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Procedia - Social and Behavioral Sciences 48 (2012) 1877 – 1886

Procedia
Social and Behavioral Sciences

Transport Research Arena– Europe 2012

Green corridors by means of ICT applications

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Abstract

Within the EU-27 CO_2 emissions for transport increased by almost one-third between 1990 and 2008. This plainly shows that the transport sector continually raises its contribution to environmental pollution.
Against this background the EU-Project *Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues* (SuperGreen) aims at promoting an environmentally sound development of the European goods transport. For this purpose, the project explores how freight corridors within Europe can be arranged in a more sustainable way. As one approach the project determines which role a smarter use of ICTs thereby can play. The present paper describes the motivation behind this approach, explains the research strategy and provides first results harvested after one year of project activities.
ICTs for freight transport are, for example, routing planners, weather-information tools or tracking and tracing applications. These systems enable an efficient utilisation of transport resources and a simplified management of the supply chain. Consequently, their application within freight corridors affords the reduction of CO_2 emissions and thus accomplishes greener transports. Beyond, non-environmental attributes such as transport costs, time and reliability are improved as well.
In order to exploit this great potential of ICTs for the benefit of the SuperGreen objective, the approach starts by a broad collection of logistics ICTs. In the second step, single logistics nodes and edges of predefined freight corridors are tested for weaknesses concerning the exploitation of their resources. Based upon this it is analysed, in how far these weaknesses can be remedied by the compiled ICTs. The third step serves for the same examination focusing on entire logistics networks. As the fourth step it is evaluated to what extend each corridor thereby can be enhanced ecologically and economically. To advise the most improvable corridors for a prioritized ICT equipment the corridors finally are benchmarked.

Keywords: SuperGreen; Green Corridors; Freight Corridors; ICTs; ICT applications

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1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of the Programme Committee of the Transport Research Arena 2012
doi:10.1016/j.sbspro.2012.06.1162

1. Introduction

Intensified trade between member states and across external borders is an essential abutment on the European Union. The associated exchange of goods is reflected in growing traffic on European roads, railways and waterways. During the period from 1995 to 2007 the transport performance within Europe continually rose by 36% (European Union 2011). The subsequent decline within 2008 and 2009 was chiefly due to the economic crisis. A further increase is expected in the coming years.

However, this development has serious ecological and economic consequences. One exemplary reason consists in the growth-related contribution of the transport sector to the EU's greenhouse gas emissions. While from 1990 to 2008, CO_2 emissions in industry, private households and the service sector could be reduced within the EU-27 states, transport emissions dramatically increased by 33%. Thus, the transport sector was responsible for one-third of overall European CO_2 emissions in 2008 (European Union 2011). Moreover, the emissions of nitrogen oxides (NO_x) and of particulates were reduced in the last years due to innovations in emission control. Nevertheless, in Germany alone half of NO_x emissions and one eighth of particle concentration are caused by freight transport (Lambrecht & Erdmenger 2009).

A further reason, for instance, concerns the existing infrastructure permanently reaching its limits of capacity due to the growing freight volume. Traffic jams caused thereby are responsible for waiting times, additional fuel consumption as well as even more harmful CO_2 emissions and thus result in high transport cost. For example, traffic jams which occur on German roads, lead to annual economic losses of 102 milliard Euros. Regarding rail traffic it was registered a loss of travel time amounting to six month caused by congestion of the train routes (Suntum 2008).

Against this background the project *Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues* (SuperGreen) was initiated aiming at using European freight corridors more efficiently and ecologically. The paper on-hand deals with this research project supported by the European Commission in the context of the 7th Framework Programme. In the following chapter the paper initially outlines the project's objective. Based upon this the methodical approach to reach the established targets is elaborated within chapter three. In addition, first results gained in the research work done to date are presented. The final chapter briefly draws a conclusion by summing up the benefits of the described approach and making suggestions for future research.

2. Objective

With regard to the heavy environmental pollution and the connected economic losses caused by the transport sector, the main objective of the research project SuperGreen is to promote the development of European freight logistics in an environmentally friendly manner by setting up sustainable corridors. In this context a corridor means a Trans-European geographic axis for goods transports.

