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Decision Support System for Intermodal Transport Policy

"DSSITP"

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FINAL REPORT

DECISION SUPPORT SYSTEM FOR INTERMODAL TRANSPORT POLICY
"DSSITP"

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ACRONYMS, ABBREVIATIONS AND UNITS

CTP	Common Transport Policy
DCW	Digital Chart of the World
DSSITP	Decision Support System for Intermodal Transport Policy
EC	European Commission
ESRI	Environmental Systems Research Institute
EU	European Union
FP	Framework Programmes
GDP	Gross Domestic Product
GIS	Geographic Information Systems
ILU	Intermodal Loading Units
LAMBIT	Location Analysis Model for Belgian Intermodal Terminals
MOS	Motorways of the sea
Narcon	National Rail Container Network
NIS	Nationaal Instituut voor de Statistiek
OR	Operations Research
PPP	Public Private Partnerships
RTD	Research and Technological Development
SIMBA	Simulation model for InterModal BArge transport
TEN-T	Trans European Transport Networks
TEU	Twenty-Foot Equivalent Unit

CHAPTER I

STATE OF THE ART IN INTERMODAL TRANSPORT

1 INTRODUCTION

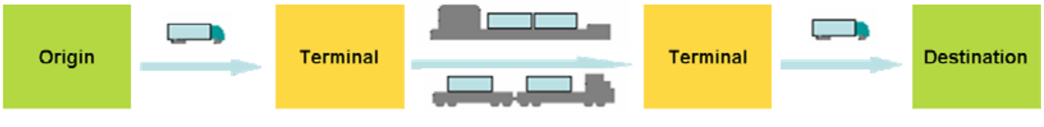
In recent years intermodal transport has received an increased attention due to problems of road congestion, environmental concerns and traffic safety. A growing recognition of the strategic importance of speed and agility in the supply chain is forcing firms to reconsider traditional logistic services. As a consequence, research and policy interest in intermodal freight transportation problems is growing. Macharis and Bontekoning (2004) define intermodal transport as the combination of at least two modes of transport in a single transport chain, without a change of container for the goods, with most of the route travelled by rail, inland waterway or ocean-going vessel and with the shortest possible initial and final journeys by road. Intermodal transport may include various types of transport modes. In this project we concentrate on the combination rail/road and waterways/road using containers as loading units.

In the next section we give a short introduction to intermodal transport by defining the intermodal chain and the actors involved. In section 3 the intermodal cost structure is compared to the one of unimodal road transport. Also the external costs of the two types of transportation modes are compared (section 4). In section 5 the intermodal terminal landscape is shown. Several new terminals were built during the last decade. We conclude by giving the available data on the intermodal transport market share.

2 THE INTERMODAL TRANSPORT CHAIN : ACTORS INVOLVED

Figure 2 describes an integrated intermodal transport chain, which can be divided into three distinct operations: drayage, transhipment and main (long) haulage. Drayage, usually done by road transport, exists in two ways. Pre-haulage is the transportation of goods from the origin to an intermodal terminal and post-haulage from an intermodal terminal to the final destination. Transhipment takes place in the intermodal terminals, moving the intermodal load unit from truck to a wagon, inland waterway vessel or a shortsea ship and vice-a-versa. The intermodal load unit (ILU) can be a container, a swap body or another type of standardised load unit. Finally, the main haulage between intermodal terminals is done by rail, inland waterway or shortsea shipping. Larger capacity provides economies of scale in the main haulage.

Figure 1: Intermodal transport chain



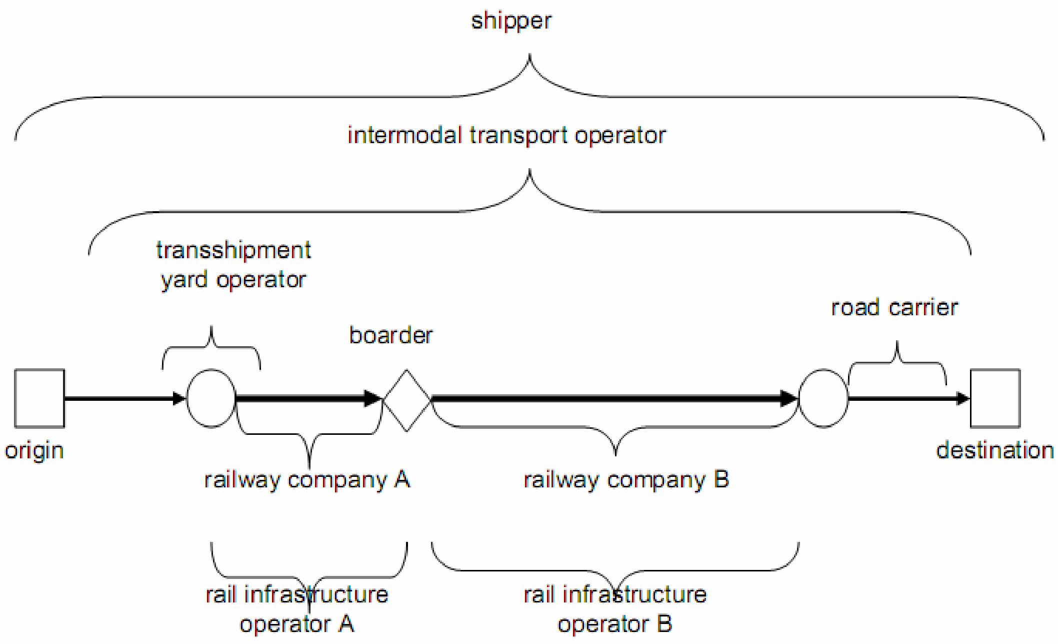
Source: Own setup

The customer may be the shipper (the owner of the cargo), but more often intermediate companies such as freight forwarders, shipping liners or other logistics service providers are involved. In intermodal transport, different logistics chain configurations may involve different types of actors or the same types but playing different roles.
Users of intermodal transport - the demand side - include shippers, forwarders, ocean shipping lines and logistics service providers. Shippers initiate the movement of cargo between locations directly or on their behalf contracts. Intermodal transport services are optimised by freight forwarders on behalf of shippers. Furthermore, logistics service providers offer a wide range of services such as warehousing in order to ensure cargo is available on time for the customers.

On the supply side, terminal, rail, inland navigation, shortsea, road and intermodal transport operators are involved. Operational organisation places terminal operators in the core of the intermodal transport chain by their role in transhipping intermodal loading units between the main haul and drayage. Transport operators handle the movement of the loading units between terminals via rail, inland waterway or sea routes respectively and road transport operators arrange the local transportation of cargo from origin and destinations. Offering door-to-door or terminal-to-terminal transport, intermodal transport operators procure transport and transhipment services. In addition to these purely commercial market players, public sector can also be included in the supply side of intermodal transport. Infrastructure managers, port authorities and regional, national public authorities and international institutions contribute to making the best possible use of infrastructure and provide an environment to encourage intermodal initiatives. The roles on the supply side of intermodal transport are complementary. Each player has to contribute to be able to produce a viable intermodal transport service.

Intermodal transport systems resemble a complex web of actors. Figure 3 represents a rail-based intermodal chain, where 13 individual actors can be detected. Additional actors such as container and locomotive leasing companies, freight forwarders and 3PL, real estate owners and public authorities can also be added. Transportation between two countries (one border) and only two modes (road and rail) make this sketch a simplified one.

Figure 2: Intermodal actors

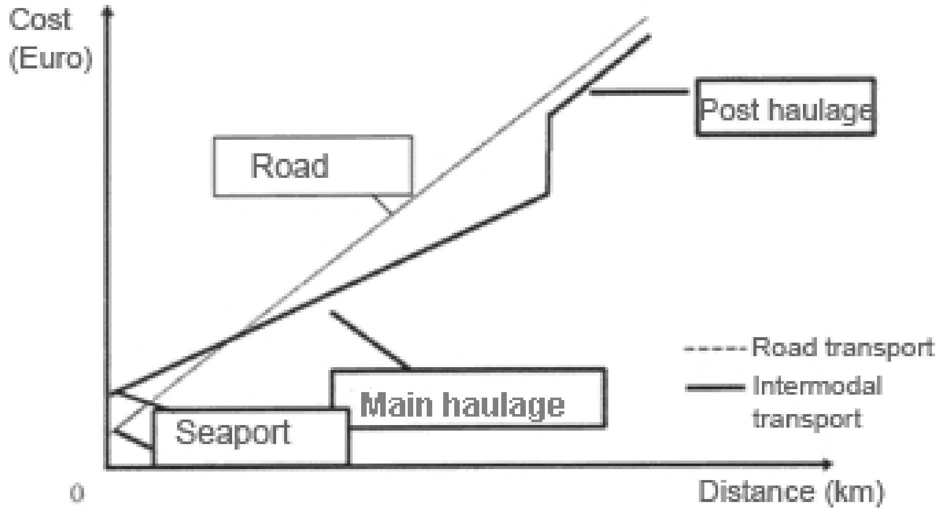


Source: Savy, 2007

3 THE INTERMODAL COST STRUCTURE

Since several types of transport are included in an intermodal transport chain, intermodal transport costs involve a variety of transport activities. Figure 4 represents the intermodal cost function. Taking a door-to-door intermodal transport chain, the function allows calculating total intermodal transport cost between an origin and a destination.

