Matthias Gather (ed.)

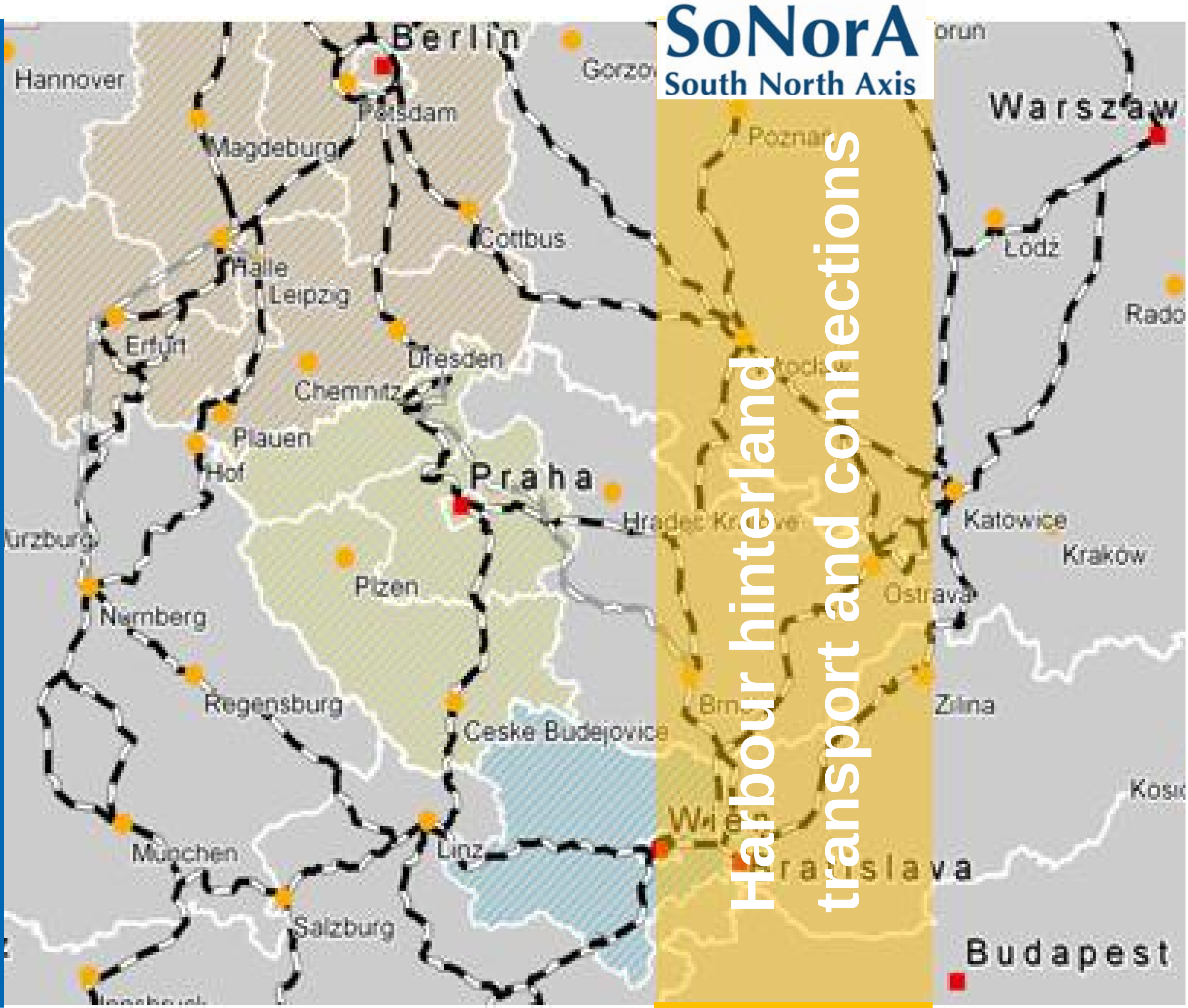
Attila Lüttmerding (ed.)

FACHHOCHSCHULE ERFURT UNIVERSITY OF APPLIED SCIENCES

INSTITUT VERKEHR UND RAUM der Fachhochschule Erfurt

SoNorA
South North Axis

Harbour hinterland transport and connections



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Harbour hinterland transport and connections

Proceedings of the 7th SoNorA University Think Tank Conference (Trieste)

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Editors: Matthias Gather
Attila Lüttmerding

17th of February 2011

Transport and Spatial Planning Institute (Institut Verkehr und Raum)
University of Applied Sciences Erfurt (Fachhochschule Erfurt)
Altonaer Straße 25
99085 Erfurt, Germany

phone: +49 / 361 / 6700 396
fax: +49 / 361 / 6700 757
email: matthias.gather@fh-erfurt.de, attila.luettmerding@fh-erfurt.de
internet: www.verkehr-und-raum.de

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Contents

INTRODUCTION

SoNorA (South-North Axis) is a transnational cooperation project of the European Union which aims to improve the infrastructure and services in the south-north orientation within Central Europe. An integral and important part of SoNorA is the University Think Tank as a network of transport scientist which has three main roles and tasks within the project:

Firstly, it aims on the creation and consolidation of a network of universities in Central Europe which are related to research and education in transport and/or spatial planning. These partners participate in SoNorA conferences, round-table discussions, the writing of scientific articles, and further research projects emerged out of SoNorA.

Closely related to point one, the second task of the Think Tank is to generate inputs for the whole project. The Think Tank gives methodological support to project partners and creates strategies and inputs for SoNorA. These scientific papers are presented on separate conferences during the regular SoNorA consortium meetings.

Thirdly, the Think Tank reviews the 24 core outputs of the project which are generated by the project partners. The core outputs will be presented to the Think Tank by the partners on the consortium meetings and then will undergo a scientific review process including ex-post-analysis and best-practice identification.

The Think Tank consists of transport researchers of different faculties and institutes of various Central European countries. It is planned to organise ten Think Tank conferences, thus one on each consortium meeting. Each conference deals with a specific topic of transport research which is related to the content of the core outputs to be delivered on that time. The topics of the past and future Think Tank conferences are the following:

No	Date	Place	Topic
1	Feb '09	Praha	Get to know
2	Jun '09	Gdynia	Transport infrastructure between the Adriatic and the Baltic Sea; Transeuropean Networks of Transport in Central Europe; Simulation and modelling, forecasting and infrastructure
3	Nov '09	Potsdam	TEN-T core network; European and national railway policies
4	Feb '10	Portorož	Infrastructure and regional development; Infrastructure, transport and trade; Infrastructure and society
5	Jun '10	Erfurt	Railway logistics and rail cargo
6	Oct '10	České Budějovice	Future of rail freight; Future of inland waterway freight
7	**Feb '11**	**Trieste**	**Harbour hinterland transports and connections**
8	Jun '11	Szczecin	Transport and the environment; Sustainable transport

9	Oct '11	Bologna	Preparation final conference
10	Feb '12	Venezia	Final conference

The last SoNorA University Think Tank conference was held on the 15th of October 2010 in České Budějovice (Czech Republic) and was focused on the topics: future of rail freight; future of inland waterway freight

The conference documented in this proceeding was held in Trieste, Italy, on the 17th of February 2011. The main focus of this 7th SoNorA University Think Tank conference was about:

- Harbour hinterland transports
- Harbour hinterland connections

Selected members of the Think Tank have written five scientific papers on different aspects of these topics which were presented at the conference in Trieste. The authors are from the Universitá degli Studi di Trieste, Municipality of Trieste and Complex Transportation Networks (Italy), as well as the Frauenhofer-Institut für Fabrikbetrieb und -automatisierung IFF (Germany), the Széchenyi István University Győr (Hungary) and the KTH Royal Institute of Technology (Sweden).

The papers are dealing with problems and prospects of the railway market for the gateway to the Northern Adriatic; introduce an intermodal transport routing information system and a methodology for estimation of port capacity as a function of road network constraints. Furthermore it is elaborated a port development model based on logistical resources while finally possibilities of improving the cubic capacity of international transportation by rail are discussed, especially in the Fran-Scan intermodal corridor.

This is the sixth volume of a series of “Proceedings of the SoNorA Think Tank Conferences” where all accepted contributions of the authors are presented. It shall provide a basis for further discussions and be the start of a successful scientific network in the field of transport and spatial planning.

THE RAILWAY MARKET FOR THE GATEWAY TO THE NORTHERN ADRIATIC: PROBLEMS AND PROSPECTS

Vittorio Torbianelli
Università degli Studi di Trieste
DICAR – Dipartimento di Ingegneria Civile e Architettura
Piazzale Europa, 1 – 34127 Trieste, Italia
vittoriot@econ.units.it

ABSTRACT

Recently, big port infrastructures investor attention has focused on the opportunities offered by the Gulf of Trieste as a European gate for container traffic, as is the case of the new container terminal planned in the Monfalcone area. In general terms, as the positive trend of Koper's port shows, this area seems to have great development potential, also in view of the Baltic- Adriatic corridor. However, the railway remains one of the key issues. Besides the fact that important railway infrastructures have to be completed, a fundamental issue is the organization of the freight railway supply, both in terms of "traction" operators and operators that provide a full service to port customers. This paper describes the present scenario and provides a critical analysis of the state of the art of the freight railway market organization in the various countries of the northern Adriatic Area (primarily Italy and Slovenia). It also discusses the degree of the market liberalisation and competition, the role of public institutions and the strengths and weaknesses of the system, also in terms of market regulation. Moreover, in view of the new port investments and of the future scenario, this article proposes some considerations on the potential development of an efficient and competitive railway market organization in this area. The main problems and limitations that could arise are identified and viable solutions are explored.

1 INTRODUCTION: THE ORGANISATION OF THE RAILWAY MARKET, FROM EUROPEAN LIBERALISATION TO REGIONALISATION

1.1 Issues and general aims

The Northern Adriatic port range, and in particular the Gulf of Trieste, has been subject to recent attention in terms of container facilities development.

Apart from the continuous rise of container traffic at the port of Koper, the Friuli Venezia Giulia region has also been the focus of attention of an important investor in partnership with a leading global stevedoring company (Unicerdit Group/APM). The development plan, officially presented recently is the creation of a 2.5 million TEU container terminal at Monfalcone and the enlargement of the existing container terminal at Trieste [6].

Attention for the Northern Adriatic gate, which is a fundamental part of the SONORA region, was also shown in another large-scale project in the Venice Area ("Master Plan for the development of the Venetian port at Marghera").

In light of this, it is important to analyse the railway situation in that area. Besides the fact that important railway infrastructures have to be completed, a fundamental and often neglected issue is the organization of the freight railway supply for the intermodal port flows, both in terms of "traction" operators ("railway enterprise") and other logistics operators that "commercialize" the block train, providing a full service to port customers.

The aim of this paper is twofold: a) describing the current state of organisation of the railway market as far as it regards the “Northern Adriatic Port Gateway”, with particular reference to the case of the “Friuli Venezia Giulia” case-study; b) providing some considerations on possible future solutions aimed at support public authorities involved in the business, to best support the development of the port region.

The basic question is the following one: what are the market-organisation induced constraints which could hinder the development of efficient and suitable services for the clients? The existence of some problems (public monopolies, inefficient duplication of services, railway public local policy not fully market-oriented, etc.) clearly appears.

Some basic solutions are proposed. In particular, a railway “local” public policy is suggested which has greater emphasis on the real market requirements and not based on the abstract idea of “public support” via creation of a “do-all” regional cargo railway company.

1.2 The European trends: “partnership” and “regionalization”

Analysis of the current and future state of organisation of the cargo-railway supply in the Northern Adriatic area cannot come before a brief overview from a wider European perspective. The European organisational framework of the railway cargo sector has been studied by several researchers who, since the 1990s, have put in evidence the changes (and the coming out of many “new entrants”) induced by the liberalisation process. In Italy the situation was still static in 2001 even if the signs of development were already evident even if compared to far more developed situations in other European countries [1].

As for intermodal container transport for ports, Gouvernal and Daydou, already in 2003 noted the liberalisation process, started with Directive 91/440, would have favoured, in Europe, a new and varied offer of “railway providers”, for the most part organised according to the “partnership between companies” model [3]. This research also recognised the main forms of partnership, which hold together both the railway enterprises – these are often, but not always, state-owned railway enterprises (“incumbent”) - and also the railway operators (responsible for commercialization and marketing). Often in these partnerships there is also the “final user” (logistics operators, terminal operators, etc.).

Partnerships demonstrate varied levels of integration between partners: from “organizational hierarchy” between railway enterprise and logistics railway operator, to subsidiary, joint venture, share holding until relationships with no form of hierarchy whatsoever (simple contracts). Parallel to the issue of partnership another issue arises form other research on cargo railway market organisation: liberalisation has often allowed “regionalisation” of the cargo railway services production. The German case, after privatisation of DB (1994) and the managerial separation between infrastructure and services, is significant [4] also by an another point of view: it shows that many cargo railway companies are controlled by Regional Administrations (“Länder”) . It also demonstrates how the coming out of “new entrants” occurred also thanks to local public capital; but often the mix of capital also saw the participation of the former “incumbent” (DB, in the case), joined to the private, as fig. 1 illustrates, with a sample of German railway companies [5]. The development of cargo railway services linked to regional authorities is an important issue, also in other countries like France [2].

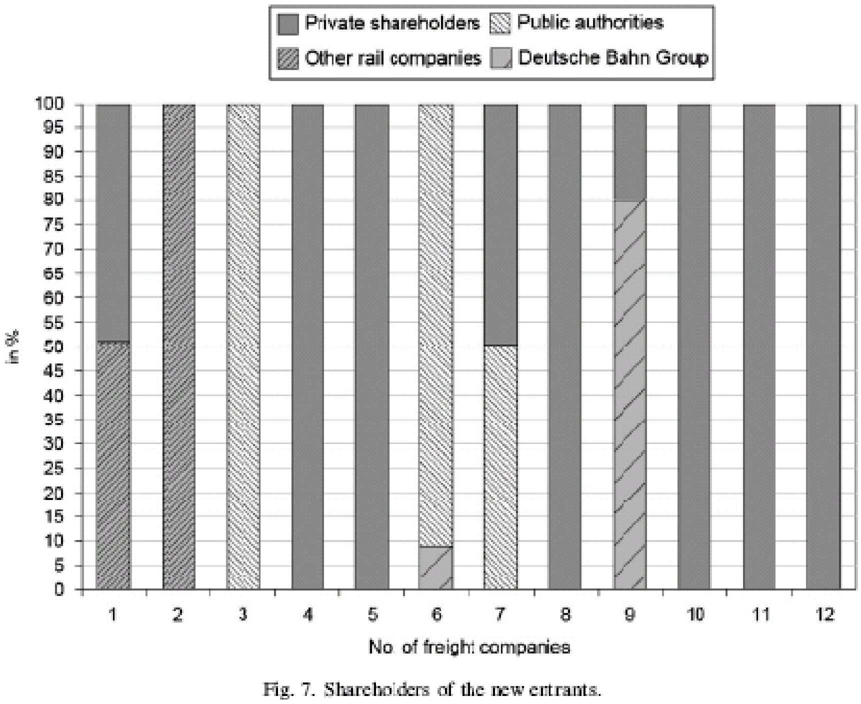

Figure 1: Shareholders of railways new entrants (Germany) [5].

Analysing the partnership models, the nature of the actors, as well as the role of the local authorities ("Regions", e.g.) is a useful tool to understand the railway market organisation relevant to the Northern Adriatic port region.

2 THE NORTHERN ADRIATIC PORT REGION: THE CURRENT RAILWAY SUPPLY

2.1 The current northern Adriatic railway market structure: the "Friuli Venezia Giulia" case study

Overall the current situation of international traffic of railway market the northern Adriatic port region can be described as follows. With reference to Slovenia and Koper, the sole Slovene port, the state-owned Slovenian railway enterprise has an important role, although there is the co-presence of other companies active on various intermodal services; for example, the cargo company of Austrian Railways (RCA) - an internationalization-oriented company playing a market leader role in central Europe - that operates in Koper with a company created for the Slovenian market, offering both "traction" and also selling, independently or in partnership, the "complete train" logistics. The formula shows the specialised cargo companies coming from the old national railways can free themselves of all constraints, acting in a highly flexible way on the international market. Moreover, there are, in Slovenia, various operators who offer rail logistics, linked both to the long-established world of the "Multimodal Transport Operators" (ICF, "Adriakombi", etc.).

Friuli Venezia Giulia, the Italian region which the port of Trieste is sited in, has a distinctive problem: the short distance between the ports and the state border with the consequential presence of close railway borders. This spatial proximity of the railway borders induces economic inconveniences (as well as technical and legal) in terms of an "efficient continuity" of railway services. For example, Friuli Venezia Giulia borders the Austrian network (about 120 km. from the ports) and the Slovenian network (around 20 km. distance).

For the Italy-Slovenia interface the relative state owned railway companies have been ready for years to manage a multi-current locomotive park. But the situation is still not resolved due to technical safety reasons (said to be in the process of being resolved) and there is not the possibility to freely use the locomotives on the relative networks. One further issue is that the Slovenian state-owned railway company is not registered in Italy as a railway enterprise. Currently, due to lack of a comprehensive agreement, the reciprocal relationship regarding the use of networks between Italy and Slovenia is found in specific agreements that allows locomotives of each company to reach specific points on the others' network, always close to the boarder; e.g. Slovenian locomotives can reach the station of Villa Opicina but currently cannot reach the Fernetti railway platform situated a couple of kilometres away, nor the port of Trieste. Regarding railway enterprises, in Friuli Venezia Giulia the Italian state-owned railway enterprise (Trenitalia) dominates the haulage market, even if in some segments there are private operators.

For intermodal traffic (container and combined transport) the role of multimodal transport operator is mainly played by a company ("Alpe Adria" S.p.A.) which is a provider of "logistic and intermodal services", whose shareholders are Friulia S.p.A., Trieste Port Authority and "Trenitalia" S.p.A. As the Alpe Adria mission states, "the company intends to develop any service connected to the transport of goods from, to and through Friuli Venezia Giulia Region. Its operations integrate the needs of the carriers with the requirements of the market". The fundamental role played by "Alpe Adria" in the intermodal market segment, does not mean that there are not other providers. Just for example, a logistics provider recently started a new intermodal service to Russia and further to China via Siberia through the "Fernetti Intermodal Terminal". "Alpe Adria" S.p.A. runs services which are, in fact, supported with public capital. This allows it to keep tariffs competitive. "Alpe Adria" has used, via agreements, the traction provided by the state-owned rail enterprises ("Trenitalia") which holds a third of the "Alpe Adria" capital.