To reach this goal the project provides for two central approaches. First, green technologies such as novel propulsion systems, heating and cooling technologies, alternative fuels and cargo handling techniques shall be implemented to attain environmentally sensitive corridors. Second, Information and Communication technologies (ICTs) shall be used to succeed in greening the corridors.

ICTs in general are understood to be any technical equipment for information storage, processing and transfer (Klaus & Krieger 2008). In logistics ICTs are important for information that has influence on traffic or its scheduling. Logistics ICTs in particular are for example routing planners and tracking and tracing applications.

The application of ICTs within freight traffic enables an efficient utilization of transport resources and a simplified management of transport and supply chains (c.f. Clausen & Geiger 2011). Consequently, their application within freight corridors affords the reduction of greenhouse gas emissions and thus accomplishes greener transports. Beyond, non-environmental attributes such as transport costs, time and reliability are improved as well.

This high potential of ICTs is already perceived at European level. On 7th of July 2010 the European Commission enacted a unitary directive for the deployment of Intelligent Transport Systems. In the range of the described measures ICTs are mentioned preferentially. The basis of this political decision is formed by the cognition that with traditional measures like the expansion of the existing infrastructure it will not be possible to satisfy the growth of the European economy and its mobility requirements in an environmentally friendly way (Europäisches Parlament und Rat der europäischen Union 2010).

Due to the great importance of ICTs for the benefit of the SuperGreen objective, the present paper focuses on the second approach of the research project. In the following it thereto addresses the question which ICTs shall be implemented in selected freight corridors, in how far a growth of sustainability can thereby be achieved and which corridors shall in consequence undergo a prioritized transformation.

3. Methodical approach

To examine ICT applications within goods transport axes a four-step-approach was developed and adopted within the SuperGreen project. The approach rests upon a pre-selection of nine, geographically and modally balanced Trans-European freight corridors out of an initial list of some 60 corridors made at the beginning of the research work (c.f. Salanne et al. 2010).

The methodical approach starts with a broad collection of logistics ICTs in the first step. Using this inventory as a basis suitable ICTs are selected for each of the reviewed corridors. To ensure in this regard a complete and precise choice of ICTs, the selection is subject to the following systematic: The second step treats transport nodes and edges as isolated elements of a freight corridor. The selection process therefore is directed on ICTs whose scope is limited to these single components. Further on, the third step regards nodes and edges as connected elements of a transport network. Thus, the perspective of the selection process is widened on complete transport and supply chains. Based upon this, the fourth and last step serves for benchmarking the corridors regarding their room for improvement exhaustible by ICT applications.

The next sections of this chapter provide an in-depth depiction of these four steps. To illustrate and validate the research proceeding first findings from each step are reflected as well.

3.1. First step: survey of logistics-related ICTs

The initial step of the developed research approach comprises an intensive inquiry about ICTs used in the logistics industry. Afterwards, for each ICT the respective purpose and functionality is elaborated. The findings of the first step constitute the basis upon which appropriate ICTs are chosen for the regarded corridors within the subsequent steps.

To ensure an exhaustive enumeration and thereby a solid working background ICTs for all logistics tasks, i.e. planning, executing and monitoring of goods transports, are considered. Thus, on the one hand ICTs for steering and controlling traffic at a specific corridor's intercept are explored differentiated according to the relevant transport modes (road, rail, maritime and inland waterways). On the other hand ICTs are spotted that are constructed for supporting overall, intermodal transport or supply chains. In order to achieve a long-term relevance of the research results both ICTs already deployed and therefore available on the market and systems which are at a progressive stage of research are considered.

Due to the vast number of diagnosted ICTs the results of the first step reproduced in the following are limited to selected examples at this point (Zacharioudakis et al. 2011a):