Figure 3: Intermodal cost function

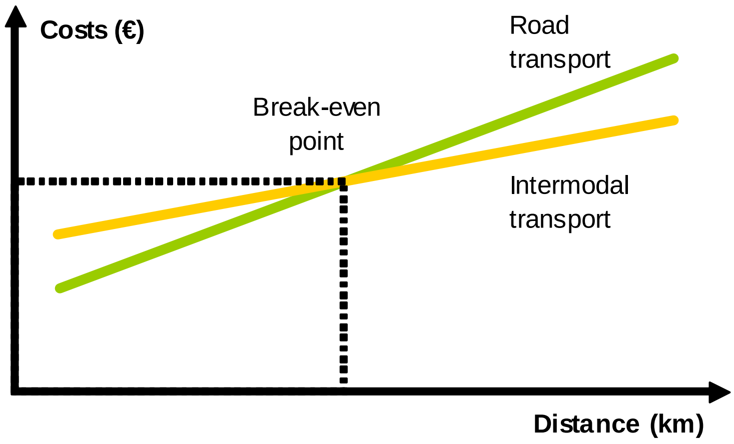


Source: Macharis and Verbeke, 2004

At the port intermodal transport has larger handling costs. This is due to the cranes that are being used for the transhipment of containers on barges. For rail transport in theory the same equipment as for road transport can be used (i.e. reach stackers). The advantage of intermodal transport lies in the smaller unit costs, as a result of the scale economies that are obtained by the large capacities that can be used. At the end of the chain, this advantage is partly compensated by the extra handling cost that has to be paid for the inland terminal handling. Also the end haulage by road has to be taken into account.

Once the total intermodal cost is calculated, it is possible to make comparisons with road-only transport. One of the most important modal choice criteria is transport costs, which is correlated with the distance travelled. Thus, this relationship enables us to understand which transport alternative is preferred in a given situation based on the concept of break-even. The total costs of road transport and intermodal transport are shown in Figure 5. Road-only transport performs better compared to intermodal transport for short distances. Once a certain distance is achieved, the costs of road and intermodal transport are equal. This is called the break-even point. The figure also shows that road transport has a lower fixed cost. This is explained by the costs of transhipment and drayage that are included in an intermodal transport chain. Above the break-even point, intermodal transport costs are lower than those of unimodal road transport.

Figure 4: Break-even point



Source: Macharis, 2004

The break-even distance reacts to the changes in the cost components of road and intermodal transport. The lines will move downward, if the fixed costs decrease. For example, a decrease in the dues for intermodal transport would shift the yellow line downwards and reduce the break-even distance. The slope of the lines reacts to the changes in the variable costs. For example, the increases in fuel prices would make the green line steeper, shifting the break-even point to the left.

Studies have been commissioned to analyse the break-even distances for each transport mode. In 1994, the Dutch Ministry of Transport calculated break-even distances of 100-250 kilometres for inland navigation and 200-400 kilometres for railways (Van Duin and Van Ham, 2003). In Belgium, inland waterway transport can be cheaper than road transport above 90 kilometres (Macharis, 2000). At the European scale, intermodal services over 600 kilometres usually prove viable, while services over distances of 100 kilometres can rarely compete with road transport (Vrenken et. al., 2005).

These studies mainly are using averages costs. Scale economies gained by the main haulage leg of an intermodal transport chain can further be increased by an introduction of larger vessels or longer train wagons. Also if thanks to intermodal transport, empty container transport can be avoided, for example if the intermodal terminal can function as an empty depot for containers, again the total cost will decrease.

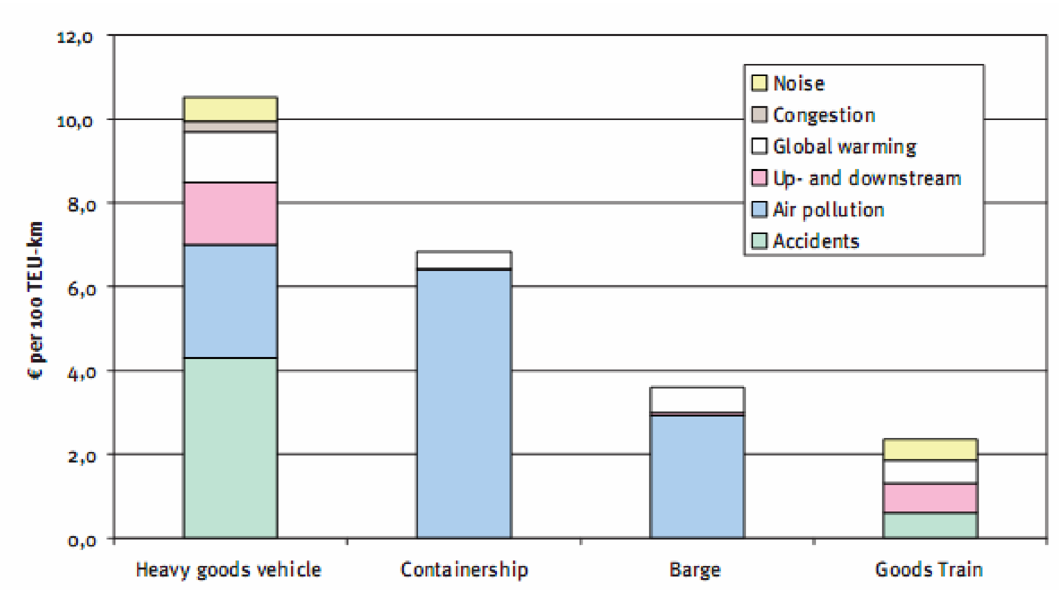
4 THE EXTERNAL COSTS OF INTERMODAL TRANSPORT COMPARED TO ROAD TRANSPORT

An external cost, also known as an externality, arises when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group. These social costs compromises all costs related to usage of transport infrastructure such as wear and tear costs, capital costs, congestion costs, accident costs and environmental costs.

In a review of the external effects of intermodal transport versus road transport, Kreutzberger, Macharis and Woxenius (2006) concluded that intermodal transport is, in most cases, more friendly to the environment than road-only transport and it can help to reduce congestion. The studies can be distinguished between those who use average indicators and give an idea on the effect of the transport modes for the whole transport system (top-down approach) and those who are calculating the costs for specific trajectories (bottom-up approaches).

An example of a top-down approach, is shown in Figure 6 where the external costs due to freight transport are calculated for the whole transportation sector per transport mode. Costs for heavy goods vehicles are very high, mainly due to accident and air pollution costs. On the other hand the containership, which scores low in accidents and noise, has relatively high air pollution costs mainly due to the high NOx emissions. Similar data are also noticed in inland waterways (barge) but on a smaller scale. Finally, freight trains encompass a comparably low cost due to lower air emissions.

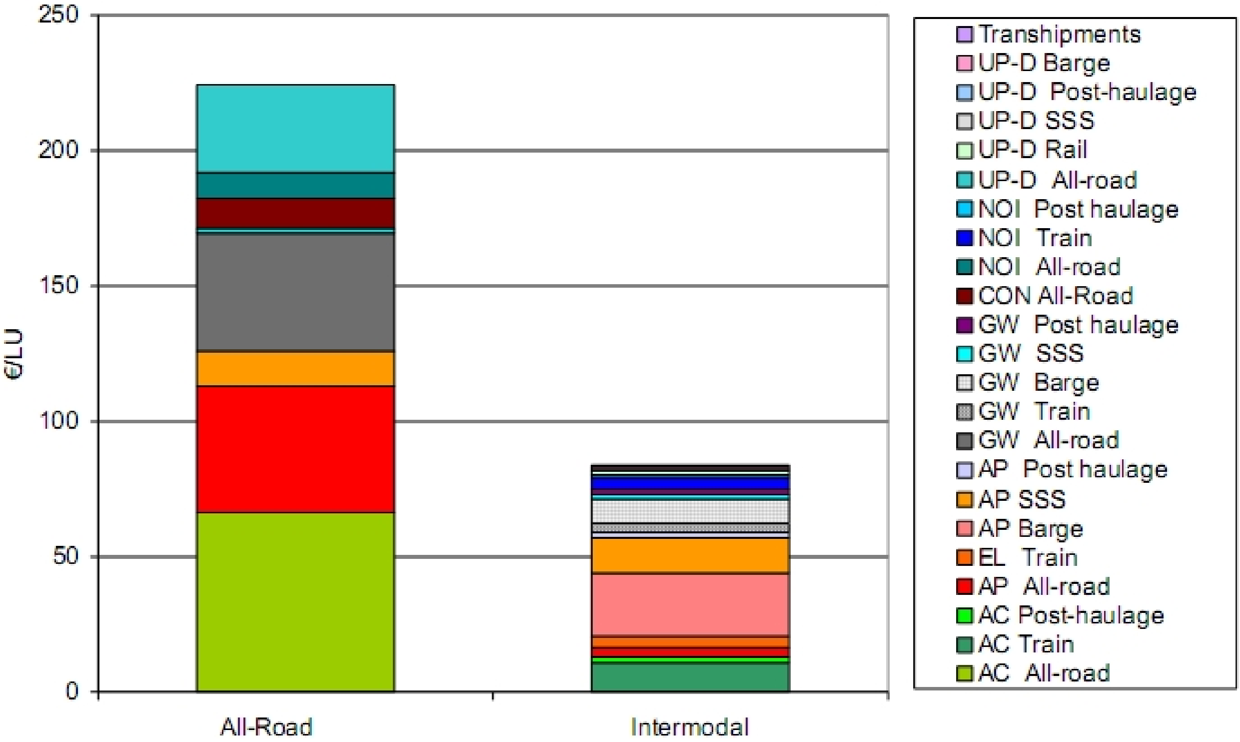
Figure 5: External costs of freight transport



Source: European Commission, 2003

A good example of bottom-up approach can be found in the European project RECORDIT. In this project the external costs of unimodal road transport and intermodal chains were calculated on selected freight corridors. The entire range of external costs are taken into account: air pollution, noise, accidents, congestion, global warming, and up- and downstream processes. For the route between Genova, Basel, Rotterdam and Manchester, where road, rail and shortsea shipping is included, the study concludes that intermodal transport accounts for 38 per cent of the external costs of road-only transport. Figure 7 presents the external costs for road transport and for the intermodal chain. For road transport, accident costs (29.5 per cent) have the highest share, followed by air pollution (20.9 per cent), global warming (19.5 per cent) and up- and downstream processes (14.5 per cent). Noise and congestion account for 5 per cent each.