2.2 The Friuli Venezia Giulia cargo railway policy: an insufficient incentive to competition?

Cargo railway policy in Friuli Venezia Giulia has been based until now on a double-tool subsidy policy:

a) direct subsidy (allowed by the EU), aimed at reducing negative environmental externalities, provided to the operators that use the railway system for intermodal transport;

b) Participation in capital (e.g. "Alpe Adria" S.p.A.)

Participation in capital poses some issues. As declared by various private stakeholders, the tariffs offered to "Alpe Adria" by "Trenitalia" (based on the industrial cost), are placed at a level markedly higher than a standard "European efficient level". Certainly, with public subsidies, the final price can be kept low, but maybe not at the highest levels of efficiency which could be achieved if with a competing company had easy access to the network.

Some operators1 speak of a 20% increase in prices in respect to comparable offers by private potential competitors.

It is true that the “Trenitalia” pricing includes the utilization of the wagons; however, the gap, according to the operators, remains significant. The situation described by the potential competitors is that of a double barrier for the competition:

a) the difficulty in establishing an operational base in the main networks nodes, where locomotives are abutted (and the staff resources localized);

b) the freedom to contract without undergoing “veiled” anti-competition actions, in particular with reference to the use of the railway cargo terminals and marshalling yards.

This latter point would be specifically due to the still close relationship between the state-owned railway infrastructure manager (which also runs the shunting works both in yards and railway terminals) with results clients define often as non-satisfactory.

In particular, regarding the “shunting” issue near and inside the ports, the Italian situation is in general problematic, being the available supply mainly based on two “linked” monopolies: the infrastructure manager (RFI) that holds the exclusive rights to provide the manoeuvres in the port marshalling yards; and the monopoly of the railway company linked to the port authorities (this is the case of Trieste) which runs shunting services in the port and “on the berths”. The system forces a break-up of the manoeuvre service into two, which is judged by many as inefficient at least economically. Recent official data gathered for the case in Trieste, attributes to the manoeuvre in the port and in the terminal a 10% higher cost than a train going to Germany.

2.3 Development prospects for an efficient regional railway policy. Which solutions?

Turning back to the “Alpe Adria” case, public support for the company has recently shown signs of crisis.

On one hand, the company has had difficulty in defining an autonomous, powerful sales strategy to foreign clients: this is probably due to the “public capital” basis of the company and the participation in the capital both of the port and the national railway (each autonomously active in promoting respectively the port and other railway services). This situation, probably, does not stimulate sufficiently the company to strengthen its commercial autonomy with for example investments in highly experienced human resources. Here there is also the linked problem of who are the subjects, and with what tasks, that should be realized within the entire promotion and marketing policy of the “Ports of Friuli Venezia Giulia system”, so as to avoid the risk of “gaps” and weakness on the one hand or useless over-lapping and contradiction on the other.

On the other hand, another issue which intensifies criticism, is the recent change in direction by the Friuli Venezia Giulia regional authority, who have been directly involved in the support of the company for a long time. This regional authority has recently undertaken an autonomous policy towards the creation of a regional railway enterprise active in both the passenger and cargo sectors, completely new and independent.

The prospect of a progressive distancing between the regional authority and the logistics rail provider “Alpe Adria” has caused problems of the continuity of public financing for “Alpe Adria”; made worse by the general lack of resources, which has brought uncertainty

[1] The information is referred to a survey informally carried on by the author (during 2010) among a panel of managers of different rail/logistics service providers interested (or involved) in the Friuli Venezia Giulia logistics market.

in fixing tariffs in advance, with serious repercussions on its ability to satisfy the market requirements. Table 2 summarises the analysis made above.

Activity/network	Railway Enterprises (R.E.)	Form of the market/access to the network/entry barriers	Partnership
From the port boundaries to the state border	• Main provider: state owned railway enterprise (incumbent) • Other private R.E. (not relevant) *** • R.E. controlled by the Regional Authority? (planned)	• Competition (formal) - with difficulties for the new entrants to get operational platforms *** • Subsidized regional company	Among public stakeholder. Multimodal Transport Operator controlled by public entities (Port Authority/State owned R.E./Regional Authority).
Shunting at the port stations/port marshalling yards	State-owned infrastructure manager (on exclusive concession by the State – owned R.E.)	Monopoly	No partnership
Shunting at the port area and port terminals	Operator controlled by the port authority	Monopoly	No partnership

Table 1: Regione Friuli Venezia Giulia (Port of Trieste) – The existing organization of the railway market relevant for the international intermodal traffic

2.4 A regional cargo railway: where to concentrate resources?

The Friuli Venezia Giulia case-study of a planned “regional (cargo) railway company” merits a brief description, also as it shows some potentially critical aspects on the role of local public powers in the railway sector.

The route to building a regional railway enterprise integrated with a logistics service provider starts with the willingness to develop a newly founded company, bringing together resources from two already existent companies: a) a small passenger railway active at a regional level, b) two small private “cargo” industrial railway operators previously involved (one in haulage and one in marketing) in the specific market segments of interest of a few industrial companies located in the Friuli region.

It is also stressed, by some critics, that the management involved in the construction of the new regional railway enterprise come in part from the abovementioned companies, giving rise - among potential customers and competitors - to questions of “neutrality” of the new company and thus the propensity to develop traffic linked to other markets, for example those of the ports.

Some also highlight that this new regional railway enterprise, supported by the public sector, would not have enough strength to be an autonomous supplier of railway “traction” on the international lines (although some locomotives were recently bought) and its background lacked experience and high skilled internal resources for the marketing of railway services specific to international port clients.

Regarding the minimum efficiency dimension, some have asked if it could be resolved through the construction of a large company, incorporating at least the Veneto area, who has also considered a regional goods policy based on the services offered by its own company ("Territorial Systems").

In the future it is imaginable that the optimal role of the regional cargo railway company could be to offer specific services limited to very specific segments of the regional network, leaving the commercial aspects to highly specialised operators.

The first target that could be of common public interest refers to the "shunting" activities: the regional company could assume the role of supplier of the railway manoeuvre both in the marshalling yards near the ports and in the port terminals. It is clear that the elimination of these monopolies and the possibility of working at least with one supplier in some way linked to the public system (for example the regional company) could represent an improvement.

Only if convenient, the regional railway enterprise could also offer the "traction" supply from the port to the regional borders, to better integrate the services, acting in that case as a private operator. However, at the same time – and that is really relevant - the regional authority should strongly support, by a political point of view, the development of "competition" and "free access" on the regional railway network, leaving the railway market the freedom of choice of the carriers on the lines outside the ports and above all the competition on the commercial market of the sale of trains to guarantee the maximum neutrality.

Another sector which could be very functional for a direct involvement of a regional railway company under public control is the supply of railway equipment (wagons, etc) to the other (private) rail logistics providers offering trains to carry cargo flows from and to the regional area.

It seems useful to ask, in a nutshell, if the model of the "small" and "do-all" (haulage, marketing, goods, passengers) regional railway company would have, in the long term, positive effects in the Friuli Venezia Giulia port context.

3 CONCLUSIONS

The main problems which could affect the development of an efficient cargo railway market organization for the Northern Adriatic gate ports in the Friuli Venezia Giulia regions are described as follows. Public policies at local level, based for a long time on a partnership with the "incumbent" national railway enterprise, have created some non-positive side-effects in terms of incentives and entry-barriers to the market. The "subsidised" traffic economy has also favoured the surviving of monopolies and duplications in the shunting segment.

Secondly, the transition from the "partnership model" to a (planned) direct entrance of the regional administration into the railway sector trough a small regional railway enterprise seems to be a solution more orientated to an aim of visibility rather than substantially promote competitive international rail services for the port sector. It seems useful to suggest that the Friuli Venezia Giulia region a) follows a regulation approach (trough grants, e.g.) to support new investment programmes carried on by professional railway companies based on competitive business plans; b) politically promotes its role of (co)responsible body for the railway infrastructure of regional interest thus promoting the use of the network and the related facilities by competitive "new entrants"; c) promotes the regional railway enterprise only as a supplier of very specific services (shunting activities, equipment).

The choices recently discussed for the port of Koper, where it is being assessed (in face of various criticism) to create a vertically integrated company between Luka Koper, Deutsche Bahn and the leading public owned forwarder of Koper, so as to favour the entrance (certainly well protected from a competition point of view) of a railway super-operator with great European strength, makes the non-specialised regional railway micro-company seem like an operation without much range.

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IMOTRIS - INTERMODAL TRANSPORT ROUTING INFORMATION SYSTEM

Olaf Poenicke
Fraunhofer Institute for Factory Operation and Automation IFF
Material Handling Systems Expert Group
Sandtorstr. 22, 39108 Magdeburg, Germany
olaf.poenicke@iff.fraunhofer.de

Nataliya Korzhynska
Scheller Systemtechnik GmbH
Devision Port Logistics
Poeler Str. 85a, 23970 Wismar, Germany
n.korzhynska@scheller.de

ABSTRACT

The Web based “Intermodal Transport Routing and Information System” IMOTRIS is being developed in a joint project supported by the Federal Ministry of Economics and Technology. IMOTRIS is intended to calculate optimal transport routes for freight in terms of service providers’ availability and capacity, transit times and ecological factors. For service providers, IMOTRIS will function as a sales and marketing platform. For shipping customers, the platform will systematically provide contacts to service providers who meet their requirements.

1 INTRODUCTION

International competition is continually confronting ports, shipping companies, freight forwarders and similar logistics providers with new challenges. Customers expect shipping to cost less and less and goods in transit to reach their destinations faster and faster. Among other things, this necessitates rapid and efficient loading of freight at the nodes between carriers. In many cases, logistics providers are unable to receive information automatically from partners in the transport chain, e.g. on the scheduled availability of ocean and hinterland carriers, to plan their own logistics operations. In addition, the exchange of information is often uncoordinated and typified by numerous format changes among different IT systems and communication channels such as telephone, fax and email. This limits the capability to rapidly and efficiently respond to new inquiries, requirements and events.

The objective of the joint project IMOTRIS is to prototype an automated intermodal transport routing information system, specifically for north-south shipments through German Baltic Sea ports. Several German Baltic Sea ports and pertinent hinterland carriers are directly involved in the project as field partners. The actual IMOTRIS platform is being developed by four development partners. One of them, the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg is in charge of the development and integration of real-time functions.

Assessing capacity, availability, speed, price, handling know-how and ecological factors, IMOTRIS will automatically calculate and output optimal transport routes for types of shipments and freight. It will also factor in value adding logistics services, e.g. temporary storage and distribution or complete providers’ coordination of complete transport chains.

2 IMOTRIS PLATFORM TARGET GROUPS

For contractors, IMOTRIS will function as a sales and marketing platform as well as a central interface for additional functions, including the planning and monitoring of freight capacities by localization and identification technologies and potential additional services that employ technologies to track shipments and monitor condition. For customers, IMOTRIS will function as a Web platform for the standardized submission of shipping requests and requirements in response to which the system delivers information on logistics providers and their transportation and handling resources. The system automatically issues routing proposals and matches potential routes to the relevant service providers. The transport routes may also be intermodal transport chains with several service providers. Customers select from the routes and service providers displayed by IMOTRIS and directly enter into negotiation with the appropriate service providers.

The IMOTRIS platform is intended to cater to small and medium-sized enterprises (SMEs) that register with IMOTRIS in order to boost the impact of their marketing and enhance or more effectively present their service portfolio. Since major logistics providers have access to global networks of contacts, they are not a primary target group. Nevertheless, registration and use of the systems will be open to any service provider.

3 HOW THE IMOTRIS SYSTEM WORKS

The complicated information systems used by individual transport providers in transport chains to manage their orders are not interconnected. IMOTRIS marks the development of a central automated intermodal transport routing information system that facilitates efficient interaction in intermodal transport chains for the purpose of aggregating flexible services. The system provides service functions that optimize planning and operational procedures for the members of transport chains as well as routing, information and booking services for shippers, agents and internationally operating transport providers as customers.

The IMOTRIS platform is aimed at optimizing and more clearly organizing intermodal transport chains by integrating the individual transport and handling providers involved. IMOTRIS consolidates market supply and demand. In the project phase, it is specifically geared toward ports and their hinterland connections. The IMOTRIS approach is chiefly based on its impact as the nexus between shippers and logistics providers (see Fig. 1).

Potential customers of logistics services use standardized input forms on the IMOTRIS platform to enter their transport requests and requirements. Based on the stored starts and destinations, the system thereupon identifies pertinent transport routes as well as the logistics providers available along the routes. Then, the shipper is free to configure a desired transport chain from the service providers displayed. From the shipper’s request, the system accordingly generates partial requests for each of the logistics providers involved, whereupon they enter direct negotiations with the shipper. The IMOTRIS platform is consciously not intended to serve the conclusion of contracts among the individual parties.

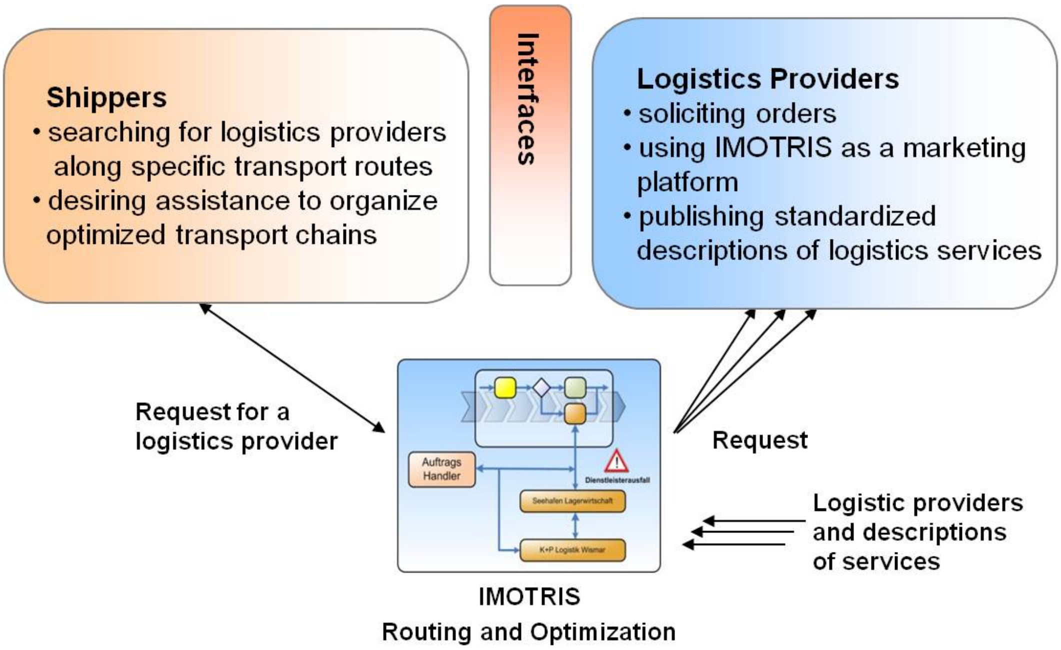

Figure 1: The IMOTRIS interface between customers and contractors

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The aforementioned functionalities were implemented by defining seven priority areas in order to develop innovative solutions for a standardized presentation of logistics services, the configuration of transport chains with different service providers and ad hoc co-loading of freight. The objectives of the IMOTRIS project include:

- a standardized presentation of logistics services,
- qualitative evaluations of logistics services,
- the configuration of transport chains with different service providers,
- performance-driven intermodal routing of specific freight,
- the identification of logistics providers along potential transport routes,
- functionalities for ad hoc co-loading of freight and
- ranking of submitted requests based on different criteria.

IMOTRIS standardizes the presentation and description of logistics services, thus rendering providers' definitions of their own services systematic, comparable and more transparent. Intermodally routing specific freight based on performance and displaying (alternative) transport routes as well as relevant service providers along the route, IMOTRIS functions as the nexus between shippers and service providers. The IMOTRIS project is developing functionalities for data evaluation, data analysis and the generation of new knowledge from the existing data.

Based on the different user viewpoints (contractors/service providers and customers/shippers), the IMOTRIS platform is subdivided into a service registration function and a service request function, described in more detail below.

3.1 Service Registration Function

The service registration function enables logistics providers to place their service portfolio on the IMOTRIS platform. They register their complete profile of services following certain standards (described in section 3.3). Registration is organized on several levels, from required basic information to company type and main services up through more precise specifications, e.g. specialization in particular types of freight. More detailed queries are based on the entered company type (e.g. port or road carrier). Basically, service providers are free to specify the information included in their profiles.