- Road transport
  - Intelligent Speed Adaption (ISA) is a driver assistant system for regulating that the speed limit of the road section currently driving on is not exceeded. The speed limit is either saved in a digital chart of a navigation system or is detected by traffic sign recognition (Egeler et al. 2009; Etzold 2002).
  - A Break Assist System (BAS) is a power brake unit attached in a vehicle that increases the pedal pressure up to the possible maximum of braking pressure in an emergency situation. The system's activation depends on the time period between the last accelerating impulse and the application of the brakes as well as on the velocity at which the gas pedal was released (Robert Bosch GmbH 2007).
- Rail transport
  The European Train Control System (ETCS) is an Automatic Train Protection System (ATP) to ensure safe rail traffic. The system monitors and controls the local speed limit, the maximum speed of the train, the correct driving route and direction, the train's ability to accommodate in its allocated path as well as its compliance of infrastructure constrains (Schnieder 2007).
- Inland waterway transport
  River Information Services (RIS) are harmonized information services to support traffic and transport management in inland navigation while also considering interfaces to other transport modes. Among the traffic-related services are a fairway information service, traffic information service, traffic management support and a calamity abatement service, whilst transport related services are supporting voyage planning, port and terminal management, cargo and fleet management, statistics and water infrastructure charging. The harmonization was achieved by integrating all services in a common system architecture to ensure consistency and synergy of the applications (Directorate-General for Energy and Transport et al. 2006).
- Maritime transport
  Vessel Traffic Service (VTS) is defined as an electronic supervising system operated by seaports and transport authorities for monitoring shipping traffic at sea and intervening in the navigation if critical situations occur. Therefore VTS mainly comprises radar control, closed-circuit television, very high frequency funk, automatic identification system and computers (Bundesamt für Seeschifffahrt und Hydrographie 2008).
- Supply chain
  The IT Logistics Platform AX4 enables all partners of a supply chain to globally exchange their logistics data and with it organize and optimize their information flow. Therefore the different electronic data processing (EDP) systems of the participants are connected via a universal interface without any need to change or interfere with their single programs (Axit AG 2011).
- Transport chain
  - Agheera means ICT systems offering worldwide, real time and permanent tracking services for assets and shipments on all transport modes. Agheera covers a variety of application areas, for example it can be used to permanently track parameters such as temperature, humidity, shock or light. Consequently there do not exist any standardized solutions. In order to create an adequate system either suited hardware is chosen from existing equipment or new technological developments are manufactured depending on the individual logistics processes and the object to be monitored (Agheera 2011).

- Schenker Smartbox is an ICT system to track containers filled with high-value, temperature sensitive or time-critical commodities in real-time. Mounted on the container door several sensors within the box measure parameters such as the door status or temperature, humidity and movement inside the container. Together with the coordinates of the container the measured data are then transmitted via mobile communication networks (DB Schenker 2011).

3.2. Second step: ICT-selection for nodes and edges

Once the survey on logistics ICTs has been carried out, those ICTs have to be picked out whose application is expected to reduce environmental pollution within the reviewed corridors. In the frame of this selection procedure the second step of the research approach focuses on the determination of ICTs that can be used in logistics nodes and edges of a corridor.

For this purpose the predefined freight corridors are checked for weaknesses concerning the exploitation of their resources. These weaknesses comprehend all inefficiencies in the consumption of resources, which are for example frequently occurring traffic jams, waiting times and accidents. The identified weaknesses are then examined for their origin. Based upon this it is investigated for each corridor which of the compiled ICTs can alleviate or even dissolve its bottlenecks.

For illustrating the second step one of the nine pre-selected corridors named *Two Seas corridor* serves as a good example. Linking Greece with Germany the Two Seas corridor is running across the cities Igoumenitsa/Patras, Athens, Sofia, Budapest, Vienna, Prague, Nurnberg/Dresden and Hamburg. On this 3,500 kilometer long axis road and rail are both used as transport modes.

