type of material and its precise three-dimensional location inside a container, for example x-ray and gamma ray based inspection systems and pulsed-fast neutron analysis (PFNA) (44, 45).

- **How we can balance the need for increased cargo security with the efficient and cost-effective operation of the intermodal freight system?**
There is already evidence that the introduction of security systems and procedures in the freight transportation/logistical system has a substantial cost both in terms of efficiency/effectiveness as well as in terms of cost. For shippers the costs are related to the hiring and training of security officers, preparing security plans and paying higher containers storage/transportation fees (47). Terminals on the other hand have to accommodate security inspection cost, purchase, install and operate special equipment, while at the same they experience substantial delays and deficiencies in managing their capacity (47). Besides the cost impacts of cargo security measures, some cyber-security applications like digital signatures have the potential to reduce costs related to errors and fraud and may bring some economic benefits (42). The National Research Council Study on Cybersecurity of Freight Information Systems (42) has identified the “assessment of the economic impacts of cost increases in the freight transportation industry” as one of the tasks on its study plan proposal. Although the actual costs (i.e. for equipment, infrastructure, etc.) of security procedures can be accommodated by the different stakeholder groups as understandable and compulsory, it is very difficult both for logistical service providers, as well as shippers/recipients to accept logistical system inefficiencies caused due to the security inspections, i.e. delays. Therefore, a key process innovation is required in order for terminals to check a significant percentage of containers with only a minor reduction on terminal’s efficiency (45). Emphasis should be placed on where the raw material, commodities, and system components have been purchased and which was the terminal of origin.

- What are the legal and institutional changes required in order to increase the effectiveness of cargo security?

Several institutional and regulatory changes are required in order to establish a uniform, standardized and integrated way of security inspection practices and procedure globally. In addition in order to avoid compromises in efficiency and effectiveness of the logistical system in general a break-down of responsibilities related to security issues should be allocated in all stages of the transportation process, and to all stakeholder groups involved. Therefore, an institutional and regulatory framework should be developed, which will ensure that no overlaps and conflicts exist, while it will foreseeing the development of the appropriate regulatory, enforcement and inspection bodies required for the actual implementation of the security inspection procedures.

In addition considering the overall discussion on freight security presented in this section it is apparent that governmental intervention is required in order to provide/develop the appropriate incentives for:

1. The development of emerging technologies related to the promotion of security of freight transport/logistics, especially at intermodal terminals.
2. The reengineering of processes related to terminal operations in such a way as to incorporate the emerging security procedures with the minimum cost on the efficiency and reliability of operations.

CONCLUDING REMARKS

A number of issues of common research interest for EU and US researchers were identified in the area of intermodal freight and logistics operations. The issues of common interest were identified through i) a critical assessment of EU and US literature addressing the relevant topic, ii) exchange of views on emerging research issues among EU and US scientists participating in the ATLANTIC network.
The cooperation developed between EU and US scientists, within the framework of the ATLANTIC project, in the area of intermodal freight terminals and logistics led to useful conclusions and the establishment of a research agenda that encompasses thematic areas related to the following pending issues:

- Are the demand requirements for freight transport services imposed by e-commerce compatible with the intermodal freight transport strategy?
- How will the emerging patterns for the spatial organization of supply and distribution networks affect the development of intermodal transport?
- What are the implications of the emerging requirements for logistical services on: i) modal split, and ii) the development of intermodal transport solutions?
- What are the major barriers in implementing successfully the emerging ITS technologies in freight transportation/distribution systems?
- What types of methodologies should be used in order to assess the impacts of ITS technologies on freight transport operations?
- How the opportunities offered by Information and Communication Technologies can be explored in order to support a seamless intermodal transport system?
- What are the standardization and harmonization activities required in order to facilitate the efficient flow of information along the entire transportation and supply chain?
- How can urban and interurban freight transportation/distribution networks be integrated?
- How can City Logistics concepts fit with the emerging requirements for logistical services and the promotion of intermodality?
- How can ITS contribute in the development of the City Logistics concepts?
- What are the barriers for implementing the City Logistics concept?
- What are the criteria for assessing the socio-economic impacts of City Logistics?
- How can alternative City Logistics concepts be implemented?
- What is the relationship between third party logistics providers and intermodal transport development?
- What are the institutional/regulatory barriers on national and international level in implementing intermodality?
- What types of incentives should be introduced in order to increase the integration of the different transport modes?
- How the introduction of ITS technologies can contribute to the efficient provision of 3PL services, in an intermodal freight transport environment?
- What is the role of government, and industry in improving the effectiveness of the cargo security process?
- What are the areas where innovative security systems and technologies should be introduced?
- How cargo security system performance can be improved across the entire intermodal transport chain?
- How we can balance the need for increased cargo security with the efficient and cost-effective operation of the intermodal freight system?
- What are the legal and institutional changes required in order to increase the effectiveness of cargo security?
ACKNOWLEDGEMENT

The research reported in this paper has been partially supported by the European Commission DG INFOSO, through the funding of the ATLANTIC Project. This paper is primarily based on the final report of the ATLANTIC Project Working Group 2.1 titled "Intermodal Freight Information, Preclearance and Logistics." The authors would like to gratefully acknowledge the contribution of Prof. C. White and Dr. I. Giannouli in the preparation of the final ATLANTIC Project report and paper.

REFERENCES

7. Cottright, J. 2001, How will changes in information technology change the demand for freight transportation and industrial location?, Roundtable Conference on E-Freight: Metropolitan Implications, Portland, OR., U.S.A.
13. ELA and A.T. Kearney, 2000, "Insight to Impact. Results of the Fourth Quinquennial European Logistics Study", European Association of Logistics
33. Brown, T., 1984, "Freight commodity brokers and general commodity trucking", Transportation Journal, 24 (2), 4-14
36. Lieb, R.C. and Peluso, L., 2000a, The use of third party logistics services by large American manufacturers, the 1999 survey", working paper, Northeastern University
40. Sankaran J., and Charman Z., 2000, "An inductive empirical investigation into third party logistics contracts", Institute of Transport Studies, University of Sydney, working paper, ITS-WP-00-08