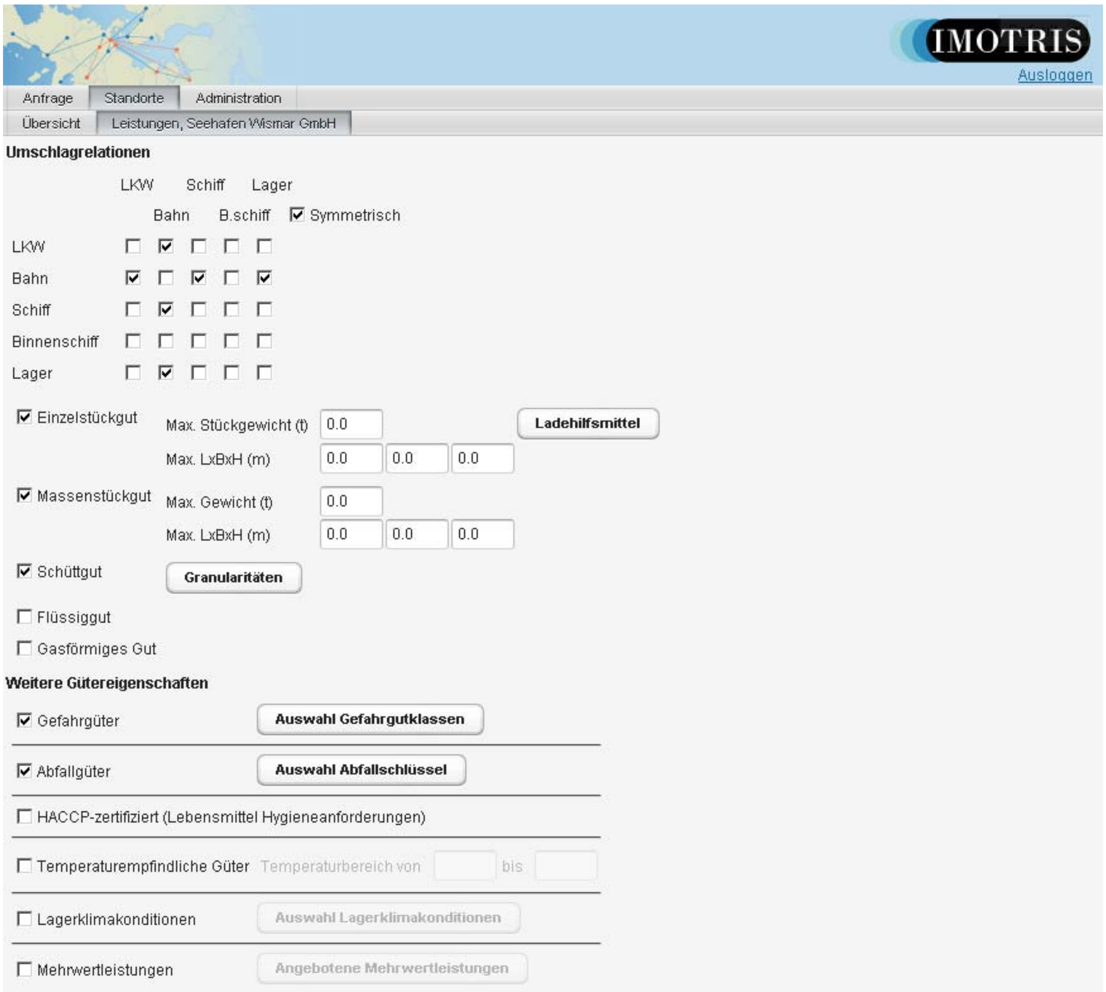

Figure 2: Specific company type sub-form

Logistics companies' registration of their capabilities entails specifying site information, transport, handling and warehousing services based on the type of freight and the attendant characteristics, e.g. temperature, hazard classes and waste disposal codes. Furthermore, transport providers register their areas of operation. They may further detail their services with the aid of a quantity structure (including maximum unit weight, dimensions, etc.) in order to enhance the quality of the information (of a bid). In addition, a company may list its value added services (e.g. packing, order picking, quality inspection, etc.) to fully present its service portfolio.

The service registration function serves as the basis for the compilation of a comprehensive catalog of service providers based on which proposals for optimal routes and service providers are issued in response to transport requests. The service provider data and catalogs on types of freight and services are managed in the IMOTRIS system by ontologies (cf. [1]).

3.2 Service Request Function

The service request function is the nexus between shippers and service providers. On the basis of the transport requirements shippers submit in the standardized form on the platform, IMOTRIS issues performance-driven intermodal routing of specific freight that displays (alternative) transport routes. The individual routes are matched to relevant service providers on the route. Displayed service providers are ranked according to criteria from the service catalog, their proximity to transport routing points and their specialization in the types of freight to be transported.

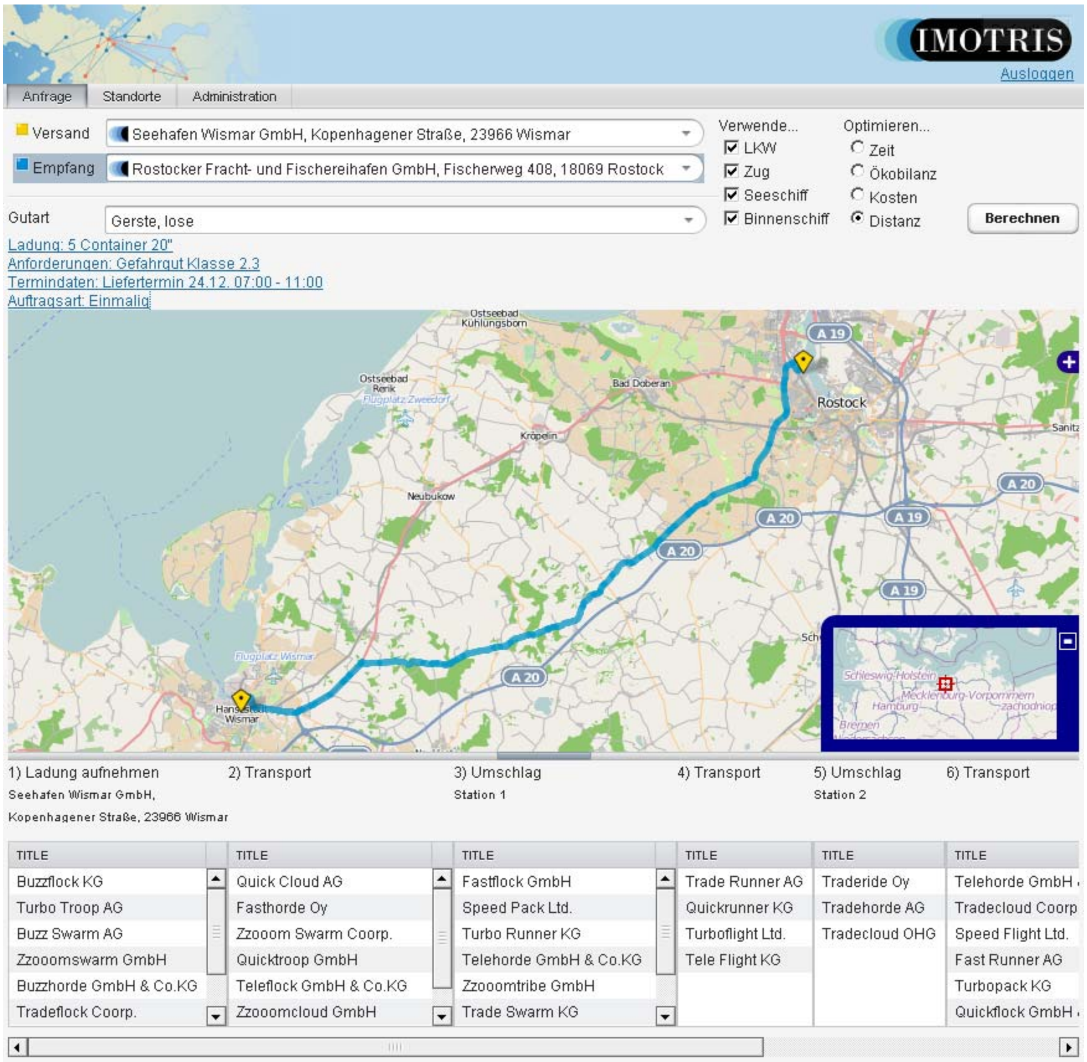

Figure 3: Result form with an intermodal transport chain

The service request function and the shipper's selection of service providers generate an extremely detailed catalog of requirements for the requested logistics services. This optimizes communication between the shipper and any potential service providers. At the shipper's request, the system automatically issues requests for quotes and forwards them to the selected contractors through standardized interfaces. Moreover, the individual requests along with the data on service providers selected may be stored in the system in order to use this order data for other IMOTRIS functions, e.g. condition monitoring, once the contracts have been concluded between shippers and service providers.

3.3 Standardized Performance Specifications

IMOTRIS employs standardized, cross-carrier performance specifications to meet the requirements of intermodal transport chains. The IMOTRIS solution was developed in the field in collaboration with logistics providers. IMOTRIS draws upon the German Institute for Standardization's current DIN SPEC 1001 (Warehousing and transport logistics - Standardized performance description and assessment in the tender phase), which contains a framework for standardized performance specifications in the transportation industry. In the IMOTRIS project, it will be supplemented with specific port services and thus provide standardized forms of performance specifications for all service providers – an undertaking the DIN SPEC 1001 project group (DIN, FIR Aachen, field partners) is following with great interest. Rooted in research, the approach to consolidated services is based on the aggregation of the services offered by field partners (n= 132) and the service structure covered by DIN SPEC1001, i.e. primary services such as transport and handling as well as specific value added services such as customs clearance and shipment monitoring. This enables service providers to enter an extremely precise profile on the IMOTRIS platform.

Logistics companies' registration of their capabilities entails defining site information, transport, handling and warehousing services based on the type of freight and the attendant characteristics, e.g. temperature, hazard classes and waste disposal codes. They may further detail their services with the aid of a quantity structure (including maximum unit weight, dimensions, etc.) in order to enhance the quality of the information. They may additionally specify value added services and information on the certification and standardization of their services. In addition to DIN SPEC 1001, other classifications and legal and technical specification are drawn upon, including:

- the freight classification directory issued by the Waterways and Shipping Administration West within the Federal Ministry of Transport Building and Urban Development,
- the internationally applicable freight classification directory issued by the Federal statistical Office,
- the International Maritime Dangerous Goods Code IMDG,
- DIN 10508 "Temperature requirements for foodstuffs" and
- ISO 6322-3 "Storage of cereals and pulses".

The formalized structure of the performance specifications establishes a common understanding of logistics services and operations among logistics providers and their customers. An effective grasp of contractually specified service offerings is conducive to productive and reliable collaboration since, along with the financial bottom line, trust is one of the crucial bases of business decisions.

3.4 Real-time Functionalities

In response to the ongoing development and increasing use of telematic systems in the logistics industry, additional services that process real-time information from transport providers are being integrated in the IMOTRIS platform, namely the two subfunctions of ad hoc logistics and condition and shipment monitoring. The ad hoc service reports the current locations of vehicles as well as their cargo capacity to the IMOTRIS platform. This enables transport providers to capitalize on free shipping capacities in already “rolling” transport ad hoc. The IMOTRIS system explicitly displays nearby requests for the transportation of shipments that fit in the free cargo capacities as potential ad hoc services. Service providers boost their vehicle utilization and can pass a part of their cost benefits along to their customers.

In addition, small and medium-sized carriers can especially use the IMOTRIS platform to track and monitor the condition of shipments. The sensor system used by the service providers transmits data on location and shipment conditions (e.g. temperature) to the IMOTRIS platform where it is centrally displayed in a georeferenced representation geared toward users.

4 DEVELOPMENT OF REAL-TIME FUNCTIONALITIES

The integration of functions based on real-time information in the IMOTRIS platform is chiefly motivated by the mounting use of telematic systems and resultant abundance of available data on shipment location and condition. While major logistics companies have their own system architectures, especially in the integrator domain, which enable them to employ their resources optimally (e.g. the SmartTruck research project in the Federal Ministry of Economics and Technology’s Intelligent Logistics in Freight and Commercial Transport program), no platforms exist, which enable small and medium-sized logistics companies to capitalize on their real-time information as value added service for their customers. Therefore, functions that track shipments and use ad hoc logistics to plan resources based on free cargo capacities are being integrated in the IMOTRIS platform as well (cf. [3]).

Two demonstration scenarios that reference real-time information are being implemented in the IMOTRIS project. The first scenario obtains information on a transport vehicle’s loaded state automatically by means of an ultrasonic sensor system and transmits it together with positioning data to the system. This information serves as the basis for the generation of an ad hoc order when service is requested.

In the second scenario, shipment tracking, once its transportation has been contracted, a shipment is tracked by positioning components and monitored with sensor systems (in this case, temperature sensors that monitor refrigerated shipments). The IMOTRIS platform visualizes the data for various user viewpoints. Incoming information on transportation resources is stored and processed by the Fraunhofer IFF’s positioning, which edits and issues the data when requested by the IMOTRIS platform.

The implemented scenarios demonstrate the IMOTRIS platform’s capability to integrate increasingly abundant real-time information. In principle, the integration of real-time data functions is open-ended. The system's architecture also facilitates the use of telematic modules, which are intermodally transported with freight cross-company. A commercial application will connect external service providers' telematic units and related external databases to the operative IMOTRIS platform. Thus, IMOTRIS will function as an integrative platform for the growing market for telematic services, which simultaneously augments telematic information with order data. Future refinements might conceivably allow an evaluation of the logistics services on the platform once shipments have been delivered.

5 CONCLUSION AND OUTLOOK

A running demonstrator system with which field tests will have been completed will be available for the German market by the time the IMOTRIS project concludes in the fourth quarter of 2011. This system is superior to established transportation exchanges because it allows logistics providers to enter their complete service portfolio in a standardized service description and shippers to contact the appropriate service providers for their specific shipping requirements. The system also boosts smaller service providers' visibility. Moreover, its integrated optimization algorithms generate ecologically and economically efficient transport chains.

The challenge at the onset of the system's launch will be to recruit enough transport providers to register for the service so that intermodal transport chains can be generated in the most extensive target areas possible. Initially, the involvement of the Baltic Sea region and its hinterland connections with Central and South (Eastern) Europe will be the priority. Once the platform is fully in use, it will be subsequently modified for other target markets (by adding versions in other languages, e.g. English and Russian, as well as additional market regulations) since logistics providers of differing nationalities are the mainstay of international transport chains. Future development of IMOTRIS holds significant potential for integrating internationally fragmented logistics operations as well.

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A METHODOLOGY TO ESTIMATE PORT CAPACITY AS A FUNCTION OF ROAD NETWORK CONSTRAINTS

Giulio Bernetti, Ph.D.
Municipality of Trieste | Mobility and Traffic Department Director
Passo Costanzi 2, 34100, Trieste, Italy
bernettig@comune.trieste.it

Fabio Lamanna, Ph.D.
timenetwork.org | Complex Transportation Networks
Scala Santa 49, 34135, Trieste, Italy
fabio@timenetwork.org

ABSTRACT

This paper provides a methodology to estimate port capacity taking into account several road network constraints, such as highway and junctions capacity. The methodology has been tested on a real case scenario of two port terminals (Trieste and Monfalcone, Italy), measuring their mutual interactions on traffic flows predicting the maximum amount of TEU that they could be able to produce in a year. The approach on the analysis takes into account the evaluation of the capacity of the existing roads interested both by daily urban traffic and by growing TEU heavy vehicles to and from the terminal facilities. Capacity analyses have been focused on the highway connecting Trieste and Monfalcone, measuring the Volume/Capacity ratio on critical sections under a fixed planned Level of Service (D). This value has been chosen to avoid the saturation of the highway in presence of the upper amount of the forecasted heavy vehicles. Road capacity analyses have been conducted on several scenarios to take into account mainly two factors related to traffic demand: the growing traffic flows over the years both of urban and port vehicles and different modal splits between rail and road infrastructures. This methodology can help in predicting actual and future requirements on the infrastructure and port facilities to provide a desired Level of Service under a fixed TEU/year capacity constraint.

1 INTRODUCTION

Port capacity has always been a fundamental topic to be investigated, because of its role in satisfying growing trades and freight services all around the world. At the same time, port development must be evaluated taking into consideration capacity of hinterland infrastructures and connections [1]. Requirements of roads and junctions linking port facilities to the inland network must be evaluated taking into account growing trades and traffic in terms of an increasing number of heavy vehicles circulating. Moreover, before planning any kind of port development [2], the current and the remaining amount of capacity of the infrastructures have to be known in order to guarantee a desired Level of Service (and to avoid saturation) on roads in function of a specific amount of TEU/year generated and attracted by port facilities.

This paper introduces a methodology to evaluate the maximum capacity (TEU/year) of a port as a function of roads constraints, mainly based on Highway Capacity Manual procedures to estimate capacity of highways and ramp-highway junctions. This methodology has been applied on several scenarios on a real test case area in Italy, each concerning growing road traffic in years and different traffic conditions. Results aid urban and port planners in estimating how much freight traffic can be sustained by the existing infrastructure and by its possible improvements.

2 METHODOLOGY

The study of port capacity first needs an estimation of road traffic flows in the area, in particular related with different hypotheses of traffic conditions. In particular it is possible to analyse three traffic situations:

1. passenger cars and heavy vehicles;
2. port traffic and urban traffic;
3. current and forecasted traffic.

Assumptions on traffic conditions are crucial in order to get a correct analysis.

Therefore the methodology requires a proper analysis of road accessibility and an accurate estimation of road capacity, with particular attention on the weakest elements of the network, such as junctions and merging areas.

This study refers to the HCM (Highway Capacity Manual) [3] in order to identify main features of the surface transportation system: it provides a systematic and consistent basis for assessing the capacity and level of service for highways and ramps.

Because most operational problems occur at ramp terminals, analysis has been focused on merging areas, where mutual interactions between different vehicle flows heavily affect system capacity.

2.1 Flow assumptions

Some hypotheses about traffic flows need to be assumed in order to assure more reliable results for this study. Assumptions mainly take into account: TEU/vehicle ratio, Annual Average Daily Traffic (AADT), peak hour traffic, loaded and unloaded vehicles, directional distribution characteristics, vehicle types, urban traffic, traffic forecast.

TEU/vehicle ratio

The twenty-foot equivalent unit (TEU) is a unit of cargo capacity often used to describe the capacity of container ships and container terminals. For the purpose of this study it is necessary to convert TEU in an equivalent number of heavy vehicles. Heavy vehicles are expected to carry a certain amount of TEU as a function of load capacity. Terminal operations and management have to be considered as well.

Annual Average Daily Traffic (AADT)

Volume information for long-range planning studies is frequently expressed in terms of TEU/year or Vehicle/year. Data management requires to know the average daily traffic averaged over a full year. It is referred to as the annual average daily traffic, or AADT, and is often used in forecasting and planning.

Peak Hour Factor

Capacity is often expressed in terms of vehicle/hour and analysis is focused on peak hour, when traffic flows are crucial. Therefore it is necessary to evaluate the relationship between AADT and the Peak hour traffic: peak hour flows are always close to the 10% AADT values.

Loaded and unloaded vehicles

The percentage of heavy vehicles travelling with full load is related to port logistics and terminal management and operations. Unloaded trucks also have to be counted as traffic component. Some hypotheses have been made in order to predict the correct amount of circulating vehicles.

Directional distribution characteristics

The amount of traffic is not the same in each direction and directional distribution affects capacity and level of service. Each direction of the facility usually is designed to accommodate the peak flow rate in the peak direction. In freight traffic analysis the directional coefficient is very important and it has to take into account import/export ratio.

Vehicle types

The entry of heavy vehicles — that is, vehicles other than passenger cars — into the traffic stream affects the number of vehicles that can be served. Trucks and other heavy vehicles have to be expressed in terms of passenger car unit (pcu), using an appropriate homogenisation coefficient.