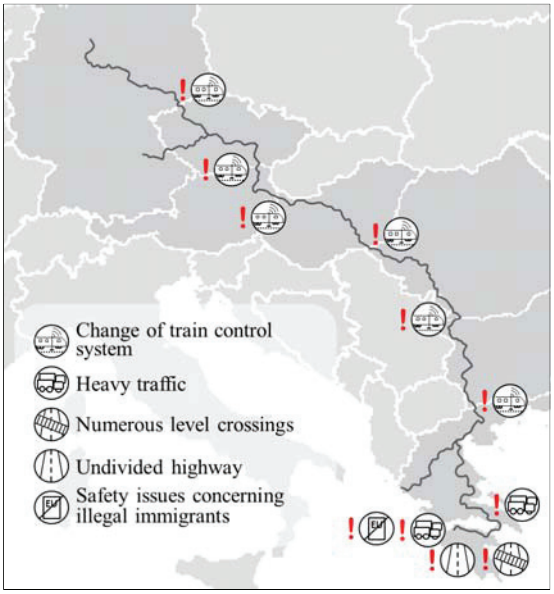

Fig. 1. Weaknesses of the Two Seas corridor

One major bottleneck along the Two Seas corridor consists in prevalent traffic jams and accidents on the Greek National Road 8A between Corinth and Patras. On the one hand the bottleneck is caused as the section partly is a two-lane, undivided highway and therefore only possesses a limited capacity. On the other hand, however, it carries a high traffic volume caused by private cars and heavy goods vehicles moving from and to the port of Patras. Given the knowledge about ICTs for road transport from the first step it can be concluded that in response to this the application of ICTs such as ISA and BAS on the part of the vehicle drivers is a feasible way to alleviate the accident hazard resulting out of the dense traffic and to avoid the associated congestion. Therefore a first result from the research project SuperGreen is the recommendation of their implementation on this highway in particular as well as on similar roads in general.

A further bottleneck of the regarded corridor concerns a well-known problem in the European rail sector. Due to the legacy of railway companies being state companies the rail infrastructure is aligned to the countries' borders. As a result the national networks are not interoperable. Main obstacles are incompatible train control and signaling systems, of which nowadays exist about twenty all over Europe (Graf 2010). Consequently, motor vehicles have to be equipped with several train control systems for cross-border rail freight transport. Otherwise the motor vehicle has to be replaced, which represents a time and cost consuming process.

The Two Seas corridor is faced with five different train control systems. In order to save investment cost as well as waiting times at the national borders a harmonized train control system applicable in the entire European rail network is urgently required. A further result of the research project therefore comprises the advisement to promote the implementation of ECTS (Zacharioudakis et al. 2011b).

3.3. Third step: ICT-selection for transport and supply chains

Within the third step of the research approach ICTs for supporting transport chains and the management of supply chains are filtered out of the collection initially compiled. This way, the ICT-selection, that so far is limited to logistics nodes and edges, is supplemented by ICTs with networking character.

Thereto the supply chains, whose transport chains lead through the pre-selected corridors, are firstly divided according to whether their transport objects represent part loads as bulk and raw materials or full loads as full ship, container, truck or train wagon loads. The reason for this differentiation is that the requirements and the potential in greening the corridors depends on the type of the objects being dispatched.

Usually supply chains for full loads already function effectively because of their simple, gradual transport stream and the low number of involved actors. In contrast, supply chains for part loads possess several stakeholders and therefore need an elaborate supply chain management. Moreover, they are characterized by branched transport routes and many additional operations at their interfaces such as goods handling, consolidation or client specific sorting. Hence, for those corridors that are embedded in supply chains for part loads, ICTs are identified which foster the exchange of information between the involved partners and cater for the planning and monitoring of the complex transport chains (Rönkkö & Salanne 2011).

For instance, the supply chains that use the above mentioned Two Seas corridor are classified as chains for part loads. The reason is that due to the geographic route of the corridor a great number of Greek enterprises take part in these supply chains. Since Greece belongs to the European countries with the highest density of small and medium-sized enterprises within the non-financial business economy (Schmiemann 2008), its imports and exports of most products are performed in small batches. The transport objects are thus mostly partial loads that are bundled by forwarders to generate full loading units. On this account, the research project SuperGreen brought the conclusion that the usage of ICTs such as the Logistics Platform AX4 within supply chains for part loads is commendable in order to set up a communication in which all engaged loading and forwarding companies are integrated.

Because of the grouping of partial to full loads and other services that might be rendered, interfaces exist between single shipment stages. As a further result of SuperGreen, a monitoring of the shipments regarding their transport status and condition during their whole way through the corridor is therefore advised. Deviations such as misloading are detected, so that corrective action can be taken immediately. Tracking and tracing systems like Agheera and Schenker Smartbox are considered as possible appropriate solutions (Zacharioudakis 2011b).

3.4. Fourth step: benchmarking of the corridors

Building on the findings obtained by the previous steps a benchmarking of the regarded corridors is carried out within the fourth step. The benchmarking serves for measuring and comparing the corridors' opportunities for ecological and economic improvement by the use of the afore-selected ICTs. This forms the basis for making a sound recommendation about which corridors shall undergo a sustainable configuration with priority.