Figure 6: External costs on the intermodal corridor Genova-Manchester



Source: RECORDIT, 2002

A North-South route is analysed between Patras via Brindisi and Munich to Gothenburg, where the results indicate intermodal transport's external costs to be 52 per cent of the external costs of road-only transport.

For the route Barcelona-Warsaw, only road and rail transport are included. This East-West route shows that intermodal transport generates about 38 per cent of the external costs of road-only transport. Over 50 per cent of the external costs are attributed to the higher accident risks for this route.

To conclude, by using intermodal transport authorities, policy makers, and the society at large will benefit as a result of less emission, energy use and a decrease in congestion.

One has however to keep in mind that the improvements induced by intermodal transport are to be considered globally and that, at the local level, intermodal transport can generate additional trucking to and from the terminals, which are often located in already congested areas.

5 THE INTERMODAL TERMINAL LANDSCAPE IN BELGIUM

Table 1 gives an overview of the intermodal terminals in Belgium. There are 19 terminals in Belgium in 2008: 6 rail terminals, 11 barge container terminals and 5 trimodal terminals combining rail, road and inland waterways.

For rail transport the terminal landscape is quite stable over the years. The two intermodal rail operators TRW and IFB have a large market share in the intermodal rail market in Belgium. In the port of Antwerp, a collection distribution system was set up by means of the development of a main hub in Antwerp, which connects the port quays and serves to the inland terminals. The main hub also provides shuttles to the port of Zeebrugge. For international routes, specialised direct trains are scheduled from the terminals in the port of Antwerp and inland terminals such as Genk.

During the last decade, several private actors took initiatives to operate new inland container terminals in Belgium. The inland waterway terminal landscape in Belgium became very dense due to the introduction of a number of new terminals since the mid 1990s.

Table 1: Intermodal terminals in Belgium

Year	Name	Municipality	Type
1979	Terminal Container Athus	Athus	Rail
1991	Avelgem Container Terminal	Avelgem	Waterway
1994	Dry Port Muizen	Muizen	Rail
1995	Euroterminal Genk	Genk	Rail
1996	Water Container Transport	Meerhout	Trimodal
1997	Dry Port Mouscron / Lille International	Moeskroen	Rail
1999	Haven Genk	Genk	Trimodal
2000	Trimodale Container Terminal	Willebroek	Trimodal
2001	Compagnie Française de Navigation Rhénane	Brussels	Trimodal
2001	Cargovil Container Terminal	Grimbergen	Waterway
2001	Gosselin Container Terminal	Deurne	Waterway
2002	Liège Logistics Intermodal	Bierset	Rail
2002	Intermodal Platform Gent	Gent	Waterway
2002	Terminal E.C.E.	Renory	Trimodal
2003	Terminal BATOP	Herent	Waterway
2004	Delcaterminal	Kortrijk	Rail
2004	River Terminal Wielsbeke	Wielsbeke	Waterway
2005	Transport Gheys	Mol	Waterway
2007	Charleroi Logistics Center	Charleroi	Trimodal

Source: Own setup

Although most of the terminals offer daily services to the ports of Antwerp and Rotterdam, some of them have a small scale such as BATOP, which is located between Herent and Antwerp. BATOP serves only one customer, the malting company Cargill. Gheys in Mol is also a small scale terminal focusing on providing logistics services to the chemical sector in the region.

Figure 8 indicates a concentration of terminals in the Flemish waterways. At the moment, new terminals are planned for Wallonia. In 2007, the terminal in Charleroi is opened however it is not offering regular container services yet.

Figure 7: Intermodal terminal landscape in Belgium

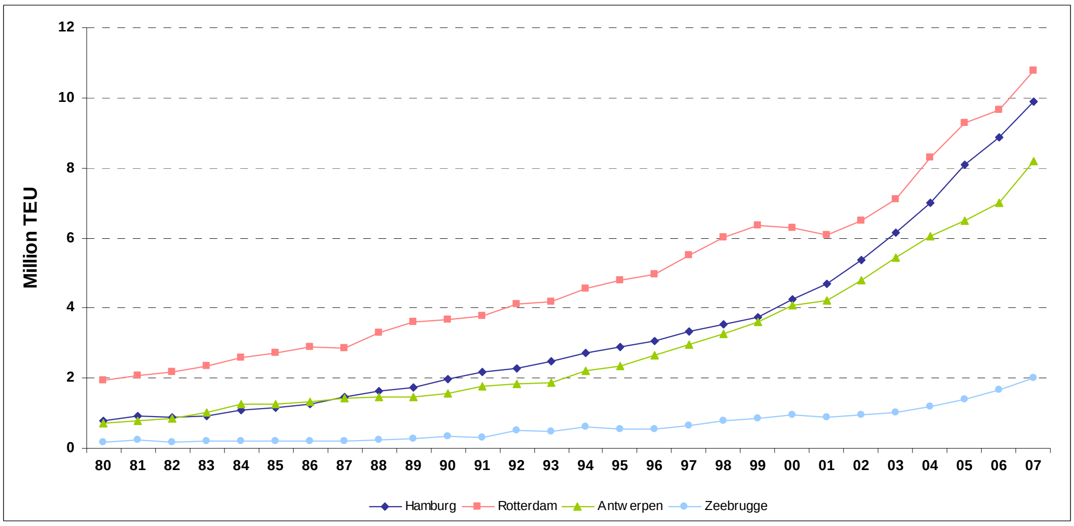
Source: Own setup

6 THE INTERMODAL TRANSPORT MARKET IN BELGIUM

In order to get an idea of the intermodal transport market against the total transport market, one should have data on the total tonkm of each segment. Intermodal transport's market share is only about 8.6 % of total EU transport volume 1998. Representing only a small portion of the total freight transport, intermodal transport takes an important share on specific corridors, particularly on the North-South corridor (Alpine traffic for rail transport) and in the seaports. Until now no comparable data are available for Belgium. However data of the modal split in the ports can provide an idea of the modal share of intermodal transport for the maritime flows. Also data available from the intermodal terminal operators can give an insight in the evolution of this transport sector.

For the maritime flows, ports are the most important origin points for the intermodal hinterland transport. Due to the globalisation of the economy and the connected increase of international trade these ports face an important increase in the amount of containers to be handled. In Figure 9 the evolution of container handling in the major ports of North-Europe is shown.

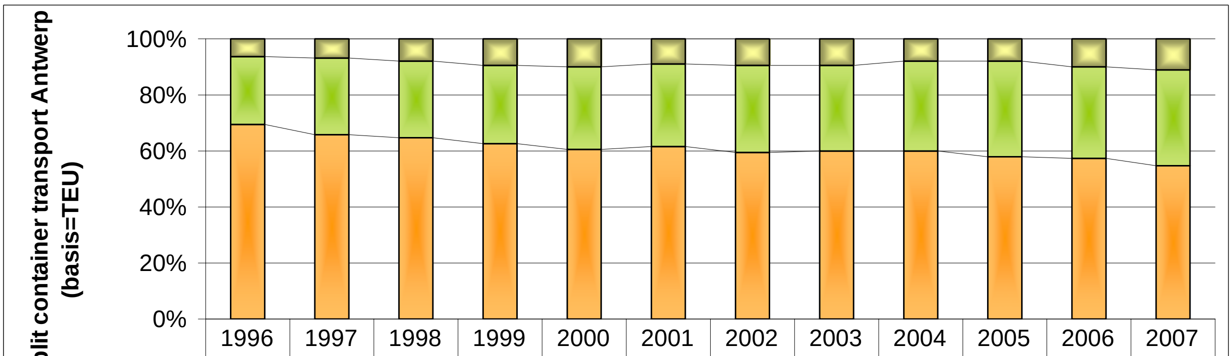
Figure 8: Container traffic growth in the port of Antwerp, Hamburg, Rotterdam and Zeebrugge



Source: Own setup – data based on the statistics of the Antwerp port authority

The port of Antwerp faces an annual increase of among 10%. In Figure 10 the modal split of these containers is shown. Most of the containers are transported by road. Inland waterways gain an extra market share of almost 10%, rail transport stays at among 10%.