Urban traffic

When port traffic shares roads and highways with other flows, it is necessary to estimate the value of all streams involved in order to analyse capacity of ramps and infrastructures. Therefore urban streams and manoeuvres have to be investigated in all the junctions and sections.

Traffic forecast

In long-range planning studies, traffic forecast has to be provided in order to define different scenarios. In this context appropriate coefficients are necessary to update traffic flows.

2.2 Merging Area Capacity

A merging area is defined where two different traffic flows (such as a flow travelling a highway and a second one entering the same infrastructure) merge into one.

The following procedure allows to find and analyse local traffic instabilities around merging areas between the entrance of a highway and port facilities ramps. The Highway Capacity Manual provides a method to evaluate the vehicle density in conflict areas as a function of traffic flows, road dimensions and some experimental coefficients.

For each merging area it is possible to evaluate Level Of Service (LOS) in function of vehicle density for each lane. The procedure concerns the following steps:

1. Evaluation of the highway flow in the conflict area (taking into account the Peak Hour Factor and the percentage of heavy vehicles) – V_f ;
2. Evaluation of the total ramp flow – V_r ;
3. Evaluation of the length of acceleration lane – La;
4. Evaluation of the vehicle density in the merging area through the following formula (1):

$$\mathbf{D_r} = 3{,}402 + 0{,}00456\mathbf{V_r} + 0{,}0048\mathbf{V_f} - 0{,}01278\mathbf{La} \quad (1)$$

Level of Service is then provided in function of the density value in the merging area.

2.3 Ramp and Highway Capacity

In order to evaluate port impact on existing infrastructures the following steps are due:

1. identify port traffic flows on ramps connecting terminal and highways;
2. identify port traffic flows on all the highway sections;
3. sum existing flows and port flows;
4. perform capacity analyses on merging areas and critical highway sections.

The aim of capacity analyses is to avoid saturation on highways and merging areas. Level of Service is expressed in terms of vehicle density. Usually a Level of Service D is required in planning analysis.

2.4 Port capacity as a function of existing and new facilities

Ramp and highway capacity analysis estimates how much freight traffic can be sustained by existing infrastructures. By means of existing and forecasted traffic flows several scenarios can be developed: the capacity analysis reveals if each scenario is acceptable or not. In other words, it is possible to evaluate port capacity as a function of road network constraints. In case of non acceptable scenarios, it is possible to evaluate which kind of improvements and facilities are necessary to improve port capacity [4].

3 CASE STUDY

The methodology has been tested on a real case scenario of two port terminals (Trieste and Monfalcone, Italy), measuring their mutual interactions on traffic flows, in terms of the maximum amount of TEU that they could be able to produce in a year.

The area covers more than 200 square kilometres in the North-East of Italy, at the Slovenian border. Situated in the heart of Europe, at the intersection between the maritime routes and Corridor 5 (Lisbon-Kiev), the ports of Trieste and Monfalcone aim to become an international hub for flows of trade by land and sea involving the dynamic market of Central and Eastern Europe.

The intensification of commercial exchange and maritime traffic between the Far East and Europe and the extension of the European Union towards the East have given a new boost to the central position of the Upper Adriatic, opening up new possibilities of growth and development for the whole area.

The two ports are directly connected by an highway that links both the port facilities and the urban areas. In particular, it is the final stretch of the A4 highway that links Trieste with the other northern part of Italy, towards Venice and Milan.

Vehicles (both passenger cars and heavy vehicles) can travel free of charge in the stretch of road between “Lisert” toll station (access point from Monfalcone port) and Trieste, whereas the remaining network is subject to toll payment. Ports are also connected to the railway network, which is not considered according to the aim of this study.

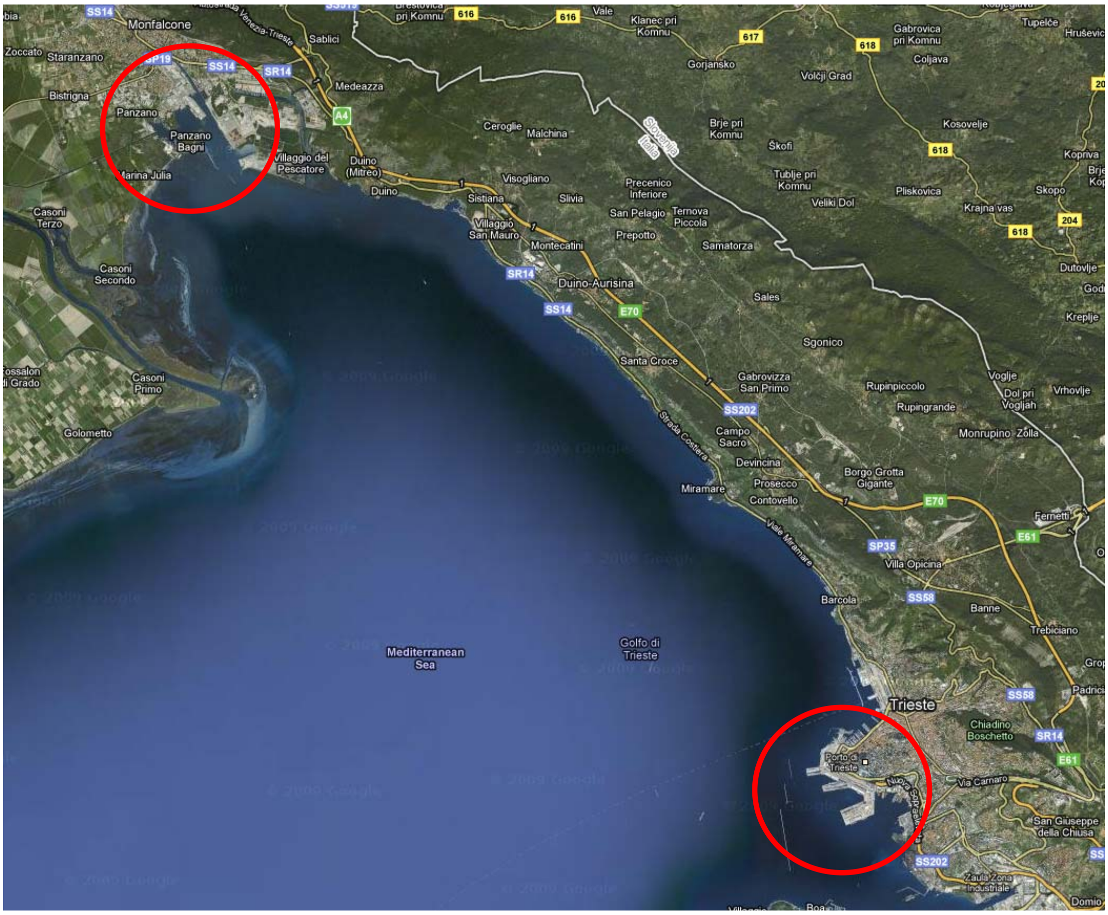

Figure 1: Case study area. Red circles show port facilities

3.1 The Port of Trieste

Trieste plays a decisive role in logistic chains and intra-Mediterranean connections. The meeting between the strategic axes of the “Motorways of the sea of the Eastern Mediterranean” and Corridor 5 is determining the growth of intermodal transport and the development of innovative solutions in the field of logistics and transport. Trieste is the terminus of regular direct ocean connections to the Far East, provided by the world’s main shipping companies. The A4 highway coming from Turin, Milan and Venice has a direct connection in its last stretch with port facilities by means of ramp junctions [5].

3.2 The Port of Monfalcone

The Port of Monfalcone is the most northern port place of the Adriatic Sea and the closest one to central Europe. The port area can be easily and directly reached thanks to the previously defined A4 highway. The toll station is located at a distance of 1.5 km from the port.

3.3 Port Capacity Analyses

The ports of Trieste and Monfalcone have been analysed in terms both as a hub (taking into account the mutual interaction between their operations and its impact on the road network) and as a single port. The maximum forecasted production to be evaluated considers the value of 1.200.000 TEU/year and 2.000.000 TEU/year, respectively in Trieste and in Monfalcone. Analyses take into account the impact of this production (in terms of heavy vehicles) on the existing road network.

Road capacity analyses are conducted on several scenarios to take into account mainly two factors related to traffic demand: the growing traffic flows over the years both of urban and port vehicles and different modal splits between rail and road infrastructures [6]. Four time horizons are analysed, each related up to the maximum amount of TEU generated and attracted by each port [7]. Finally, a set of possible infrastructural improvements on roads and junctions are suggested to provide more capacity on the road network.

3.4 Traffic Flows Estimation

The amount of heavy vehicles circulating on roads is a function of port capacity and therefore of how many TEU a port can achieve during one year of operations. Heavy vehicles data are estimated as a function of the amount of TEU forecasted in several scenarios related to a time horizon of 5, 10 and 15 years.

Capacity analysis takes into account existing roads interested both by daily urban traffic and by growing TEU heavy vehicles to and from the terminal facilities. Traffic flows are evaluated through different available sources, such as real traffic data collected on the main road network, simulations and flows assignments within the Trieste area and statistical estimations. In particular, current and forecasted road traffic is estimated by means of:

1. Traffic data counts during year 2009 at the “Lisert” toll station. Data are divided into freight and private vehicles and then collected with the aim of comparing them with others referred to the peak hour on an average day.
2. Traffic assignments on the road network of the Trieste area. The graph is built and calibrated over the years by means of statistical socio-economical data (O/D matrix) and by real traffic counts on several road sections. Data can help in finding current and forecasted traffic flows on the graph.
3. Statistical estimations. The correlation between the AADT flow measured at the toll station and the peak hour flow in the urban area is estimated around 10% of AADT; this value is validated through real traffic counts.
4. Directional and Load Coefficients. The percentage of heavy vehicle travelling with full load is 75%, each carrying 1,8 TEU. The directional coefficients taking into account the “import-export” operations are fixed at 0,65 (TEU from the port facilities) and 0,45 (TEU towards the port facilities) [8].

3.5 Merging Area And Capacity Analyses

Current capacity of merging areas connecting port facilities and the main highway is estimated as a function of current road traffic. Therefore, evaluations are conducted in the same way considering traffic increase over the years under the hypothesis of growing trades. The most critical sections are identified:

1. Port of Trieste. Ramp junctions between the last highway section connecting facilities with the existing road network, in both directions;
2. Port of Trieste. Highway sections in the urban stretch between terminal and urban area;
3. Port of Monfalcone. Connection between “Lisert” toll station and the existing road network towards port facilities;

4. Port of Monfalcone. Connection between the ramp and the existing road with the highway just before the toll station;
5. Both ports. “Lisert” toll station.

3.6 Infrastructural Improvements

Several improvements on ramps, junctions and connections between port facilities and the road network are assumed. They have been related with port operations and focused on previously defined critical road elements with the aim of increasing capacity:

1. Improvement A in Monfalcone. “Lisert” toll station removal and a new lane between Monfalcone and the highway;
2. Improvement B in Monfalcone. It includes the previous one and a new lane on the A4 highway (Venice direction);
3. Improvement A in Trieste. A new ramp access between the port and the urban highway stretch. This improvement can avoid saturation in the most critical merging areas of the highway.

4 RESULTS AND DISCUSSION

Results have been presented through a matrix in which rows and columns represent the growing TEU production and attraction by the two terminals. The matrix shows the combination of TEU available for each set of infrastructural improvements previously defined.

Matrices have been painted in function of single infrastructural improvements, and of their possible combinations. Labels can be represented as follows:

- no infrastructural improvements (except for Lisert tollstation removal)
- improvement A in Monfalcone
- improvement B in Monfalcone
- improvement A in Trieste
- improvement A in Monfalcone and A in Trieste
- improvement B in Monfalcone and A in Trieste

4.1 Scenario 0

Scenario 0 concerns the results of the impact of the current traffic flows on the existing and forecasted road infrastructure. If the port operations of Monfalcone were to be at their lower level (up to 5% of the maximum year production), the port of Trieste could produce the maximum amount of TEU/year forecasted (1.200.000) in presence of the new ramp access. The maximum production of the port of Monfalcone is possible only in case of a third lane on the A4 highway towards Venice, because of the traffic flows on the ramp connecting the terminal and the highway.

	TRIESTE																					
MONFALCONE	% GOMMA	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
% GOMMA	TEU gomma	0	60.000	120.000	180.000	240.000	300.000	360.000	420.000	480.000	540.000	600.000	660.000	720.000	780.000	840.000	900.000	960.000	1.020.000	1.080.000	1.140.000	1.200.000
0%	0	0	60000	120000	180000	240000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000
5%	100.000	100000	160000	220000	280000	340000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000
10%	200.000	200000	260000	320000	380000	440000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000
15%	300.000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000
20%	400.000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000
25%	500.000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000
30%	600.000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000
35%	700.000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000
40%	800.000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000
45%	900.000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000
50%	1.000.000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000
55%	1.100.000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000
60%	1.200.000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000
65%	1.300.000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000
70%	1.400.000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000
75%	1.500.000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000
80%	1.600.000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000
85%	1.700.000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000
90%	1.800.000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000	2760000	2820000	2880000	2940000	3000000
95%	1.900.000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000	2860000	2920000	2980000	3040000	3100000
100%	2.000.000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000	2960000	3020000	3080000	3140000	3200000

Figure 2: Scenario 0 (2010)

4.2 Scenario 1

Scenario 1 concerns the results of the impact of the forecasted traffic flows (in 2015) on the existing and forecasted road infrastructure. The port of Trieste is able to produce the same TEU/year on the hypothesis of the previous scenario 0 despite the increase in traffic.

	TRIESTE																					
MONFALCONE	% GOMMA	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
% GOMMA	TEU gomma	0	60.000	120.000	180.000	240.000	300.000	360.000	420.000	480.000	540.000	600.000	660.000	720.000	780.000	840.000	900.000	960.000	1.020.000	1.080.000	1.140.000	1.200.000
0%	0	0	60000	120000	180000	240000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000
5%	100.000	100000	160000	220000	280000	340000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000
10%	200.000	200000	260000	320000	380000	440000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000
15%	300.000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000
20%	400.000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000
25%	500.000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000
30%	600.000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000
35%	700.000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000
40%	800.000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000
45%	900.000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000
50%	1.000.000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000
55%	1.100.000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000
60%	1.200.000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000
65%	1.300.000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000
70%	1.400.000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000
75%	1.500.000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000
80%	1.600.000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000
85%	1.700.000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000
90%	1.800.000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000	2760000	2820000	2880000	2940000	3000000
95%	1.900.000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000	2860000	2920000	2980000	3040000	3100000
100%	2.000.000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000	2960000	3020000	3080000	3140000	3200000

Figure 3: Scenario 1 (2015)

4.3 Scenario 2

In Scenario 2, related to 2020 forecasted traffic flows, the maximum productions of both ports are subjected to the development of both the new ramp in Trieste and of the third lane towards Venice in Monfalcone. A limited amount of productions of both ports can be sustained in case of minor improvements, such as Improvements A on Monfalcone and Trieste.

	TRIESTE																					
MONFALCONE	% GOMMA	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
% GOMMA	TEU gomma	0	60.000	120.000	180.000	240.000	300.000	360.000	420.000	480.000	540.000	600.000	660.000	720.000	780.000	840.000	900.000	960.000	1.020.000	1.080.000	1.140.000	1.200.000
0%	0	0	60000	120000	180000	240000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000
5%	100.000	100000	160000	220000	280000	340000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000
10%	200.000	200000	260000	320000	380000	440000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000
15%	300.000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000
20%	400.000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000
25%	500.000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000
30%	600.000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000
35%	700.000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000
40%	800.000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000
45%	900.000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000
50%	1.000.000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000
55%	1.100.000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000
60%	1.200.000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000
65%	1.300.000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000
70%	1.400.000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000
75%	1.500.000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000
80%	1.600.000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000
85%	1.700.000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000
90%	1.800.000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000	2760000	2820000	2880000	2940000	3000000
95%	1.900.000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000	2860000	2920000	2980000	3040000	3100000
100%	2.000.000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000	2960000	3020000	3080000	3140000	3200000

Figure 4: Scenario 2 (2020)

4.4 Scenario 3

In the last scenario, related to 2025 forecasted traffic flows, there is an increase combination of possible port productions without the third lane.

	TRIESTE																					
MONFALCONE	% GOMMA	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
% GOMMA	TEU gomma	**0**	**60.000**	**120.000**	**180.000**	**240.000**	**300.000**	**360.000**	**420.000**	**480.000**	**540.000**	**600.000**	**660.000**	**720.000**	**780.000**	**840.000**	**900.000**	**960.000**	**1.020.000**	**1.080.000**	**1.140.000**	**1.200.000**
0%	**0**	0	60000	120000	180000	240000	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000
5%	**100.000**	100000	160000	220000	280000	340000	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000
10%	**200.000**	200000	260000	320000	380000	440000	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000
15%	**300.000**	300000	360000	420000	480000	540000	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000
20%	**400.000**	400000	460000	520000	580000	640000	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000
25%	**500.000**	500000	560000	620000	680000	740000	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000
30%	**600.000**	600000	660000	720000	780000	840000	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000
35%	**700.000**	700000	760000	820000	880000	940000	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000
40%	**800.000**	800000	860000	920000	980000	1040000	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000
45%	**900.000**	900000	960000	1020000	1080000	1140000	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000
50%	**1.000.000**	1000000	1060000	1120000	1180000	1240000	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000
55%	**1.100.000**	1100000	1160000	1220000	1280000	1340000	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000
60%	**1.200.000**	1200000	1260000	1320000	1380000	1440000	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000
65%	**1.300.000**	1300000	1360000	1420000	1480000	1540000	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000
70%	**1.400.000**	1400000	1460000	1520000	1580000	1640000	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000
75%	**1.500.000**	1500000	1560000	1620000	1680000	1740000	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000
80%	**1.600.000**	1600000	1660000	1720000	1780000	1840000	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000
85%	**1.700.000**	1700000	1760000	1820000	1880000	1940000	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000
90%	**1.800.000**	1800000	1860000	1920000	1980000	2040000	2100000	2160000	2220000	2280000	2340000	2400000	2460000	2520000	2580000	2640000	2700000	2760000	2820000	2880000	2940000	3000000
95%	**1.900.000**	1900000	1960000	2020000	2080000	2140000	2200000	2260000	2320000	2380000	2440000	2500000	2560000	2620000	2680000	2740000	2800000	2860000	2920000	2980000	3040000	3100000
100%	**2.000.000**	2000000	2060000	2120000	2180000	2240000	2300000	2360000	2420000	2480000	2540000	2600000	2660000	2720000	2780000	2840000	2900000	2960000	3020000	3080000	3140000	3200000

Figure 5: Scenario 3 (2025)

5 CONCLUSIONS

In this paper a methodology to estimate port capacity as a function of road network constraints is introduced. The study of port capacity needs an estimation of road traffic flows in the area, in several time horizons and in different hypotheses of traffic conditions. The methodology requires a proper analysis of road accessibility and an accurate estimation of road capacity, with particular attention on the weakest elements of the network, such as junctions and merging areas. By means of existing and forecasted traffic flows several scenarios can be developed as a function of road network constraints. In case of unacceptable scenarios, it is possible to evaluate which kind of improvements and facilities are necessary to improve port capacity.