According to current planning the benchmarking will revert to the key performance indicators (KPIs) rendered in table 1 (Palsson et al. 2010). On the one hand these KPIs have an ecological orientation in order to assess the ability of each corridor to increase its environmental performance. On the other hand these KPIs have an economic focus to evaluate in how far the costs of the corridor usage can be reduced. This way the opposite effects of ICT applications on ecology and economy within areas of conflict as well as mutual benefits within win-win-situations are considered.

Table 1. KPIs for benchmarking freight corridors

KPIs	Evaluation parameters	Orientation
Environmental sustainability	• Greenhouse gases • Polluters	Ecology
Cost efficiency of transport chains	• Absolute unit costs • Relative unit costs	Economy
Transport avoidance	Number of transports	Ecology & Economy
Loading factor incl. return cargoes	Capacity utilization	Ecology & Economy
Service quality	• Transport time • Reliability • ICT application • Frequency of service • Cargo security • Cargo safety	Ecology & Economy
Infrastructure sufficiency	• Congestion • Bottlenecks	Ecology & Economy

The research approach provides that in the first instance the afore-selected ICTs are evaluated by means of the mentioned KPIs. By interviewing several experts it will be analysed, whether the ICTs have a positive, neutral or negative impact on the KPIs and therefore on ecology and economy. This evaluation is carried out on a qualitative level.

For example, by reducing accidents and traffic delays driver assistant systems such as ISA make transports more secure and fluent. Hence, greenhouse gas emissions and other polluters are reckoned to be reduced by their usage. Moreover, they render transit times shorter and more predictable. Along with that an improvement of transport service quality may be anticipated. However, it cannot be assumed that applying these systems the number of transports will be lowered directly or that the rate of vehicle loading will be raised since these systems have no consolidating function.

Since it is known from the previous two steps which ICTs shall be employed within each axis, the entire corridors can subsequently be estimated by transmitting and aggregating the ICT-related key figure values. A comparison of the corridors will finally reveal which corridors are endued with the highest room for ecological and economic improvement. For these corridors a prioritized ICT equipment will be recommended in order to efficiently improve sustainability in the transport sector.

4. Conclusion

The paper on-hand presents a four-step-approach for evaluating the application of ICTs within European freight corridors.

The spectrum of ICTs which is compiled in the first step and allocated to the corridors within the second and third step ranges from transport mode-specific applications to cross-system logistics solutions. This allows testing all regarded corridors for ecological and economic improvement through ICT implementation despite their individual transport means, nodes and objects. This holistic consideration of freight corridors can be regarded as a strength of the approach. Moreover, the approach can correspondingly go beyond the underlying scope of analysis by being applicable to further European freight corridors not examined so far.

When benchmarking the corridors in reference to their potentials for improvement within the fourth step ecological as well as economic key figures are used. This way the approach is provided with the strengths to consider that beside their ecological influence the ICT applications can as well have an impact on the cost-effectiveness of the environmentally sensitive designed corridors and thereby promote the shift of traffic in their favor.

Further on, the direct comparison of the corridors results in a clear and transparent identification of those corridors whose technical modernization would bring about an increased sustainability and can be reached with relatively small effort in the same time. Thus, a further strength of the approach is that targeted recommendations can be put to the European Commission enabling to embark on a prioritized strategy of action by expediting the ICT equipment of the leading corridors.

In conclusion it can be noted that initial steps towards a sustainable European goods transport were already taken within the research project SuperGreen.

However, further efforts are necessary to complete the research work. This includes continuing the described approach in order to supplement the results available so far. Also after the project's life research work should be carried on by continuously actualizing the list of considered ICTs as well as by exploring their potential implementation. The ICTs covered to date match with the status quo of currently available systems as well as solutions disposable in the near future. This way a long-ranging relevance of the results is ensured. To also seize newly emerging opportunities innovative trends and market developments have to be observed and valuated.

In addition, the approach was only applied on pre-selected corridors. As a next step the procedure should be transferred to further European axes.

Last, the results have to be put into practice. Thereto the recommendations resulting out of the project should be considered within European policies and their implementation insistently pursued.

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