Figure 9: Modal split for the port of Antwerp

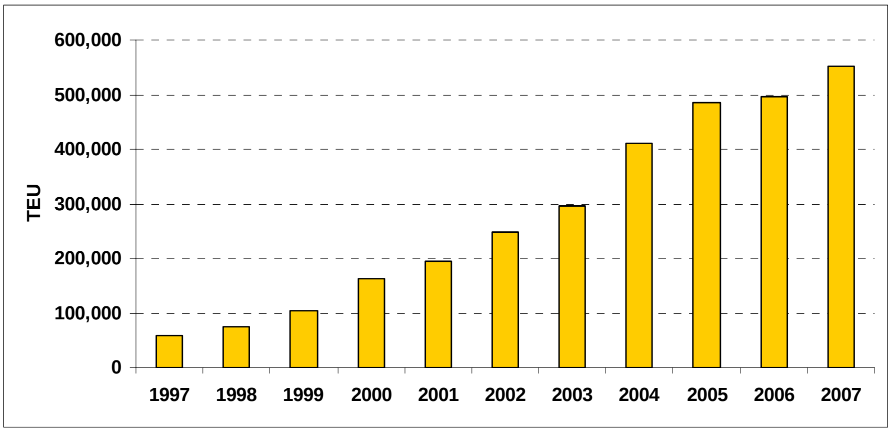


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Rail	6%	7%	8%	9%	10%	9%	9%	9%	8%	8%	10%	11%
Barge	24%	27%	28%	28%	29%	30%	31%	31%	32%	34%	33%	34%
Road	70%	66%	65%	63%	61%	61%	59%	60%	60%	58%	57%	55%

Source: Own setup – data based on the statistics of the Antwerp port authority

This evolution is also confirmed by the data of the individual terminal managers (See Figure 11). In Flanders 515,791 TEU were transported in 2007 by container barges towards the inland terminals. Especially the 38 per cent increase in 2004 is impressive.

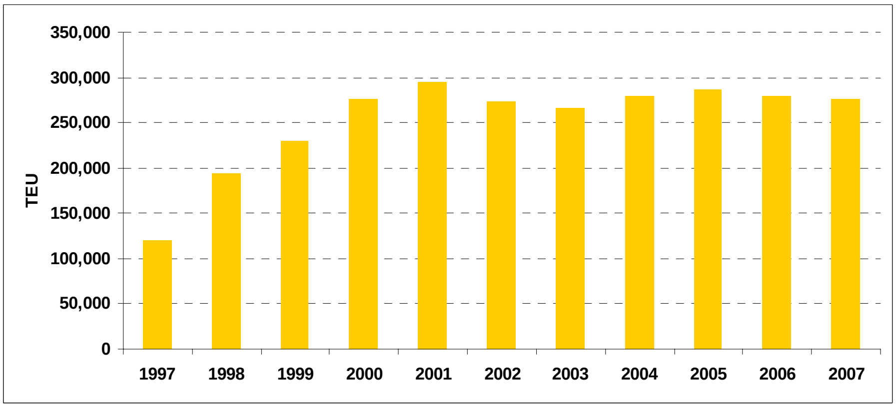
Figure 10: Evolution of the number of TEUs on the Belgian container terminals



Source: Pekin and Macharis- data based on the statistics of PBV and Lloyd

For rail/road transport, an increasing trend from 1997 to 2001 is followed by a stagnation (See Figure 12).

Figure 11: Evolution of the number of TEUs on the Belgian rail terminals



Source: Pekin and Macharis, 2008 - data based on the statistics of IFB and TRW

7 CONCLUSION

Intermodal transport is gaining increased policy attention thanks to the possibilities to lower costs, decrease the environmental pressure and congestion and by providing an alternative way to ship containers to the hinterland. Its market is growing the last couple of years although in absolute numbers road transport is still the most dominant mode for hinterland traffic. Several new terminals were started up and a vicious circle is created between the larger volumes of containers that need to be handled in the seaport and these satellites in the hinterland. Policy measures can help to further increase the market share of intermodal transport. These different policy measures will be explained in the next chapter.

CHAPTER II

INTERMODAL TRANSPORT POLICIES

1 INTRODUCTION

Transport policies originate because of the vital role of transport in every aspect of daily life. Serving a vital role in the economic development, freight transport is an important component of society at large. Transport is placed in the agenda of governments and international institutions because it raises questions in national security, public safety and the environment, and competition. While transport is capable of offering significant benefits, it also causes many negative externalities. This situation emphasises the need for transport policies, which are designed to maximise the benefits and minimise the negative effects of transport.

Evolution of the European transport policies has summarised in a strategy to stimulate better use of the existing transport resources and to take better advantage of the different transport modes. This strategy can only be achieved when there is a balance between transport modes. Hence intermodal transport has a pivotal role for balanced transport flows in Europe.

Intermodal transport is promoted through policies that are addressed at all political levels. The policy maker's role in intermodal transport policies is to assure an environment for a smooth functioning market, maintain a complete and interoperable multimodal transport network and promote its optimised use to minimise environmental externalities. Intermodal transport policy in Europe is based on a co-modal approach, the efficient use of different modes on their own and in combination to achieve a high level of both mobility and of environmental protection. Addressed to potential customers, who mainly use road only transport, the policy aims to create awareness of the capabilities and advantages of intermodal transport.

Section 2 introduces the European transport policies. Deriving from the historical development of the Common Transport Policy, the main focus is on the 2001 White Paper "Time to decide" and its mid-term review. In section 3, an intermodal policy framework is presented. This framework serves as an input for the assessment framework. Intermodal infrastructure in a European level is explained with the concept of the Trans European Transport Networks in section 4, and research and development activities in Europe are introduced in section 5. Section 6 summarises the Marco Polo programme and national subsidy schemes and charging and pricing policies are discussed in section 7. Section 8 presents other policies that could favour intermodal transport. Finally, in section 9 conclusions are drawn.

2 EUROPEAN TRANSPORT POLICIES

Transport is a key element in generating economic progress through trade and labour mobility. Ensuring the distribution of goods throughout the single market from manufacturer or producer to end-user, transport contributes to the welfare of the European union and its citizens. For Europe, transport also represents an important sector of the economy, which is accounting for almost 10 per cent of the European Union's gross domestic product (GDP), and employing 10 million Europeans. There has been a continuous growth in traffic in Europe, reflecting increased mobility levels, rising income levels, increased social and leisure time, and the breaking down of national barriers within Europe. In contrast to the positive effects of transport, the increase in mobility of persons and goods points to a concern at a European level. Thus the European transport policy has the pivotal role in achieving sustainable mobility in Europe. In this section, we will discuss the evolution of the European transport policy.

2.1 Historical development

An integrated transport policy at the European level has developed since the Community's founding Treaty of Rome (1957), where the Common Transport Policy (CTP) was defined as one of the Community's priority tasks. However progress towards the realisation of a CTP was slow. November 1993 marks a turning point in the evolution of the CTP, when the Treaty of Maastricht entered into force. Coupling with the establishment of the European Economic Area provided a new basis for the Community to contribute to the establishment and development of transport infrastructure (COM92 494 def).

The development of the CTP followed a slow pace until 1986, when the Single European Act required the removal of physical barriers between the European countries. The Maastricht Treaty emphasised a balanced development of economic activities in Europe in order to achieve a sustainable growth respecting the environment. The concept of sustainable development translated into the formulation of a CTP based on sustainable mobility. In 1992, the aim of the CTP was clearly stated in the White Paper published by the European Commission and in 1995, the Commission took an initiative to issue a transport policy action plan 1995-2000, declaring the timetable for implementation of the actions announced in the 1992 White Paper on Transport (COM95 302, 1995). From six members in the 1950s to 27 in 2007, today the European Union promotes an integrated CTP to regulate competitiveness, cohesion and environment.

2.2 White Paper "Time to decide"

The Commission adopted the "White Paper European Transport policy for 2010: Time to decide" on 12 September 2001. Defining transport as the essential driver of industry, trade, way of life and further European integration, the White Paper places it at the heart of European society. Four key objectives of the paper are to shift the balance between transport modes, eliminate bottlenecks, gear transport policy to users and manage the globalisation of transport.

Although the White Paper itself has no legislative or executive force, the Commission proposes an integrated package of 60 policy measures. The following guidelines underpin the policy proposals of the Commission:

- Revitalising the railways
- Improving quality in the road transport sector
- Promoting transport by sea and inland waterways
- Balance between growth in air transport and environment
- Turning intermodality into reality
- Building trans European transport network
- Improving road safety
- Adapting a policy on effective charging for transport
- Recognising the rights and obligations of users
- Developing a high quality urban transport
- Putting research and technology at the service of clean efficient transport
- Managing the effect of globalisation

In the first objective of the White Paper – "Shifting the Balance Between Modes of Transport" – the Commission highlights the growing imbalance between the transport modes in the EU. The dominance of road only transport and the higher growth rate of air transport negatively affects the environment. On the other hand, this situation constitutes a potential for rail and inland navigation. The Commission suggests a better regulated competition between transport modes. Therefore, it places intermodality to link-up modes. To realise this objective, it proposes revitalising the railways by opening of market including the rail freight; connecting ports to railway, inland waterways and shortsea shipping (Motorways of the Sea); improving quality in the road sector; and helping to start up intermodal transport services (Marco Polo, EILUs, Freight Integrators etc).

In the second objective of the White Paper – "Eliminating Bottlenecks" – the Commission addresses the bottlenecks on main international routes in Europe. In order to maintain the cohesion and the internal market of the EU, the Commission plans to propose a revision of the Trans European Transport Networks (TEN-T) guidelines. A two-stage revision includes eliminating bottlenecks on priority routes and encouraging "Motorways of the Sea" (MoS). The limited budget of the transport infrastructure projects are also handled by pooling of funds.

The White Paper also aims to gear transport policy to users by "Putting Users at the Heart of Transport Policy". Although passenger transport is in the core of this objective, a reform legislation on efficient charging and fuel taxation are suggested by the Commission.

2.3 White Paper mid-term review "Keep moving"

The 2001 White Paper proposed policies to overcome challenges of the modal imbalance, congestion on European roads and cities and the impact of transport on the environment. Accordingly, various policy measures were formulated between 2001 and 2006. Over the past five years, a change in the context of mobility in Europe is observed. Enlargement, resulting in a EU with 25 countries, placed mobility on a continental scale. On the one hand, a reliable transport system is a key factor in meeting the global competitiveness. On the other hand, growing concern is directed towards the environmental aspects of transport, where greenhouse gas emissions, global warming and increasing oil prices took place. This situation requires a broader, more flexible transport policy toolbox (COM06 314). Thus it was time for a mid-term review of the 2001 White Paper.