This methodology is applied on a case study in Italy. Results help in predicting current and future requirements of the infrastructure and port facilities to provide a desired Level of Service under a fixed TEU/year port capacity constraint. The methodology is focused on free traffic flows and it does not take into account any port policy which can manage arrival and departure times, scheduled time frames and other constraints. By means of an appropriate policy, port capacity can be re-calculated and improved.

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ELABORATION OF PORT DEVELOPMENT MODEL BASED ON LOGISTICAL RESOURCES

Dr. Tamás Hartványi, Gábor Horváth
István Széchenyi University
Institute of Built Environment and Transport
Egyetem tér 1, H- 9026 Győr, Hungary
hartvanyi@sze.hu, gabhor@sze.hu

ABSTRACT

The performance of waterway transportation can be measured mainly in the ports. A port is a very important element of the transport system and the logistical infrastucture. The logistical infrastructure plays a specific role in the restructuring of regional economies, as it is indispensable for the successful cooperation in the industrial production chains.

Our research intended to elaborate a system in which the missing logistics infrastructure can be formed involving and concentrating the existing resources and based on the co-operation of transport actors. The following questions had to be answered:

1. How to create logistics infrastructure in a competitive market so that the regional impacts are precisely considered?
2. How to support the independent small and medium sized companies in order that they would be able to provide complex and high quality logistics services and they still maintain their autonomy?
3. What kinds of regional synergetic effects exist that can support logistics development?

The model helps to find the connection between different logistics capacities owned by independent companies.

1 HARBOURS, PORTS, TRENDS

Ports have undergone several changes during their long history. These changes involve their

- size
- range
- infrastructure
- tools
- capacity
- and even location occasionally.

The port in Győr is a good example with its special history involving various locations:

1. In the old downtown: direct by the city fort walls
    - by the river Raab, at the sidewall of Klastrom with stores
    - on the river Moson-Danube, at the market place

constructed for special long boats, ('burcsella' ~ scow), which transported goods and sellers to town.

2. In the outskirt: on a town section of Moson-Danube

Due to industrial development for row material supply of factories, also with industrial railway and cranes, for supplying engineering industry and concrete-panel factories, receiving wood supply from Szigetköz, storing agricultural products of the region in granaries. [1]

3. Extending connections with producing and trading units (stores) located on external areas by constructing channels. (Industrial channel with port basin, built in 1915-1926)

4. Outside the city: at the border of the cities Győr and Gönyű, in the Danube delta. International public port, established in 1992, due to restrictions concerning shipping on the river Moson-Danube and also reformulating and modernizing of economic and transportation structure. The conception aimed at establishing a multimodal logistics centre. [2]

The development and establishment took place in a period of social, political and economic system change in Hungary. Due to the aforementioned reasons and the crisis of the Southern Slavic countries it was also the period of deterioration of shipping in Hungary. These circumstances required the review of further development criteria and the real chances to create a logistics service centre. In the followings will be demonstrated the feasibility model of a regional logistics service centre based on the specific Hungarian example.

2 THE STRUCTURE OF THE MODEL

2.1 Goals and ways

This research intended to elaborate a system in which the missing logistics infrastructure can be formed involving and concentrating the existing resources and based on the co-operation of domestic small and medium sized businesses. The following questions had to be answered:

1. How to create logistics infrastructure in a competitive market so that the regional impacts are precisely considered?
2. How to support the independent small and medium sized companies in order that they would be able to provide complex and high quality logistics services and they still maintain their autonomy?
3. What kinds of regional synergetic effects exist that can support logistics development?

A complex model has been elaborated that proposes an algorithm by which the formation of logistics centres in ports can be supported involving small and medium sized companies. [3]

The initial input of the model is based on a survey exploring the existing regional logistics capacity, transport infrastructure and demand. Comparing supply and demand deficit and possible development concept can be determined.

Relevant actors of regional economic and social life must be involved in the elaboration of development concept. The intended range of services must be outlined, regional effects are to be predicted and financial calculations and studies must be carried out. Survey on willingness for co-operation is an important element of the concept since the virtual centre is based on close collaboration of different organisations.

In the planning phase the IT system is outlined and the development association is founded. Financial verification of the project is carried out in the last phase, information about the possible sources is used as an input, and the final feasibility study is the output of the model.

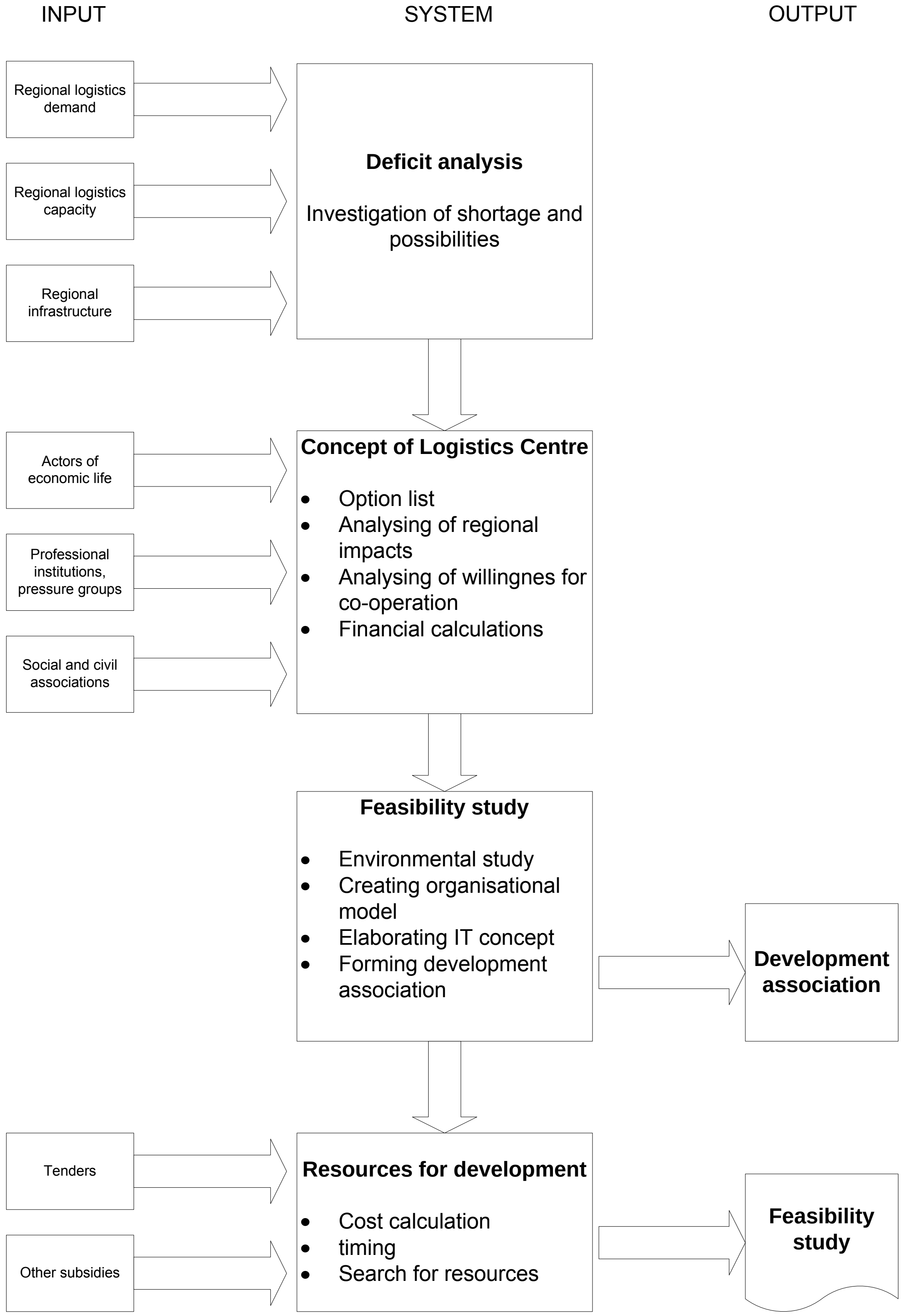

Figure 1: Structure of the proposed model

2.2 The main work phases

The model consists of the following phases (PH):

PH 100 Comparing transport service supply and demand

- Survey of regional industrial manufacturers, agricultural performance and the service sector.
- Analysing the qualitative and quantitative parameters of regional supply of transport, freight forwarding, warehousing, handling capacity.
- Comparing supply and demand, analysing shortage/surplus, setting the development targets.

PH 200 Analysing of transport infrastructure

- Exploring and evaluating of existing transport / loading / material handling capacity

PH 300 Concept of logistics centre

- The concept is based on the first two phases. Shortage, options and existing capacity are considered and regional development plans are also integrated.
- Verification of the model.

PH 400 Feasibility concept

- The expert team elaborates versions detailing locations, facilities, organisational structure and management concept.
- The IT system concept is adjusted to the physical and organisational solutions.

PH 500 Sources for development

- Costs and required capital investment are calculated. Revenue from sold options and of existing operation can be estimated. Sources for additional finance are explored.

3 CONDITIONS TO APPLICAT THE MODEL

3.1 Role of the government

The methodology does not count on direct central, governmental investment. The role of the state should be based on tendering processes in which the government can support the activity of local, regional actors in projects that match the national economic targets.

The possible methods:

1. Non refund grants in case of extremely underdeveloped regions and/or poor quality of services.
2. Free of interest loans for new and extending companies when the return of investment can not cover the usual interest rate.
3. Low interest rate for supporting the domestic companies' investments.

The state should make efforts to support the practical application of up-to-date IT solutions by communicating the issues nation wide and by calling for innovative tenders. The tendering process increase the effectiveness of financial resources and encourages the regions to launch independent projects. The only required direct state finance is the development of national transport infrastructure. The model points out the importance of transport network and its effects on logistics services, but the actual state finance methodology in this field is not investigated.

The regional efforts can be supported by active tax policy as well. In order to balance the national economy geographically such tax/subsidy system should be introduced that based on solidarity and mutual advantages. An explored form of financing investments is the Build – Operate – Transfer (BOT) construction. The company which attains a concession constructs a facility and operates it for a certain amount of time set in the contract (depending on the expected time of the costs to be reimbursed), and finally the project returns to the concession announcer.

3.2 Regional tasks

The model represents regional approach so the importance of collaboration with local authorities city councils and civil organisations cannot be overemphasised since these institutions are eager and ready for regional development. The local authorities can give tax allowance or they can provide the necessary sites for the facilities. Civil organisations can assure the public support by communicating the plans and using their relations to other relevant actors. That is why it is very important that the probable partners have to be informed about the projects as soon as possible and they are involved in the work according to their competence.

3.3 Using of existing capacities

The model pays attention to the existing logistics capacities and compares the regional supply and demand. The concept of the model is that the most effective way of covering the shortage, deficit in regional logistics capacities does not necessarily mean new investments that can increase the competition between small and medium sized businesses. Instead of that the actors of the supply side have to specialise for given services a joint appearance on the market makes them able to provide complex, high level logistics service. The model helps to find the connection between different logistics capacities owned by independent companies.

Because the lack of financial resources a small or medium sized hungarian logistics service supplier has little chance for extending its capacity or profile. By applying the proposed model the capital investment can be avoided and a special kind of outsourcing can be set. From the point of view of physical facilities the solution does not mean concentration so the so-called multi-central model has to be applied. [4]

On the market the alliance is able to provide complex logistics services that have been produced only by large international companies. The realisation of necessity for co-operation makes the small and medium sized companies more competitive and strengthens their market position. In the alliance the dominant companies have the leading role and such informatics and management systems have to be built and operated in which the inter-alliance competition can be eliminated. General model for the legal form and management structure of the alliance cannot be given since during the development significant changes can be experienced.

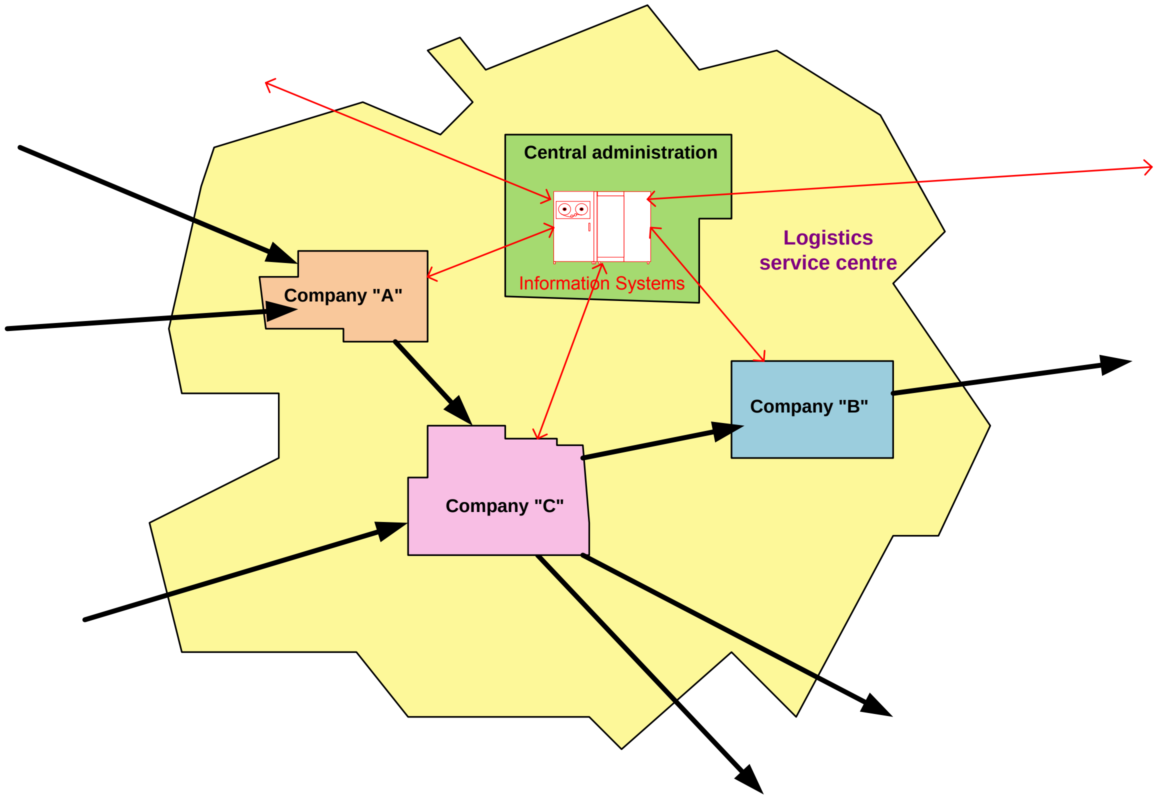

Figure 2: Model of multi-central logistics centre of a port

4 OPERATIONAL AND INFORMATICAL TOOLS

4.1 Theories of port operation

Port alliances are not just established today, several alliances already worked in the Medieval ages, mainly focusing on sea shipping issues.

Landlord theory

- The state owns the strategic assets of the ports
  - The port authority supplies infrastructure (pl. basins, river walls, intern ways, industrial railway network, public utilities).
- Investments, operation and employment are the liability of the private sector, which is due to pay charge.
  - The elements of superstructure (equipment, crane engines, buildings etc.) are in private ownership.
  - The staff dealing with goods is employed by private enterprises.

Tool theory

- The port authority owns both the infrastructure and the superstructure but
- it lets them on lease by private enterprises dealing with goods. These private enterprises operate them with their own employees.

Service theory

- The public (state or local government owned) port authority is the owner of all assets and also
- supplies all services, including all forms of dealing goods, with own employees.
- In the former socialist countries almost all ports operated in a service-system. [5]

4.2 IT tools

The operation of proposed alliance requires new approach and means. The information is the most important strategic resource of the logistics centre, proper handling and processing of information are elementary. That is why up-to-date telematics solutions have to be applied that are based on open network concept. Since the multi central system is built up by more or less independent companies the most important issue of the joint operation is the informatics.

The appropriate open informatics system consists of three separated domains:

1. *Internal management and controlling* system which is an integrated system based on usual modules. It supports the internal informatics and controls the use of resources. Because the features of logistics services different mobile telematics solutions are to be applied.
2. *Management and control of logistics service centre*, in which the planning and timing of capacities are done, marketing activity and joint economic operation are served.
3. *External informatics system*, that sets the connections and links to customers and other external informatics systems. It provides information about the offered capacities and services, makes dispositions and trace ability possible, supports EDI, enables outsourcing.

Informatics domains must be separated by IT means that are able to assure the fulfilment of safety requirements.

The IT based system is able to build up and operate logistics chains that can meet the actual needs. In the first step the informatics system set the model of logistics chain, and that chain is operated by the allied companies as a project. The offered "product" is the logistics chain, the customer buys the service of the logistics centre that operates as a virtual company. The "virtual company" uses the information system of the logistics centre and the resources of allied companies. After finishing the job the virtual company is dissolved and a new one is created for the next task.