Extensive consultations with the Member States and other actors of the European transport system, have provided an overview of the current situation and the expectations for the future. Deriving from this input, the Commission directed proposals to shape the future transport policy of the EU. Maintaining the overall objectives of transport policy as the same: a competitive, secure, safe and environmentally friendly mobility, the toolbox is designed to establish a broad dialogue with all stakeholders at national, regional and local levels of government as well as by citizens and industry themselves. Therefore, a renewed agenda is proposed to achieve shifts to more environmentally friendly modes, especially on long distances and congested corridors. Optimisation of all transport modes, which must be more environmentally friendly, safe and energy efficient, is needed. Reflection of the mid-term review of the White Paper has introduced the concept of "co-modality" – the efficient use of different modes on their own and in combination to achieve a high level of both mobility and of environmental protection.

The 2006 White Paper mid-term review introduces the following main actions:

- **Sustainable Mobility.** Promoting rail freight corridors and inland navigation; developing a Common European Maritime Space White Paper; and European ports policy.
- **Protection.** Developing an urban transport Green Paper; launching of major programme for green transport; and promoting training for transport professionals.

- **Innovation.** Defining an action plan for logistics; launching of major programme to bring intelligent transport systems to market; implementation of ERTMS (European Rail Traffic Management System); and launching of the 7th Framework Programme
- **International dimension.** Developing a strategy for integrating the EU's neighbouring countries into the internal market.

In line with the mid-term review of the 2001 transport White Paper, the Commission launched a series of policy initiatives:

- Boosting the efficiency, integration and sustainability of freight transport in Europe (COM(2007) 606);
- Freight Transport Logistics Action Plan (COM(2007) 607);
- Towards a rail network giving priority to freight (COM 2007) 608);
- Commission Communication on a European Ports policy (COM(2007) 616);
- Consultation Motorways of the Sea (SEC(2007) 1367);
- Consultation on a maritime transport space without barriers reinforcing the internal market for intra-European maritime transport (SEC(2007) 1351).

The current package of policy measures contributes to the promotion of intermodal transport in various ways. The Freight Logistics Action Plan aims to simplify administrative processes, reviews loading standards and sustainable quality and efficiency. The Communication on a freight-oriented network focuses on ensuring lower transit times and increasing the reliability in the rail transport to improve its competitiveness. The European ports also receive attention through the Communication on a European Ports Policy, in order to enhance their performances. Progress made in developing the MoS network will be continued and shortsea shipping will be promoted through facilitation and simplification of administrative and documentary procedures.

Subsequently, the Commission opened the Greening Transport Package on July 2008 (COM(2008 433). With the aim of moving transport further towards sustainability. The package includes action to improve pricing and charging of transport modes.

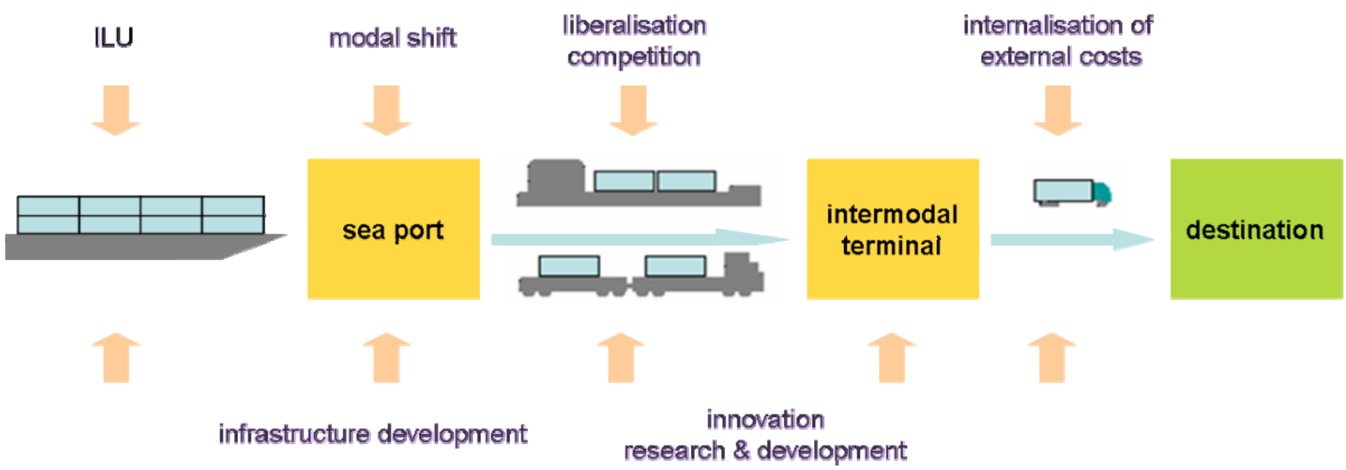
3 INTERMODAL TRANSPORT POLICIES

As explained, the evolution of the European transport policies has summarised in a strategy to stimulate better use of the existing transport resources and take better advantage of the different transport modes. This strategy can only be achieved when there is a balance between transport modes. Hence intermodal transport has a pivotal role for balanced transport flows in Europe. In this section we will present an overview of the European policy measures that support the further development of intermodal transport.

Intermodal transport is promoted through policies that are addressed at all political levels. The policy maker's role in intermodal transport policies is to assure an environment for a smooth functioning market, maintain a complete and interoperable multimodal transport network and promote its optimised use to minimise environmental externalities. Intermodal transport policy in Europe is based on a co-modal approach, the efficient use of different modes on their own and in combination to achieve a high level of both mobility and of environmental protection. Addressed to potential customers, who mainly use road only transport, the policy aims to create awareness of the capabilities and advantages of intermodal transport.

Figure 13 presents a range of intermodal policy measures. Various combinations of policy instruments or packages can be formulated along the intermodal transport chain. This requires a close co-operation among the stakeholders in order to create synergies. EU's intermodal policy is designed to provide an integrated framework in order to develop a structured approach to intermodal freight transport. Figure 13 is used to summarise the key elements of the European intermodal transport policy. Infrastructure development is recognised by the EU as an essential factor to initiate intermodal transport. Targeted TEN-T investments aim to establish an intermodal network. Furthermore intermodal transfer points (terminals) are designed and projects are aimed to overcome missing links. Second vital element of intermodal policy in the EU is on setting rules and standards. Legislative progress on intermodal loading units and intermodal liability are contributing to establish a uniform intermodal transport system. In addition is the intermodal market regulated through liberalisation and competition rules. Innovation and technology is indispensable for the integration of intermodal transport in supply chains. Framework Programmes enable to conduct research on intermodal transport in order to serve both this integration and steer the Commission for formulating efficient policies. Finally, operational aspects of intermodal transport are addressed through common charging and pricing. Internalisation of external costs within the framework of green transport gets growing attention.

Figure 12: Intermodal policy framework



Source: Macharis et al., 2008

Although no directive is specifically devoted to intermodal transport, the Commission is a defender and promoter of intermodality (Burkhard and Nemoto, 2005). The policy objective behind the Commission's action to promote intermodal freight transport is seen in the Communication on "Intermodality and Intermodal Freight Transport in the EU" (1997). As a vital policy document recognizing that a business as usual approach is not a sustainable one, the communication offered a systems approach to look at mode independent utilization of spare capacity in all modes advocated to the intermodal system that encourages co-operation and integrity between transport modes and competition between transport operators. The 2001 transport White Paper and its mid-term review in 2006 also proposes measures which assign critical roles of intermodal transport to make the market shares of the modes of transport return by 2010 to their 1998 levels. Table 2 provides a list of policy and regulatory framework of the European intermodal transport policy, which we have briefly introduced in Section 2.

Table 2: Policy and regulatory framework of the European intermodal transport policy

Year/Reference	Title
1992/COM(92)494	White Paper on the Future of the Common Transport Policy
1992/92/106/EEC	Council Directive on the establishment of common rules for certain types of combined transport of goods between Member States
1992/93/45/EEC	Commission Decision concerning the granting of financial support for pilot schemes to promote combined transport
1997/COM(97)243	Communication on intermodality and intermodal freight transport in the EU
1995/COM(95)691	Green Paper on Fair and efficient pricing
1996/COM(96)421	White Paper A strategy for revitalizing the Community's railways
1996/1692/96	Community Guidelines for the development of the Trans-European Transport Network
1997/COM(97)242	Communication on Rail Freight Freeways
1997/COM(97)678	Green Paper on Port infrastructure
1998/COM(98)466	White Paper on fair payment of infrastructure use
1998/2196/98	Council Regulation concerning the granting of community financial assistance for actions of an innovative nature to promote combined transport
2001/COM(2003)370	White Paper: European transport policy for 2010: time to decide
2003/COM(2004)56	Commission proposal for a Directive on intermodal loading units
2006/COM(2006)314	Communication on the mid-term review of the European Commission's 2001 Transport White Paper
2007/COM(2007)607	Communication on the freight transport logistics action plan
2008/COM(2008)433	Communication on the greening transport

Source: Macharis, C et al., 2008

4 TRANS EUROPEAN TRANSPORT NETWORKS

The concept of the TEN-T is in line with the completion of the single market. The opening of borders for the free movement of goods and persons since the Single European Act (1986), has not made communications between countries any easier. Various obstacles existed preventing to achieve a complete free movement and a balance between different regions of the Community. In order to guarantee free movement of goods and persons and to maintain economic and social cohesion, harmonisation of transport policy through improving the Member States' infrastructure was required.

The completion of the single market brought certain obstacles on free movement of goods and people due to incomplete or congested European transport infrastructure networks. The need for the creation of the TEN-T is stated in the Treaty of Maastricht. Major infrastructure projects with a long time frame are developed to integrate national land, sea and air transport infrastructure networks throughout EU. Bottlenecks and missing links are identified to be removed. Furthermore, new transport links are foreseen between the EU and its neighbours in the European Free Trade Association (EFTA) as well as in Central and Eastern Europe. The main objective of the TEN-T is to create a sustainable infrastructure at a Community level, which is capable of delivering high-quality transport services. In order to achieve this objective, all of the transport modes will be integrated into a single trans-European transport network.

The concept of the trans-European networks (TENs) was given legal base in Copenhagen European Council (1993). This development is followed by the identification of 14 major priority projects in Essen European Council (1994). In 1996, the Council and the European Parliament adopted guidelines for the development of TEN-T. As a result, the existing plans were brought under a single framework. In the same year, the Commission, with its annual report on the TENs, evaluated the progress achieved in the priority projects but also added the need for a revision of the financial instruments of the projects; since the public funding was not enough to cover these costly projects. The need for this revision was also included in the 1997 report. With Agenda 2000, the enlargement process was brought up to the agenda and in 2001, the TEN-T guidelines were extended to port infrastructure (seaports, inland ports and intermodal terminals). The report of the High Level group, which was chaired by Karel Van Miert, lead to the extension of the list in 2004 to take account of the accession of 12 new Member States of the EU. TEN-T comprises 30 priority projects which should be completed by 2020.

The long legislative history is only the beginning of the process, and the centre of attention is how to implement the projects into reality. The TEN-T projects requires vast amount of funding. In 2008, the overall cost of the TEN-T project is estimated at € 900 billion (from 1996 to 2020).

The Community has concentrated its financial efforts to contribute to the implementation of the TEN-T. The financial instruments of the Community include the TEN-T budget, Cohesion and Structural Funds and the European Investment Bank loans. For the period 1993-2006, the Community financing of the TEN-T was 29 per cent; its share is expected to decrease to 27 per cent for the period 2007-2013. The Cohesion fund has two vital objectives, transport and environment. At present all new Member States, Portugal, Spain and Greece qualify for support from the Cohesion Fund. It has to be noted that the European Investment Bank offers services both to private and public entities.

The EU contribution is needed for achieving the TEN-T. However, serving the common European interest through the TEN-T initiative, does not imply a major support from the Community. Thus, the private sector is encouraged to invest as well in order to complement public financing. The Member States direct a budget from the taxpayers, public borrowing and to a certain extent by charging users to finance the TEN-T projects. Charging for infrastructure use constitutes insights not only to attract investors but also to establish public private partnerships (PPP).

PPP have been used mainly for constructing tunnels, bridges, motorways or airports. Once a delicate risk sharing agreement is established, PPP provide an attractive structure for the private entities. Although the public entities usually take higher political risks, there should also be a compromise in revenue risks.

Various actors, including authorities at member State level, regional and local level, transport mode related undertakings, construction companies, interest groups, financial institutions and European citizens are involved in the implementation of TEN-T. This situation requires a need for coordination. When the Priority projects and the cross-border projects are considered, the amount of actors involved is multiplied by a factor two or more, depending on the countries involved. To improve coordination of the TEN-T, the Commission has introduced the concept of European Coordinators.

4.1 The development of nodes

60 per cent of the priority projects are railway projects. Although high-speed rail projects are in the majority, rail freight projects and intermodal rail road projects also exist. Two are inland navigation projects and one refers to motorways of the sea.

Some of TEN-T projects have already been completed or will be completed soon. Oresund fixed link (2000), Malpensa airport (2001) and the Betuwe railway line (2007) are successfully completed. High-speed railway axis Paris-Brussels/Brussels-Cologne-Amsterdam-London is expected to be completed in 2009. Many priority projects consist of individual sections, which are realised through a step-by-step approach. However, the timetable points delays for the other major projects. On May 2008, a report on the implementation of the TEN-T priority projects was published. According to the findings of the report, it will be difficult to meet the 2020 deadline for some of the most complex projects, such as the Alpine crossing, along with a number of other bottlenecks on the priority projects.

There are several reasons which explain the delay of the TEN-T implementation. First of all, there is a lack of financing; second coordination problems cause an inefficient project planning; and finally, regulatory constraints cause an additional obstacle (EC, 2008).

By 2020, TEN-T will cover 89,500 kilometres of roads and 94,000 kilometres of railways. The inland navigation network will account for 11,250 kilometres and intermodal landscape will compose of 294 seaports and 210 inland ports.

Implementation of the TEN-T means the construction of new roads for the missing links. 4,800 kilometres will be built by 2020. Most of these new links will be located in the periphery (Ireland, Portugal, Greece and the Baltic countries). In addition upgrading of existing roads will be done for example to realign and widen roads. 3,500 kilometres is foreseen for the existing road network.

The Commission places railway transport in the core of the TEN-T. In addition to developing high-speed links, the TEN-T also focuses on developing intermodal lines for freight transport. Attention is devoted to the central European countries to maximise the capacity of the existing lines and to eliminate bottlenecks. Interoperability is also a challenge especially to connect peripheral countries. Under the TEN-T 12,500 kilometres of rail will be constructed and 12,300 kilometres will be upgraded.

Although facing topological limitations, inland navigation represents a cost-effective and environmentally friendly transport mode. In Western Europe, inland waterways are found in Benelux, France and Germany. The TEN-T aims to integrate the national waterway networks. In this respect, existing canals and rivers are modernised.

The TEN-T plays a crucial role in developing axes but the TEN-T network is also composed of nodes, which are linked to the axes. Thus seaports, inland ports and intermodal terminals are included in the TEN-T projects. Ports are the gates of the European Union. Higher trade flows take place in ports in the Hamburg-Le Havre range and increasing trends are observed for the Mediterranean ports. European ports should be capable of serving their hinterland through a variety of transport modes. Increase in container transhipments requires successful intermodal transport services as well. TEN-T projects aim at improving the efficiency of traffic flows through ports by:

- Infrastructural improvements in maritime access
- Port infrastructure
- Inland transport infrastructure
- Hinterland access arrangements

Intermodal terminals are vital for the hinterland connectivity of seaports. Therefore policies are formulated to integrate these nodal points in the TEN-T. Finally, the airport network is also considered. First, airports of common interest are identified. Then, policies are directed to improve environmental compatibility and to increase the capacities of the airports.

4.2 The development of information and management systems

Two pillars establish the TEN-T, the physical network (axes and nodes) and the virtual network (information and management systems). ICT is a key to controlling transport systems. Some key indicators which can be handled through intelligent transport systems include safety, environmental effects and congestion.

In road transport, a European traffic management system is built, which aims to achieve interoperability of the existing systems. The users of transport benefit from the information system, such as RDS-TMC system (Traffic Message Channel).

Infrastructure management in railway transport is a pre-condition to sustain interoperability, which stands for a vital bottleneck. The TEN-T allows the technical harmonisation of infrastructure and the introduction of a system at European level (implementation of ERTMS).

Finally, the Commission also supports ICT applications in inland navigation and shortsea shipping. In all transport modes, monitoring cargo movements by means of tracking and tracing systems are possible via satellite systems. A European initiative to create a global satellite navigation system, Galileo is an ongoing project of the TEN-T. Uniqueness of Galileo is its specific design for civilian use worldwide and freely available open services.

4.3 Revision of trans-European transport networks

Revision of the TEN-T is an inevitable consequence of the European enlargement process and its reaction towards the globalisation. An important aspect of revising the TEN-T is the inclusion of the motorways of the sea.

The MoS initiative was introduced in the 2001 White Paper, which recommended a rebalancing of transport modes. Intermodality is seen as promoting this modal shift away from road transport. Thus MoS is capable of providing integrated intermodal services, based on shortsea shipping.

The policy goal is to develop a network of motorways of the sea between different European ports, each linked to railway and inland waterways. MoS will provide a competitive alternative to the congested road network. Through TEN-T, MoS axes are identified and projects on these axes are developed for intermodal transport applications. Both physical and virtual infrastructure are taken into consideration.

5 RESEARCH AND DEVELOPMENT

The European intermodal transport policy and research and technological development (RTD) activities have been usually addressed together (Janic and Bontekoning, 2002). There are close interactions between research and policies. In most cases, the Commission and other European institutions prefer to include research in their policy making procedures. Research projects provide inputs for intermodal policies. Ex-post and (or "or") ex-ante analysis are conducted in order to assess various policy measures. Furthermore, under numerous research programmes, research projects are funded by the EU to support the development of intermodal technologies and operations. As a final step, the implementation of research and technological development is done through case studies and pilot applications.

The EU and the Member States support RTD projects on a co-funding basis. Availability of funds attracts not only research institutes but also private companies, that are often too small to be able to generate the necessary critical mass of resource for RTD (Vrenken et al., 2005). Shared investment enables close cooperation between the public and the private sector, which allows the implementation of research results. The EU also encourages RTD at European level, where various Member States are included. In this section, an overview of intermodal freight transport research agenda in Europe will be presented.