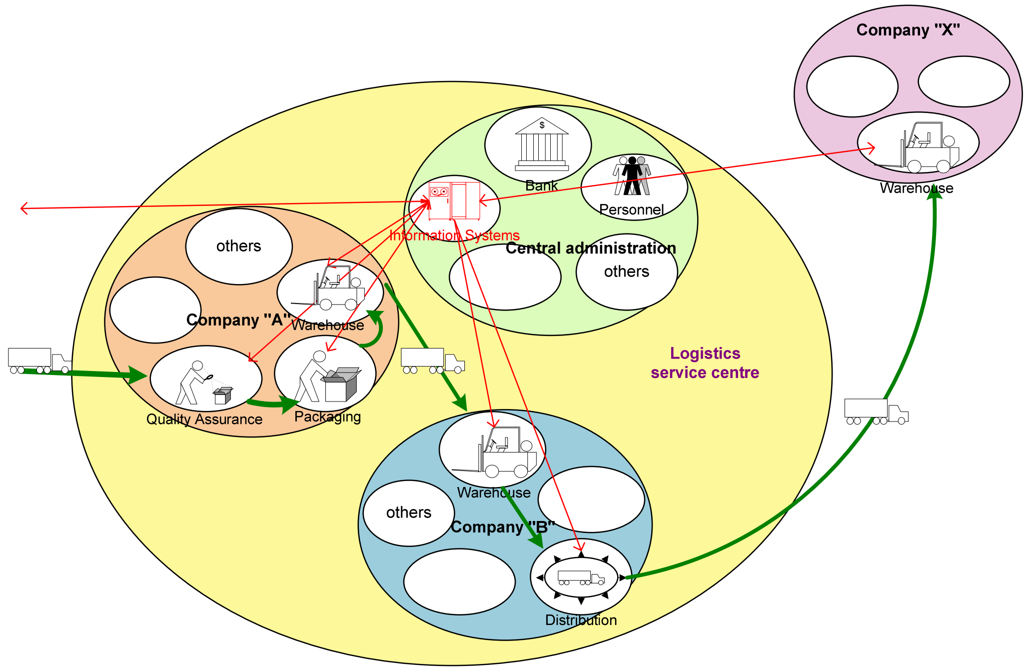

Figure 3: The logistics chain

The allied companies can reach their strategic goals by operating such informatics and organisational model which enables them to provide logistics services flexibly in the framework of a virtual organisation. [6]

5 VERIFICATION AND PRACTICAL APPLICATION

The methodology has been applied in practice as well. The geo-transport location of Győr provides an extraordinary opportunity for the town to implement a successful economic restructuring program as a regional logistical centre.

On the basis of the model we developed, it is possible to design a well structured development project. Its stages are described in figure 4.

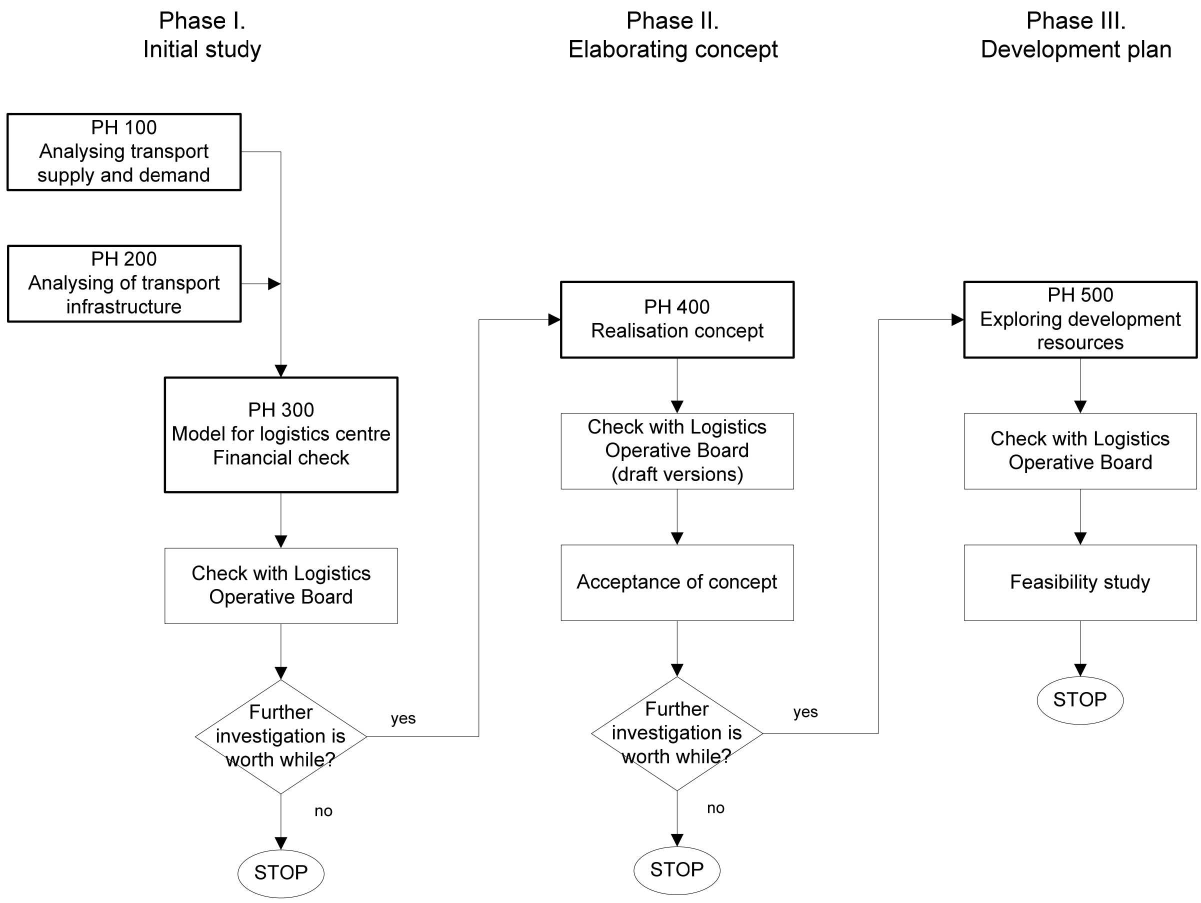

Figure 4: Structure of a project

6 RESULTS

The implementation of such a project opens the possibility for the development of the logistics resources of the area. The individual companies in dynamic cooperation are able to exploit the overland and water transport channels, and to deliver higher level logistical services. Such logistical environment would be able to attract operating capital which prefers suitably organised industrial parks. Thus can the development of transport and logistical infrastructure indirectly become an indicator of the general economic development of the region.

7 CONCLUSIONS

Logistics infrastructure in ports can be built effectively on regional basis - without external capital investment - involving the relevant actors of regional economic and social life. Local public co-operation and control can assure the efficient way of achieving regional aims. Thus logistics can be significant element of regional development.

The state has an indirect role, the government must act as a catalyst supporting subsidising principle.

Small and medium sized companies realising their economic interest and using appropriate methodological and technological support are able to offer complex, competitive logistics services in a co-operative organisational structure.

Co-operation technology means IT solutions based on open network principles, which make the foundation of a virtual logistics company possible.

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THE FRAN-SCAN HI-CUBE INTERMODAL CORRIDOR (G2, P/C 450)

Hans E. Boysen
Royal Institute of Technology
Department of Transport Science
Teknikringen 72, SE-100 44 Stockholm, Sweden
heboysen@kth.se

ABSTRACT

Intermodal freight shows recent growth on the European railway network. While the cost of mode transfer makes intermodal traffic uncompetitive over short distances, operation over long distances is made more difficult by diverse technical standards. This paper investigates the clearances and mass limits applicable on highways, seaways and railways, and identifies opportunities for incrementally improving the cubic capacity of intermodal transportation by rail. It proposes to link the two European regions with the highest highway clearances by raising the clearances in a connecting, existing railway corridor correspondingly, to provide the ability to carry up to 4.50 m tall highway trailers on standard intermodal wagons Britain-France-Belgium-Netherlands-Germany-Denmark-Sweden-Norway (P/C 450). This corridor would also provide a path for the taller standard wagons of northern and eastern Europe (G2) to access railheads in Belgium, northern France and the British southeast.

1 INTRODUCTION

1.1 Background

Growing international trade is one of the results of continuing international integration. Transportation demand keeps rising, and there is a pronounced political will to shift traffic from road to rail for reasons of sustainability. In particular intermodal traffic is growing [1], with load units being transferred between transportation modes. This necessitates coordination of capacity standards between the transportation modes of highways, seaways and railways as well as between geographical regions. In the recent past, capacity standards were decided at the national level, resulting in significant discrepancies in capacity levels between modes and regions. Discrepancies still remain to some extent, hampering the attainable efficiencies of intermodal transportation.

1.2 Purpose and scope

The purpose is to raise the capacity for efficient handling of intermodal loads in Europe, and to identify opportunities where higher capacity standards can reasonably be achieved. Included in the study are the highway and railway networks of Europe and Caucasus as well as key connecting sea links.

1.3 Method

The study will investigate the present levels of technical capacity limitations for intermodal loads in Europe. A survey is made of the existing height, width and mass limitations of the European highway, seaway and railway networks and links. Discrepancies between present standard levels are identified. Modal complementary strengths and weak links are searched for, and limiting factors are examined. Finally, revised standards are proposed, and opportunities to achieve these are assessed.

2 INTERMODAL LOAD LIMITATIONS BY TRANSPORT MODE

2.1 Highway limitations

Larger and heavier loads have the potential to further transport efficiency and economy per unit volume and unit mass, but are subject to national regulatory limitations of maximum dimensions and mass. The limitations in effect as of 2010 are shown in Table 1.

Nation	Max. vehicle height	Max. vehicle width
France, Norway, Sweden, UK	No defined limit	2.60 m
Ireland	4.65 m	2.60 m
Finland, Iceland	4.20 m	2.60 m
Armenia, Moldova, Montenegro, Serbia	4.00 m	2.50 m
Macedonia	4.10 m	2.60 m
Azerbaijan, Bosnia-Hercegovina, Bulgaria, Greece, Liechtenstein	4.00 m	2.55 m
Others	4.00 m	2.60 m

Table 1: Permissible maximum vehicle dimensions on the highway in Europe and the Caucasus [2]

As shown in Table 1, the permissible maximum width is fairly uniform, ranging from 2.50 m to 2.60 m. The maximum height varies more, generally 4.00 m in most of Europe, but higher permissible maximum heights apply in Macedonia, Finland, Iceland and Ireland, ranging from 4.10 m to 4.65 m. Moreover, in France, Norway, Sweden and the UK there is no defined maximum legal height. Here, the practical heights are instead determined by the available highway clearances, which in France, Norway and Sweden generally accommodate vehicles of 4.50 m and in the UK 4.95 m (16 ft 3 in). Accordingly, many modern box-type trucks and trailers are built to make full use of these practical vehicle heights.

Limits are not necessarily static. Between 2003 and 2010 the permissible height in Ireland was raised from 4.00 m, initially to 4.25 m and then to the present 4.65 m, while the limit in Macedonia was raised in 2010 from 4.00 m to 4.10 m. The distribution of permissible or practical vehicle heights is shown graphically in Figure 1. In the UK, beyond the general practical vehicle height of 4.95 m, a network of designated roads named the High Load Grid is cleared for vehicles as tall as 5.49 m (18 ft) or 6.10 m (20 ft) [3].

Mass limits on European highways are differentiated depending on vehicle configuration. For a 5-axle tractor-trailer combination, as is commonly used for intermodal transportation, mass limits range from 38 tons in Russia and Ukraine to 60 tons in Finland and Sweden, but are typically within 40 tons to 44 tons [4]. In the EU the mass limit of a semi-trailers are 20 tons for a two-axle semi-trailer and 24 tons for a three-axle semi-trailer [5]. Beyond the permissible maximum vehicle dimensions and masses shown, high-wide or heavy oversize loads are accepted in some cases but may require special permits, markings or accompanying escort vehicles.

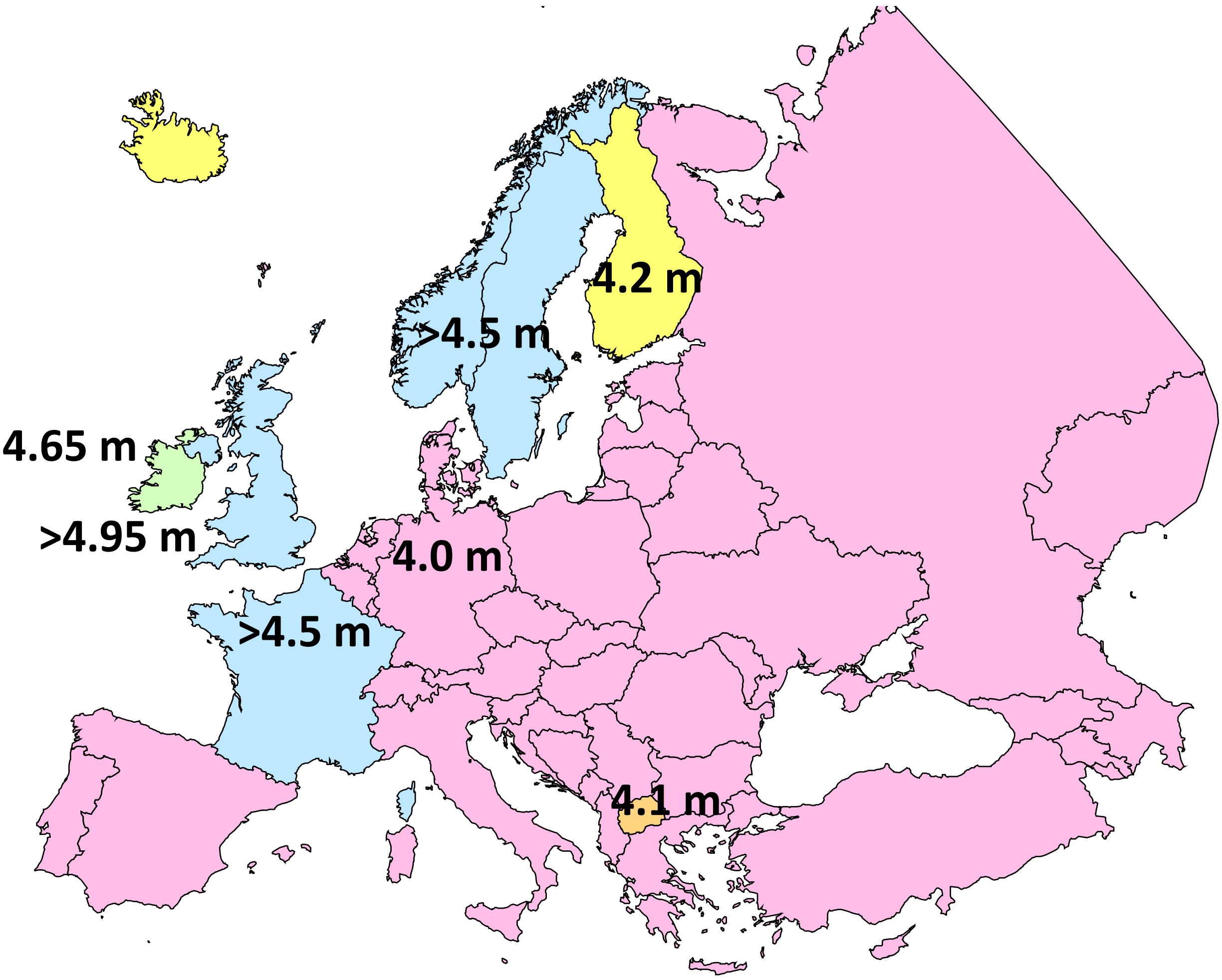

Figure 1: Permissible or practical maximum vehicle heights in Europe and the Caucasus

2.2 Marine limitations

The maximum dimensions for trucks and trailers carried on ferries and ro-ro ships are generally individual to each vessel. The accepted maximum dimensions were investigated for some key shipping routes connecting regions of diverging highway dimensional limits.

Examples of maximum vehicle heights on selected seaways are shown in Table 2.

Route	Max. ro-ro load height
Ireland – Great Britain	4.40 m to 5.20 m (Stena Line) [6]
Ireland – France	4.40 m to 5.00 m (Irish Ferries) [7]
Great Britain – France	4.80 m (DFDS) [8] 4.50 m (Seafrance) [9]
Great Britain – Norway	6.70 m (DFDS) [8]
Great Britain – Sweden	4.50 m (DFDS) [8]
Sweden – Finland	4.70 m to 4.80 m (Tallink Silja) [10] 4.40 m to 4.60 m (Viking Line) [11]

Table 2: Accepted maximum vehicle heights on sample ferry and ro-ro shipping routes

As shown in Table 2, on each of the investigated routes at least some vessels accept ro-ro load heights that match or exceed the highway limits in effect in the regions connected. Accepted widths are also specific to each vessel, and are normally well beyond the 2.60 m that is a common limit on the highway. To give some examples, Stena Line accept widths up to at least 6.00 m on their vessels linking Great Britain and Ireland, wheras DFDS accepts vehicles up to at least 3.20 m wide on their vessels linking France and Great Britain and 3.50 m between Great Britain and Sweden [6,8].

Mass limits generally match or exceed those on the highway. For purpose-built marine containers handled by lo-lo ships, ISO standard cross sectional dimensions are: height 2.591 m (8 ft 6 in) or 2.896 m (9 ft 6 in) and width 2.438 m (8 ft). In summary, carrying ro-ro loads corresponding in size and mass to what is permitted on the highway, and slightly smaller lo-lo marine containers, ocean shipping is a capable link for intermodal loads, where shipping routes exist.

2.3 Railway limitations

The maximum permissible cross section of a railway vehicle and its load are defined by the loading gauge, which applies under static conditions. The maximum height and width of European mainline loading gauges are shown in Table 3.

Nation or region	Max. vehicle height above top of rail	Max. vehicle width
Finland	5.30 m (KU)	3.40 m (KU)
ex-Soviet Union	5.30 m	3.25 m
Sweden	4.83 m (C) 4.65 m (A)	3.60 m (C) 3.40 m (A)
High Speed 1, Eurotunnel, Betuwe, Øresund, Lötschberg Base Tunnel etc.	4.65 m (GC)	3.15 m (GC)
Albania, Austria, Bulgaria, Greece, Czechia, Denmark, Germany, Hungary, Luxembourg, Netherlands, Poland, Romania, Slovakia, ex-Yugoslavia	4.65 m (G2)	3.15 m (G2)
Belgium	4.602 (GB-M6)	3.15 m (GB-M6)
Switzerland	4.60 (EBV O2) 4.50 (EBV O1)	3.15 (EBV O1, O2)
Norway	4.595 m (M)	3.40 m (U)
Portugal	4.50 m (Cpb+)	3.44 m (Cpb+)
Spain	4.33 m (Iberian)	3.44 m (Iberian)
France	4.32 m (GA, GB, GB1)	3.15 m (GA, GB, GB1)
Italy	4.28 m (G1)	3.15 m (G1)
Ireland	4.039 m (wagons)	2.90 m (wagons)
Great Britain	3.890 (UK1)	2.844 m (UK1)

Table 3: Railway loading gauge maximum dimensions in Europe and the Caucasus

As seen in Table 3, European mainline railway loading gauges range in maximum height from 3.89 m (UK, loading gauge UK1) to 5.30 m (Finland and the former Soviet Union), and in maximum width from 2.84 m (UK, loading gauge UK1) to 3.60 m (Sweden, loading gauge C).