Intermodal RTD activities are initiated through three main spectrums such as:

- The Framework Programmes
- The COST-Transport Actions
- The PACT and The Marco Polo Programme

5.1 The framework programmes

The EU supports the development of intermodal freight transport through its multi-annual framework programmes (FP) for RTD. Table 3 summarises a selection of the FP projects on intermodal freight transport. The first group is conducted within the 4th FP. Both operational and decision-making related aspects are included in the objectives of the selected 5 projects. In 1998, "Sustainable Mobility and Intermodality" was introduced as a key action under the 5th FP, which lead to extensive RTD in intermodal transport. The examples in the table point out that research has been conducted in order to achieve efficient door-to-door intermodal transport chains. In this respect, existing knowledge is disseminated and case studies are widely developed. The 6th FP extended the scope of research areas by introducing cross-cutting research activities and the European Research Area (ERA). Thematic areas are complemented by cross-cutting research activities and the ERA aims to stimulate the coherent development of the European RTD policy by supporting programme co-ordination and joint actions conducted at national and regional level as well as among European organisations.

Table 3: Selected FP projects on intermodal freight transport

FP	Project	Research
4th FP 1994-1998	CESAR	Improvement of intermodal transport performance and quality by an appropriate information system.
	IMPREND	Improvement of pre- and end- haulage at terminals, achieved by defining and testing a number of formulae on how to do that.
	IQ	Analysis of the quality aspects influencing intermodal transport at both intermodal terminals and networks with the aim to improve interoperability, interconnectivity and accessibility of intermodal terminals.
	PRECISE-IT	Optimisation of intermodal operations, particularly addressing those operational problems that can be put in relation to the position of ITUs and/or vehicles at the terminals
	TERMINET	Identification of promising innovative directions for bundling network new generation terminals and terminal nodes for combined and intermodal transport in Europe.

5th FP 1998-2002	EUTP	Dissemination of the existing knowledge related to the intermodal freight transfer points in the EU at both national (member states) and international (EU) levels with the purpose to provide a better co-ordination of R&D activities.
	IP	Improvement of the integration of ports into intermodal transport chains, which is expected to be achieved by harmonising administrative procedures and by offering a set of information and communication (ICT) tools and services, which would facilitate exchanging of data between the partners involved in transport chains.
	BESTUFS	Dissemination of the best European practice, success criteria, and bottlenecks in moving the goods in urban areas. The project is expected to contribute to integration of the urban collection and delivery services into 'door-to-door' transport and logistics chains.
	RAILSERV	Revitalisation of rail transport through investigation and development of measures that will enhance rail's competitiveness in the European freight transport market.
	RECORDIT	Improving the competitiveness of intermodal freight transport in Europe through the reduction of cost and price barriers, which currently hinder its development, while respecting the principle of sustainable mobility.
6th FP 2002-2006	BRAVO	This important intermodal demonstration project will lay foundations for achieving a significant and sustainable increase in intermodal volume on the Brenner corridor.
	CREAM	Analyse the operational and logistic prerequisites for developing, setting up and demonstrating seamless rail freight and intermodal rail/road and rail/short sea/road services on the Trans-European mega-corridor between the Benelux countries and Turkey,
	CREATING	Stimulating waterborne transport in an economical way, by giving new impulses to inland navigation. Whereas the hinterland transport of maritime cargo such as maritime containers already takes place via inland waterways to a large extent, continental cargo is almost completely transported by road.
	FREIGHTWISE	Support the co-operation of transport management, traffic and infrastructure management and administration sectors in order to develop and demonstrate suitable intermodal transport solutions in a range of business cases.
	PROMIT	Contribute to a faster improvement and implementation of intermodal freight transport technologies and procedures, and to help Promoting Innovative Intermodal Freight Transport and modal shift by creating awareness on innovations, best practices and intermodal transport opportunities for potential users as well as politicians and research community.

Source: 4th and 5th FP Janic and Bontekoning, 2002 and 6th FP own setup

For the period 2007-2013, the 7th FP is designed to continue the RTD activities in Europe. Compared to the previous framework programme, the FP7 represents a substantial increase with its total budget of over € 50 billion. Its building blocks include, cooperation, ideas, people, capacities and nuclear research. Intermodal transport is defined as one of the key thematic areas under the "cooperation" programme. Furthermore, the objective of the specific programme "ideas" includes "frontier research", which leads to producing new knowledge leading to future applications and markets. The "people" programme on the other hand guarantees researcher mobility at European level. Finally, the "capabilities" programme aims to strengthen the research capacities that Europe.

5.2 The COST-Transport action

COST – (European Cooperation in the field of Scientific and Technical Research) – is defined as an intergovernmental network, which supports cooperation among scientists and researchers across Europe. Intermodal transport receives an interest with the COST actions.

5.3 The PACT Programme

In 1992, the Commission launched a mechanism for granting financial assistance for pilot actions for combined transport (The PACT Programme). The programme is for a period of five years (1 Jan. 1997 to 31 Dec. 2001) and funding of ECU 5 million has been made available for that period. The programme mainly provided start-up assistance for innovative projects which are likely to increase the use of international intermodal transport by improving its competitiveness. The industry was highly involved in the PACT Programme, enabling to demonstrate the applications of intermodal transport.

For the period 1996-2001, the programme financed 92 project on projects that develop innovative modal shift concepts. The EU invested approximately € 7 million per year and the return in terms of modal shift was satisfactory with 2.2 billion tkm per year, which accounts for 1 per cent of all intermodal transport.

In 2001, the Marco Polo Programme has replaced the PACT Programme. Both the scope of actions and the budget of the programme expanded with the launch of the Marco Polo and Marco Polo II Programme (see section 6).

6 FINANCIAL SUPPORT FOR "MODAL SHIFT"

In the transport sector, government subsidies are designed to provide incentives to attract certain transport activities. Policymakers often formulate subsidies with economic concerns. The intermodal transport sector also receives transport subsidies. This section focuses on the subsidy schemes that are formulated by the Member States for financial support for modal shift especially towards intermodal transport. Finally the Marco Polo programme will be explained as an example of a community wide instrument.

6.1 National and regional incentive schemes

Investments in the transport sector are capital intensive and have their revenues on the long term, which limit the investors' willingness. Therefore a well functioning financial mechanism is a precondition to realize intermodal transport systems. Representing an important policy instrument, Member States formulate a variety of subsidy schemes, which have significant impacts on both the level of freight transport and the modal choices made by transport users. The concept of Public-Private-Partnerships (PPP) is widely used in completing transport projects. Within community competition rules the EC is very open for issuing positive decisions concerning state aid cases of national initiatives on promoting intermodal transport. Below national and regional subsidy schemes of 5 European countries are given. Each scheme is taken by the European Union competition authorities.

6.1.1 Austria

In Austria, certain intermodal transport operations are considered to be of public interest. Therefore fiscal incentives are provided for those intermodal transport operations. The current subsidy scheme (N140/04) is the extension for the period 2003-2008 of the previous scheme (N121/99) covering the period 1999-2002. With the objective of achieving a 3% modal shift from road, the scheme provides grants for:

- Equipment for combined/intermodal transport;
- Innovative technologies and systems to improve the combined transport system;
- Feasibility studies for specific implementing measures;
- External training costs for introductory training to specific computer systems or technologies.

Another subsidy scheme (N644/01) that subsidised loans to encourage the transfer of road transport operations to railway or inland waterway for the period 2001-2006, is also extended for another period 2007-2011 (N76/07).

6.1.2 Belgium

Belgium has an extensive transport network to distribute containers that are arriving to the port of Antwerp and Zeebrugge. In the last decade, the Flemish government introduced various subsidy schemes for container barge waterways transport. The Walloon government follows this trend as well.

Focusing on intermodal rail transport, the Flemish aid (N 566/02) for combined transport provided an annual budget of € 3 million for the acquisition of combined transport equipment, transhipment equipment and aid for information system. The subsidy scheme, which expired end of 2003, covered investment costs of the railway operators that offered:

- New combined transport operations, i.e. a new route, new types of traffic or a new contract;
- Expansion of existing combined transport operations;
- Maintaining the capacity of existing combined transport operations.

A subsidy (N 249/04) is specifically designed to national intermodal rail transport. The Belgian government grants an annual budget of € 30 million to the intermodal operators, which offer transport services within Belgium of minimum 51 kilometres. The subsidy is composed of a fixed part (20 Euros) and a variable part (maximum 0.40 Euros per kilometre). The objective of the aid scheme, which is extended till end 2008 (N 656/07), is to help maintain existing rail traffic levels of 300,000 ITU and to increase rail traffic by 20% over a period of three years.

In order to promote inland navigation, the Flemish government developed a policy measure that stimulates the construction of new quay walls coupled with a reduction of canal-dues. The public private partnership programme allows the co-financing of the construction of quay walls for 80 per cent by the Flemish government and 20 per cent by the private sector. The quays stay property of the Flemish government and the private investor guarantees that a fixed tonnage of freight will be transported by inland waterways in the ten years to come. The programme, which established the support of the European Commission until 2010 (N 550/01 and N 344/04), realized a 66.5 percent growth in the inland waterways transport over the previous 5 years (Promotie binnenvaart, 2006). In May 2007, the EC authorized another Flemish measure to grant a subsidy of 20 Euros per each container transhipped to a Flemish inland container terminal from or to an inland waterway vessel (N 682/06).

Similar initiatives are also developed in Wallonia. In March 2005, the EC authorized a Walloon measure to grant a subsidy scheme to promote intermodal transport in the Walloon region (N 247/04 and N 4/04). According to the government decision of December 2004, the Walloon government, with the objective of developing regular container services in Wallonia, started to subsidize investments in the terminals such as the transhipment infrastructure. The government decision also aims to modernize the fleet. In addition to the investment aid, a subsidy of 12 Euros is foreseen for the containers that are transhipped to a Walloon inland container terminal from or to an inland waterway vessel (OPVN, 2006). Finally, a subsidy of 12 Euros is also applied for the terminal in Brussels (N 720/06).