Thus, compared to the size limitations on the highway, the railway loading gauges are wider and in most cases taller as well, with few exceptions. The geographical distribution of railway loading gauges in Europe is shown in Figure 2. On the European standard track gauge network, the most prevalent loading gauge is the German G2 gauge, which applies in a contiguous belt from Denmark and the Netherlands in the northwest to Turkey in the southeast.

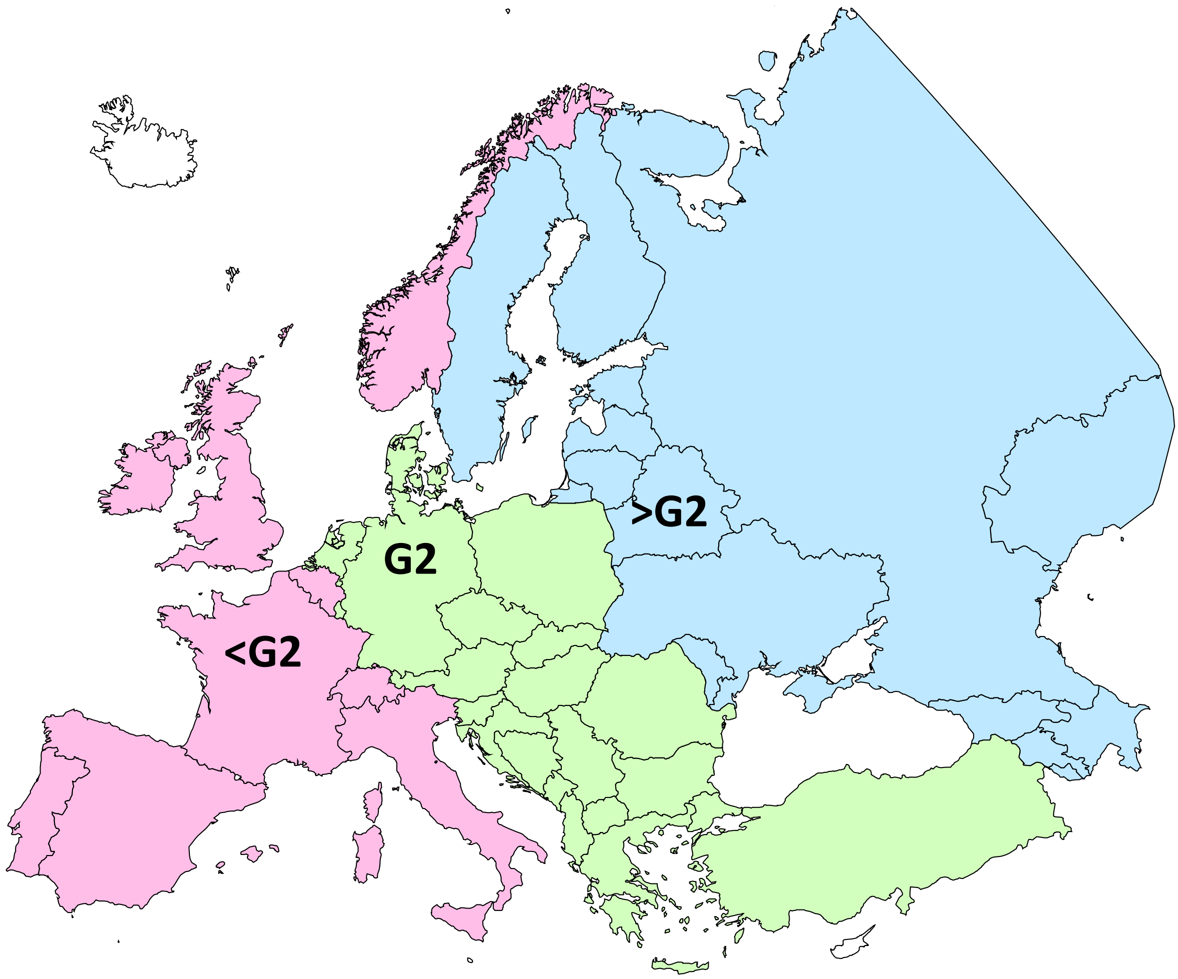

Figure 2: Geographical distribution of railway loading gauges in Europe and the Caucasus

The usefulness of the railway loading gauges is reduced by the typically tapered or rounded shape of their upper portion.

For the purpose of intermodality with highway and seaway transportation, railway intermodal gauges of rectangular cross section are defined by the International Union of Railways (UIC) for widths approximating marine standards and highway limits, up to 2.50 m and up to 2.60 m, respectively. Discussion here will be confined to 2.60 m width only, as being the more demanding.

UIC code 571-4 sets the maximum heights of container mounts to 1.175 m and trailer pockets to 0.33 m above top of rail (ATOR), in accordance with early container and trailer wagon designs ("types 1a and 1b") [12]. Based on these standard heights, coding of intermodal load units for 2.60 m width is as follows [13,14]:

- trailers of extreme height ### cm on the ground are coded P ### (P=pocket), and reach up to ###+33 cm ATOR when loaded onto a standard pocket wagon;
- containers and swap bodies of extreme height ### cm on the ground are coded C ###+85 (≈ 84.5) (C=container), and reach up to ###+85+33 cm (≈ +117.5 cm) ATOR when loaded onto a standard container wagon.

Railway line intermodal gauges are coded P/C. The height relationships are shown in Figure 3 for an example of P/C 450.

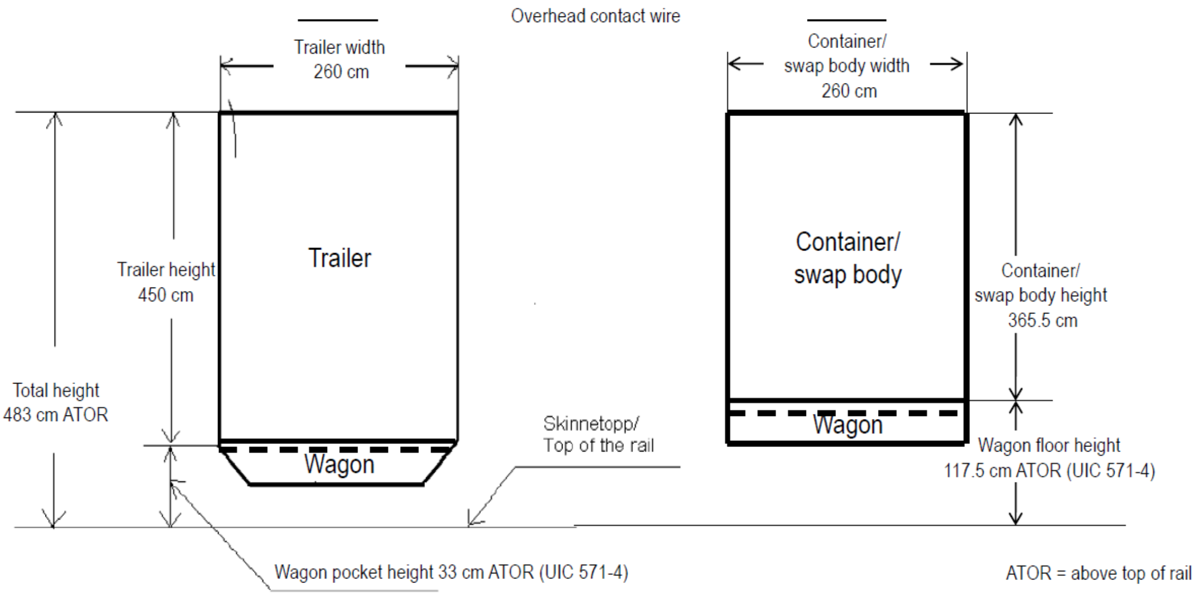

Figure 3: Definition of intermodal gauge P/C 450

In practice, most modern container and trailer wagons are lower at approximately 1.15 m and 0.27 m, respectively, thereby enabling slightly taller loads than the nominal wagon heights. Low-floor container wagons with 0.825 m floor height are also available. Examples of intermodal load unit heights that can be handled within P/C 450 are given in Table 4.

Wagon container mount height ATOR	**Wagon type, examples**	**Max. container/swap body height within P/C 450**
1.175 m	UIC 571-4	3.655 m
1.150 m	Sdggmrss-t	3.680 m
0.825 m	Sffggmrrss	4.005 m
Wagon pocket height ATOR	**Wagon type, examples**	**Max. trailer height within P/C 450**
0.330 m	UIC 571-4	4.500 m
0.270 m	Sdggmrss, Sdgmns	4.560 m

Table 4: Maximum load unit height in P/C 450 as a function of actual wagon height

The available clearances for intermodal gauges are being enlarged gradually, by removing existing obstacles, particularly at the “top corners”. The prevalent intermodal gauges in continental Europe are as follows [15,16,17]:

- P/C 410, 422, 432 and 450 in Sweden
- P/C 410 in Austria, Denmark, Germany, Hungary, Netherlands, Norway
- P/C 400 in Belgium, Poland
- P/C 384, 405 in Switzerland
- P/C 377 in Czechia, Slovakia
- P/C 364 in Portugal, Spain
- P/C 359, 385 in France
- P/C 351, 364, 410 in Italy.

Thus, semi-trailers of 4.00 m height and containers and swap bodies of 3.15 m height are able to travel through much of northern Europe on lines cleared for P/C 400 or higher, using standard wagons. In much of southern Europe, in contrast, low-floor wagons must be used, or load heights must be restricted further.

Mass limits depend on the combination of permitted axle load and wagon design. While axle load limits depend on wheel diameter, operating speed and track construction, intermodal wagons are available with two, four or six axles. As an example, modern two-trailer wagons are available for load limits of 2□43 tons at 120 km/h, well above the highway mass limits per trailer [18]. Thus, the mass limits of modern intermodal wagons do not restrict the lading in the trailers, but wagon mass limits may be reached with heavy containers.

Volume, on the other hand is a real constraint, as many railway lines in northern and southern Europe have insufficient clearances to carry intermodal loads up to the same heights as permitted on the highways in the same region.

3 INTERMODAL COORDINATION

In a truly intermodal transportation system, overall efficiency is enhanced by combining modes to exploit the relative strengths of each while circumventing their relative weaknesses. Thus the high highway clearances of the British Isles, France and Scandinavia can be exploited while avoiding the comparatively low railway clearances of the British Isles and France. To connect these regions, however, the lower highway clearances in the nations in between are an obstacle that can be circumvented by using either rail or ocean transit.

4 THE FRAN-SCAN HI-CUBE INTERMODAL CORRIDOR (P/C 450)

The tall vehicles permitted on the highways of the British Isles, France and Scandinavia contribute to transport efficiency in their home regions, but international movement is hampered by missing links. While ferries and ro-ro ships link seaports of France, Ireland and Great Britain with each other, and Great Britain with Norway and Sweden, no such service is found between France and Scandinavia.

Would a rail corridor between Britain, France and Scandinavia with sufficient clearances to carry 4.50 m tall semi-trailers be feasible? Such a rail corridor would need to bridge the intermediate nations where highway clearances are lower. An approximate route is shown in Figure 4.

The distance that needs to be bridged is that between northern France and southern Sweden. Thus, to link southern England, northern France and southern Sweden by a direct rail route, the route that will be studied is Folkestone – Calais – Lille – Malmö.

Using existing logistics hubs and rail lines and benefitting from new, already planned links, a feasible route may through Folkestone – Eurotunnel – Calais – Lille – Rotterdam – Osnabrück – Hamburg – Fehmarnbelt – København – Øresund – Malmö. In Malmö it would connect north toward Oslo and toward Stockholm and Helsinki (by ferry). In addition to serving the end markets, it would also link and provide higher clearances to the seaports of Calais, Gent, Antwerpen, Rotterdam, Bremen, Hamburg, Lübeck, København and Malmö.

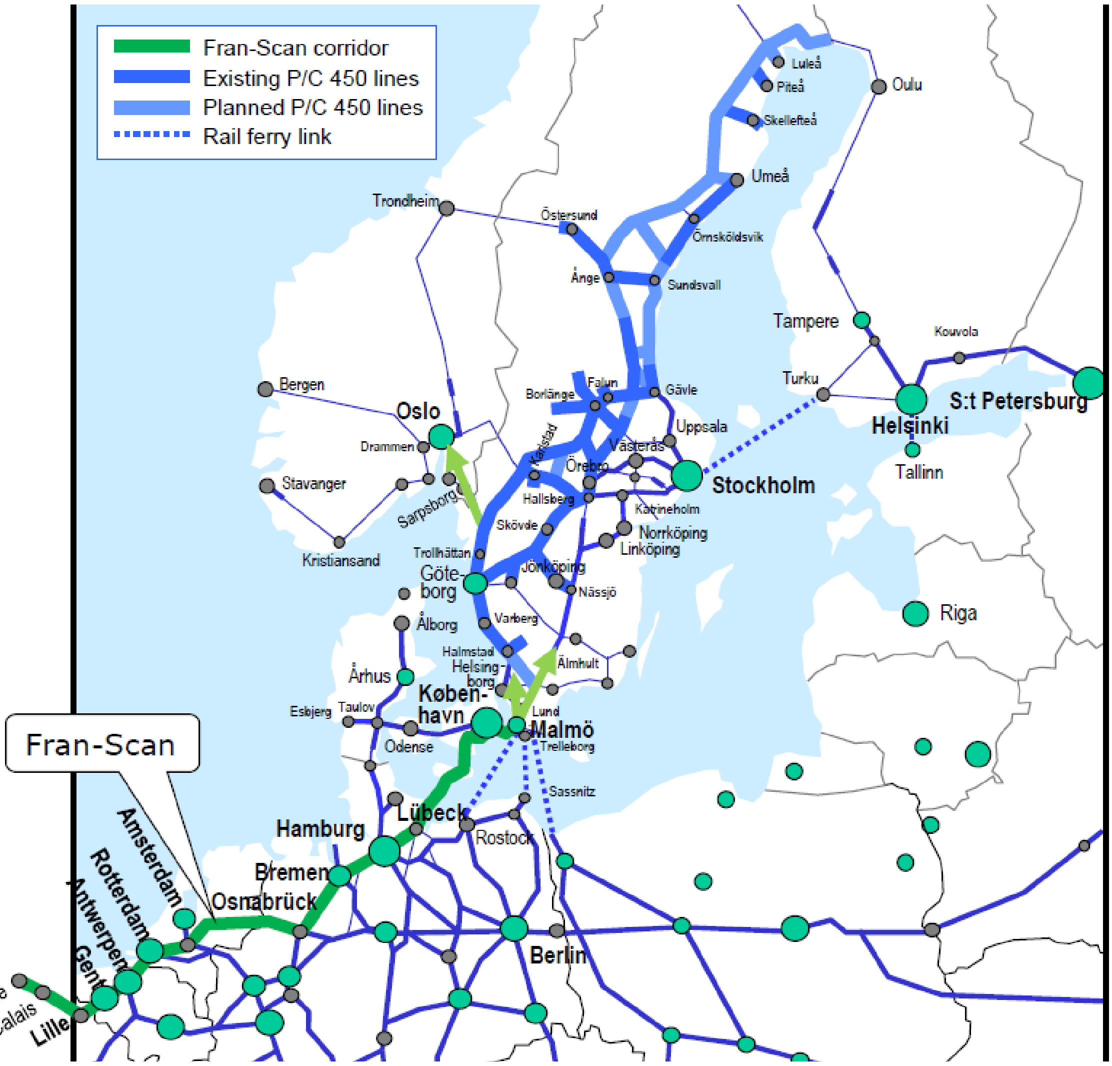

Figure 4: The Fran-Scan hi-cube intermodal corridor

The present loading gauges and intermodal gauges along this corridor are shown in Figure 5, in reference to the overhead line (OHL) and top of rail (TOR) levels [19].

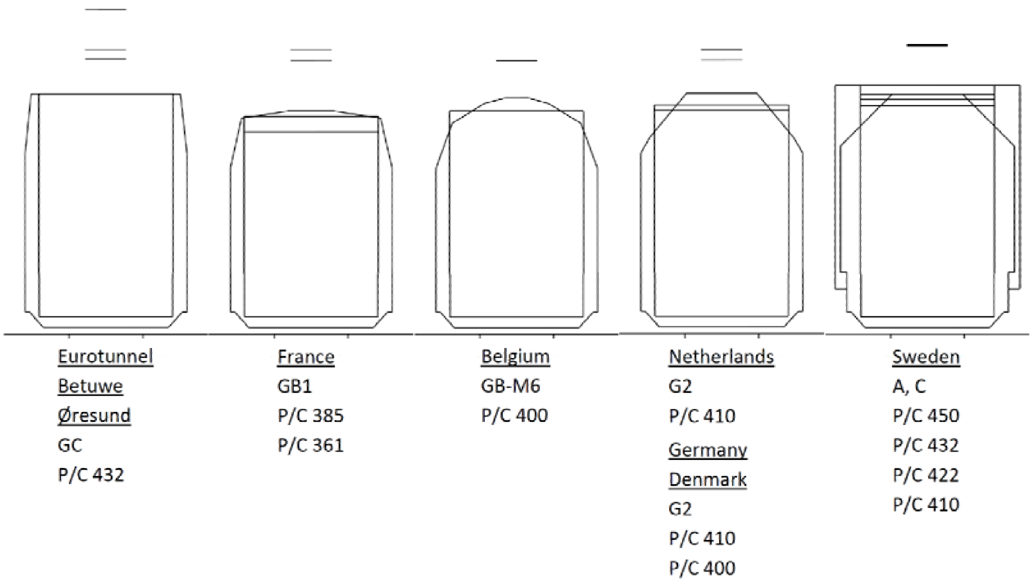

Figure 5: Present railway loading and intermodal gauges in the Fran-Scan corridor

From the west, the Eurotunnel railway between Folkestone in Britain and Calais in France already has high clearances, built from the beginning with UIC loading gauge GC which is 4.65 m tall and capable of intermodal gauge P/C 432, and with the OHL installed as high as 6.30 m ATOR.

Between Calais and Lille and toward the border with Belgium, the conventional (non-LGV) railway line has loading gauge GB1, which is 4.32 m tall and capable of intermodal gauge P/C 385. Normal OHL height in France is 5.50 m ATOR.

Through Belgium the loading gauge is GB-M6, which is 4.602 m tall and expanded at the “top corners” to intermodal gauge P/C 400. Normal OHL height in Belgium is 5.30 m ATOR.

Through the Netherlands, Germany and Denmark the loading gauge is G2, which is 4.65 m tall and expanded at the “top corners” to intermodal gauge P/C 410. Exceptions exist: The railway between Hamburg and Lübeck has a short section near Bad Oldesloe coded as intermodal gauge P/C 405, and the line between Rødby and Ringsted is coded as P/C 400. Normal OHL height in the Netherlands, Germany and Denmark is 5.50 m ATOR, but 5.30 m on high speed lines.

On the Øresund railway between København and Malmö the loading gauge is GC, which is 4.65 m tall and capable of intermodal gauge P/C 432, and with the OHL installed at 5.33 m ATOR.

Finally, in Sweden the loading gauge between Øresund and Malmö is Swedish A, which is 4.65 m tall and expanded at the “top corners” to intermodal gauge P/C 410 or 422. Normal OHL height in Sweden is 5.60 m ATOR. Malmö is the confluence of railways and highways from Norway via Göteborg and from Finland via Stockholm. Most of the railway from Göteborg is cleared for P/C 422 or 450, and that from Stockholm for P/C 422 or 432. Many lines in Sweden are cleared for Swedish loading gauge C, which is 4.83 m tall and capable of intermodal gauge P/C 450. This network is being extended steadily with additional lines being cleared.

The data above and in Figure 5 shows that the loading gauges and intermodal gauges presently applying in the studied Fran-Scan corridor are less than the P/C 450 needed to carry the tall semi-trailers of 4.50 m height. But it also shows that the normal overhead contact line installation is quite tall.

To assess the possibility of raising the present loading and intermodal gauges to accommodate P/C 450, the necessary clearance and the resulting OHL height needed will be investigated, top-down.

Calculation of overhead line minimum design height (example):

- OHL construction tolerance		30 mm
- Contact line dynamic movement		50 mm
- Electrical minimum clearance [20,21]		
25 kV	220 mm	
15 kV	150 mm	
3 kV	50 mm	
1.5 kV	35 mm	
- Vehicle dynamic movement		50 mm [19]
- Intermodal gauge height, P/C 450 (static)		4830 mm [13,14]
- Track ballast tamping allowance		50 mm [20]
Minimum height of OHL		5045 mm to 5230 mm

The calculation shows that the minimum design height of overhead line needed is 5045 mm to 5230 mm, depending on OHL voltage and including an OHL construction tolerance and a ballast tamping allowance.

The needed design height of the overhead line per above is compared with the normal OHL height according to the national construction standards for the proposed route of the Fran-Scan corridor, see Table 5. This will indicate whether sufficient clearance is already available between the P/C 450 intermodal gauge and the OHL.

Corridor segment	**Overhead line voltage**	**Electrical clearance needed**	**Overhead line height needed for P/C 450**	**Overhead line normal height**	**Overhead line normal height sufficient for P/C 450**
Eurotunnel	25 kV	0.22 m	5.23 m	6.30 m	yes
France	25 kV	0.22 m	5.23 m	5.50 m	yes
Belgium	3 kV	0.05 m	5.06 m	5.30 m	yes
Netherlands	1.5 kV	0.035 m	5.045 m	5.50 m	yes
Betuwe line	25 kV	0.22 m	5.23 m	5.50 m	yes
Germany	15 kV	0.15 m	5.16 m	5.30 m, 5.50 m	yes
Denmark	25 kV	0.22 m	5.23 m	5.30 m, 5.50 m	yes
Øresund	25 kV	0.22 m	5.23 m	5.33 m	yes
Sweden	15 kV	0.15 m	5.16 m	5.60 m	yes
Norway	15 kV	0.15 m	5.16 m	5.50 m	yes

Table 5: Railway electrical overhead line heights for P/C 450

As shown in Table 5, the study indicates that the normal height of the overhead line is sufficient to accommodate P/C 450 for all corridor segments. This is promising, indicating that sufficient vertical clearance should be available over most of the corridor distance involved. However, there may also be spots where the overhead line is installed below the normal height, and where it may need to be raised to give sufficient clearance for P/C 450.

Apart from the overhead line with its (normal) ±0.4 m stagger, other obstacles to the proposed gauge enlargement may also be present, which must be checked for along the proposed route.

A survey is needed of the extent of low spots and other obstacles present, and an assessment of the cost of raising the overhead line and any other obstacles to (at least) the height needed.

Looking forward, much of the distance between Hamburg and København will be upgraded or newly constructed in connection with the Fehmarnbelt fixed link, which is due to open in 2020:

- triple tracking Hamburg – Ahrensburg or further
- double tracking and electrification Bad Schwartau – Puttgarden (2027)
- new tunnel or bridge Puttgarden – Rødby
- double tracking and electrification Rødby – Vordingborg
- electrification Vordingborg – Ringsted
- new double track and electrified line Ringsted – Køge – København.

This is the opportunity to secure adequate clearances needed for the future over a significant section of line and as part of the proposed Fran-Scan corridor.

5 CLEARING A PATH BELGIUM TO BRITAIN FOR WAGONLOAD (G2)

Although railway intermodal traffic has been growing rapidly over recent years [1], wagonload service still moves more freight than intermodal in many corridors, and the impact of clearances on wagonload should be considered as well. A key merit of wagonload is that the load limit and cubic capacity far exceed the capacity of intermodal loads, compared either per wagon or per meter of track. Thus, where tracks are available, wagonload has the capability of moving large amounts of freight very efficiently.

Large fleets of railway or leasing company-owned wagons are built either to the larger G2 gauge (3.15 m x 4.65 m), able to travel through northern, central and eastern Europe but unable to enter south western Europe, or to the smaller G1 gauge (3.15 m x 4.28 m), able to travel across most of Europe except the British Isles. The benefit of the G2 loading gauge is its higher cubic capacity per meter of track and per wagon, approximately 11% higher for a modern sliding-door wagon built to G2, compared with G1. For commodities with specific dimensions, such as newsprint rolls, the height itself may also be important.

In conjunction with the proposed Fran-Scan intermodal corridor lies an opportunity to significantly benefit wagonload service as well. By only minor additional gauge clearing, a path could be opened for wagons of the G2 gauge to travel through Belgium and northern France and into Great Britain as far as to London (Barking) [22]. From Calais via Folkestone to London, the Eurotunnel and High Speed 1 (formerly Channel Tunnel Rail Link) railway lines are constructed from the beginning to the GC (3.15 m x 4.65 m) loading gauge, and thus already capable of handling wagons built to the G2 loading gauge. In Belgium and northern France, in contrast, the connecting conventional (non-LGV) railway lines are cleared only for the GB-M6 (3.15 m x 4.602 m) and GB1 (3.15 m x 4.32 m) loading gauges, respectively, and therefore unable to handle wagons of the G2 loading gauge, but only wagons of the G1 gauge.

Clearing a route to the Eurotunnel for the P/C 450 intermodal gauge, this gauge in combination with the existing GB-M6 and GB1 loading gauges will almost enclose the G2 loading gauge as well, but for a small portion at the “roof corner”. The combined gauges are shown in Figures 6 and 7.

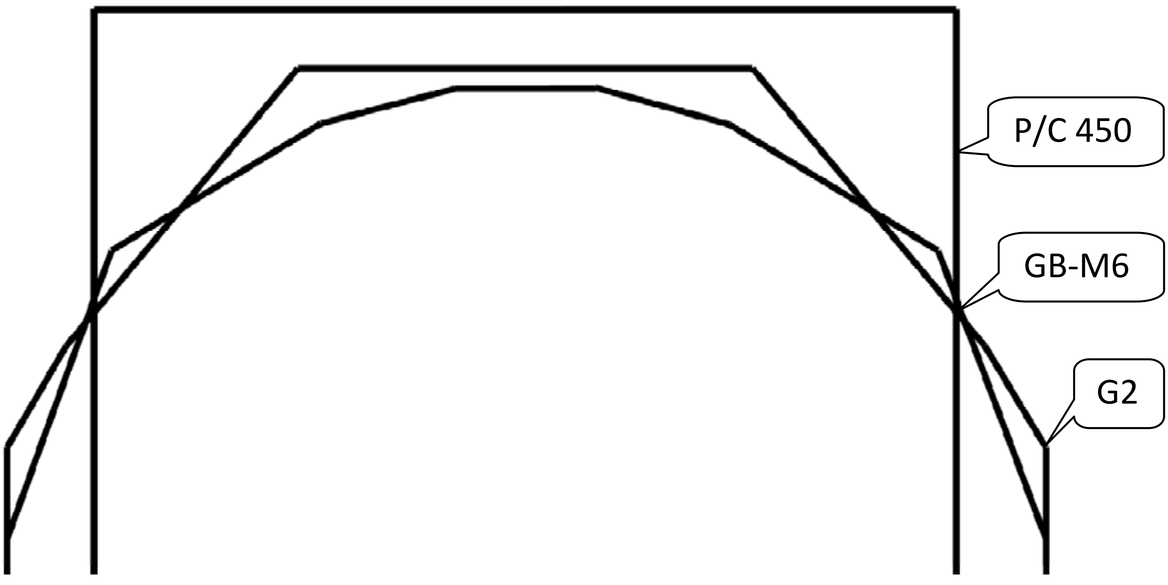

Figure 6: Belgium: loading gauges GB-M6, G2 and intermodal gauge P/C 450 compared

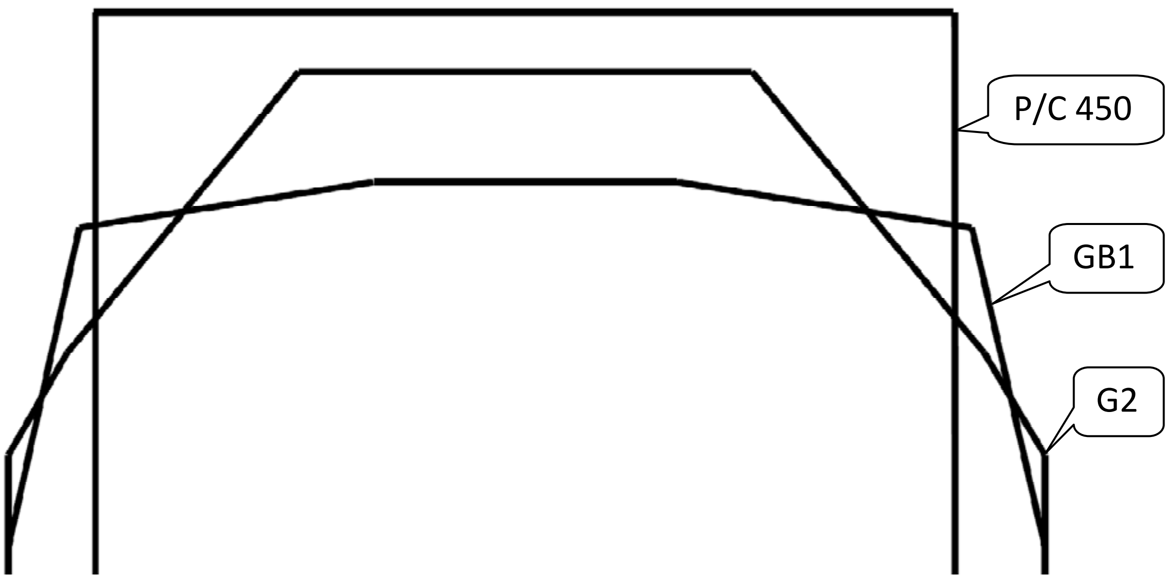

Figure 7: France: loading gauges GB1, G2 and intermodal gauge P/C 450 compared

Thus, when raising clearances through Belgium and France on GB-M6 and GB1 lines to accommodate the P/C 450 gauge, for minimal additional clearing at the "roof corners", a path is also achieved that can accommodate wagons of the larger G2 loading gauge.

With the Fran-Scan route as outlined above in Section 4, this would open access for the larger G2 gauge wagons to the seaports of Antwerpen, Gent and Calais as well as to the logistic hubs of Lille and Folkestone and into London.

6 CONCLUSIONS AND RECOMMENDATIONS

Normal highway vertical clearances higher than 4.0 m exist in Iceland (4.2 m), Norway (4.5 m), Finland (4.2 m), Sweden (4.5 m), France (4.5 m), UK (4.95 m), Ireland (4.65 m) and Macedonia (4.1 m). Highway trailers of corresponding height are prevalent in these regions.

Carrying highway trailers of up to 4.5 m height by rail between these regions would provide a service that the international highways can not provide presently.

Highway trailers of 4.5 m height can be carried by rail on UIC standard pocket wagons within the Swedish railway loading gauge C and intermodal gauge P/C 450.

Intermodal gauge P/C 450 can be handled within Swedish loading gauge C.

Existing vertical clearances to railway electric overhead line normal heights are sufficient to carry highway trailers of 4.5 m height by rail on UIC standard pocket wagons Norway – Sweden – Øresund – Denmark – Germany – Netherlands – Belgium – France – Eurotunnel – Folkestone, although lower spots may exist in isolated locations.

Minor additional gauge enlargement would open Belgium, northern France, Folkestone and London to the G2 loading gauge, which is used by the larger enclosed wagons of northern and eastern Europe.

When upgrading (e.g. electrifying) or building new railway lines, it is important to secure large clearances, matching or surpassing other links of the same corridor. Large, flat-top loading gauges are desired, as shown in Figure 8.

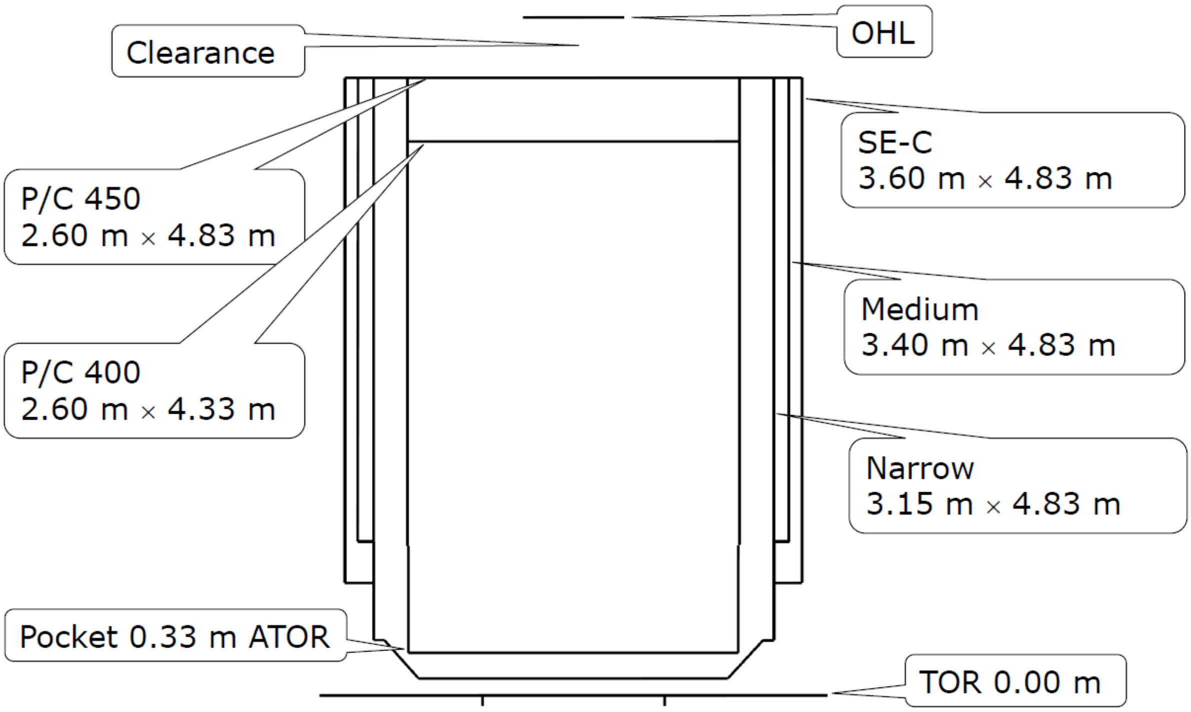

Figure 8: Desired flat-top loading gauges for new or rebuilt lines

7 FUTURE WORK

The next step to realizing the proposed Fran-Scan hi-cube intermodal corridor should be a detailed feasibility study, including:

- definition of candidate routes
- survey of the existing actual clearances along candidate routes
- cost analysis for clearing existing obstacles to the P/C 450 and G2 gauges
- cost analysis for clearing existing obstacles further, to 3.15 m × 4.83 m rectangular, or larger
- market analysis
- cost/benefit analysis.

The effort needs to be coordinated internationally to include the corridor in its entirety, primarily Folkestone – Lille – Malmö, and possible branches and extensions.

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LIST OF AUTHORS

Dr GIULIO BERNETTI
Municipality of Trieste
bernettig@comune.trieste.it

HANS BOYSEN
Royal Institute of Technology, Department of Transport Science
heboysen@kth.se

Prof Dr MATTHIAS GATHER
University of Applied Sciences Erfurt, Transport and Spatial Planning Institute
Matthias.gather@fh-erfurt.de

Dr TAMÁS HARTVÁNYI
István Széchenyi University Győr, Institute of Built Environment and Transport
hartvanyi@sze.hu

GÁBOR HORVÁTH
István Széchenyi University Győr, Institute of Built Environment and Transport
gabhor@sze.hu

NATALIYA KORZHYNSKA
Scheller Systemtechnik GmbH, Devision Port Logistics
n.korzhynska@scheller.de

Dr FABIO LAMANNA
Complex Transportation Networks
fabio@timenetwork.org

ATTILA LÜTTMERDING
University of Applied Sciences Erfurt, Transport and Spatial Planning Institute
attila.luettmerding@fh-erfurt.de

OLAF POENICKE
Fraunhofer Institute for Factory Operation and Automation IFF, Material Handling Systems Expert Group
olaf.poenicke@iff.fraunhofer.de

Prof Dr VITTORIO TORBIANELLI
Universitá degli Studi di Trieste, DICAR − Dipartimento di Ingegneria Civile e Architettura
vittoriot@econ.units.it