6.1.3 France

In France, a state aid (N 623/02) is granted for the operation of scheduled combined freight transport services as an alternative to the unimodal road transport. An annual budget of € 40 million is foreseen for period 2003-2007. The aid aims to cover extra costs of intermodal transhipments that are taking place in the terminals.

An experimental rail (rolling) motorway service was launched in 2003 between Bourgneuf-Aiton (France) and Orbassano (Italy) with an authorisation of a state aid (N 155/03). Providing a rail service to cross the Alps the project aims to contribute a modal shift towards rail transport. The French government furthers its support in this field with the following initiatives:

- The "route roulante 2006" project (rolling road) for which the first trials are planned on the route between Perpignan and Bettencourt from March 2000.
- The "Eco fret Atlantique" project on the route between Vitoria, Hendaye and Lille.

6.1.4 Germany

In 2001, German combined transport operator Kombiverkehr and Italian transport company RTC formed a joint venture company to offer a new service between Munich and Verona through Brenner, the principal axes of German intermodal transport. An Ad-hoc start-up aid (NN 134/02) is granted to this service, which aimed to shift traffic from road to railway by introducing a new transport technology. This innovative idea is planned by a high performance capacity locomotive.

The German government also supported the construction of combined transport terminals through a subsidy scheme (N 406/02). Focusing on the high construction and property purchase costs in order to build the intermodal terminals, the subsidy scheme provided for a budget of € 110.5 million to facilitate the construction of terminals for 2002-2005. This subsidy scheme (N 397/05) is prolonged for 2006-2008

On operational level, an aid scheme (N 238/04) for the funding of new combined transport traffic is introduced for a 3 years duration. With a budget of € 45 million, the start-up aid covers a maximum of 30% of the operating costs of the new transport services.

6.1.5 Italy

In Italy, two-thirds of the total traffic is made by Trans-Alpine route. Most of the thirteen state aid cases presented by Italy are on investment and start-up aid for equipment and infrastructure. There are also some cases covering environmental premiums.

A recent aid scheme (N 575/06) provides a budget of € 9 million for 2007-2009 to modernise regional infrastructure and services in order to improve the efficiency of intermodal freight transport services. The subsidy scheme supports the railway undertakers to invest in intermodal transport infrastructure, information systems and transhipment equipment.

In order to conclude, the transport policy in Europe is being driven more by public policy concerns instead of business dynamics. Since public policy concerns vary in intensity between different Member States and regions in Europe the development of continent wide solutions is very difficult to implement. European intermodal transport policy and national intermodal policies of the Member States should complement each other.

6.2 Marco Polo

As a successor of the PACT programme, the Marco Polo programme was set up in 2003 with the aim of shifting international road freight transport to shortsea shipping, inland waterway and rail. The current programme (Marco Polo II) runs from 2007 to 2013, with a total budget of € 400 million. Between 2003 and 2006, 55 projects have been financed. The subsidies reduce the high financial risks of market players during the start-up phase of new intermodal transport services. Furthermore incentives are given to develop innovative solutions for using intermodal transport. In 2007, the scope of the programme is extended by including motorways of the sea and traffic avoidance measures. It should be noted that the programme can also fund international projects involving third countries if there is a Community interest.

7 CHARGING AND PRICING POLICIES

7.1 Charging principles

While prescribing European policies on transport, a more direct approach involving imposing cost measures on transport users is also used to enhance economic efficiency. Transport users pay only a percentage of the actual costs for the society of their usage. Economists indicate that the external costs of transport should be borne by the users. When this cost is ignored, the market fails, underlining the necessity of corrective policy measures (Rouwendal and Verhoef, 2006).

Charging principles are designed to compensate the costs of infrastructure maintenance and management. Economic theory suggest that charging policies based on marginal costs lead to better usage of the available transport capacity than charging policies based on average costs or cost recovery rules (Ecorys, 2005). The marginal costs is calculated when an additional vehicle or vessel uses the transport infrastructure. They reflect costs such as infrastructure damage, congestion and pollution. Thus they vary according to vehicle or vessel type, engine emissions and peak times.

Another charging principle depends on the external costs of transport. It is widely accepted that transport activities give rise to environmental impacts, accidents and congestion. Unlike the benefits of transport, these costs are generally not borne by the transport users. The internalisation of external costs of transport acts as a policy measure to integrate external costs to the decision making process of transport users. The current policies have lead to innovations in the road transport sector to minimise their external effects. The result of internalisation provides opportunities for intermodal transport solutions, although their competitiveness is challenged by the improvements in the road transport sector.

Although a European implementation for common charging principles are aimed, for the moment Member States apply different infrastructure charges. In 2008, the Commission proposed a common European framework on charging and pricing. The aim is to develop a model, which will serve as a basis for infrastructure charge calculations accompanied by the internalisation of external costs for all modes of transport.

7.2 Charging on transport modes

Road hauliers have to pay road tolls or user charges (Eurovignette). Depending on the country, these costs can be variable such as a toll or a fixed sum such as the Eurovignette. The Eurovignette system is based on a time-based fee in the form of a vignette, which is mutually recognised and valid in all participating countries. User charges are scaled according to vehicle emission classes and range from € 797 to € 2,233. On the other hand, tolls are used to collect distance-based charges. Tolls are also scaled according to vehicle emission classes but the type of roads and the time periods are also considered. In Europe we observe countries with toll systems (France, Spain, Italy, Austria and Germany) and others with user charging systems (Denmark, Sweden, Belgium, Netherlands, Poland and Hungary).

Railway infrastructure usage is taken into account by the rail infra charges, which enable the infrastructure managers to compensate their infrastructure maintenance and management costs. Different principles shape the rail infrastructure charges in Europe. Social marginal costs and full costs are taken as pricing principles. Furthermore, factors such as train weights, type of engines and time periods are also taken into consideration to refine the charges, which are fixed or variable. The charges for rail freight transport differ in European countries. For a freight train of 1,000 gross tonne km, the charge per train-km varies between € 0.6 and € 2.5 in Austria. For example in Brenner the total charge will amount up to € 3.5. In Czech Republic a typical charge would be around € 3.4 and in Switzerland up to € 6. On the other hand the charges per train-km are only € 0.67 in the Netherlands (OECD, 2005).

Concerning inland navigation, pricing policy aims to finance infrastructure expenditure and to reach environmental objectives. Unlike other transport modes, infrastructure costs are largely not dependant on use in inland waterways. Maintenance costs, especially dredging are an important part of the costs. The charges take 3 forms: fuel charges, waterway charges and harbour and lock dues. Different functions of waterways constitute an obstacle to develop charging principles. There are also agreements on free access to waterways such as Mannheim Convention on the Rhine river. In conclusion, most waterways in Europe are free of charge and the systems of charges are not coherent. In Belgium, "Scheepvaartrechten" system amounts to € 0.00025 per ton-km. In France, there is a toll system, which depends on vessel type, goods transported and route.

7.3 Annual vehicle taxes and fuel taxes (excise duties)

Common rules on annual taxes for heavy goods vehicles over 12 tonnes are defined by Directive 99/62/EC, which was modified by Directive 2006/38/EC. The Directive provides minimum rates for fuel taxes according to the number and the configuration of axles and with the maximum permissible gross laden weight:

(in €/1 000 litres)	Leaded petrol	Unleaded petrol	Diesel fuel
Minimum rate	421	359	302

The rates themselves still differ from one Member State to the other.

7.4 Cross-modal financing for railways

One of the aims of charging is to increase the ability of transport sectors to finance themselves. There is a link between charging for the infrastructure and investments in infrastructure. Revenues from one mode can be reinvested in another mode to facilitate infrastructure financing. This innovative infrastructure funding model is called cross-modal financing.

Successful examples of cross-modal financing are seen in the Transalpine corridor. The Swiss, Italian and Austrian governments allocated funds, which are fed by two thirds of the revenues of the km-based road tax, the fuel tax, VAT and credits from the capital market.

8 OTHER POLICIES THAT FAVOR INTERMODAL TRANSPORT

8.1 Operational measures

The policy of promoting intermodal transport is widely applied in Europe at various levels. Some national governments introduce policies on weight restrictions and weekend bans. From an operational point of view, intermodal transport will benefit from releasing traffic restrictions at the weekends and at holidays, enabling drayage operations. Furthermore, exemptions from the weight restrictions (i.e. 44 tonnes instead of 40) in intermodal chains contribute to improve competitiveness of intermodal transport.

8.2 Intermodal transport promotion

Both the Member States and the EC widely applies the policy of promoting intermodal transport. Various policy measures and projects are directed to create an awareness of the capabilities and advantages of intermodal transport among potential customers. The main objectives of intermodal transport promotion are to create awareness to all parties of possibilities for cooperation between transport modes and to establish virtual portals for all intermodal modes.

Some countries establish consultancy services to provide support for shippers or logistics service providers to identify opportunities for modal shift. Targeted promotion of intermodal transport takes place both at the company level and industrial sites. Deriving from modal shift analysis, implementation steps procedures are envisaged. Dissemination of best practices are also widely used.

9 CONCLUSIONS

This chapter introduced the European transport policy on intermodal transport. Following a brief explanation of the historical development of European transport policy, an intermodal policy framework is presented. Various policy measures are connected to this framework, which serves as an input for the DSSITP assessment framework. The following policy measures are discussed:

- Intermodal infrastructure at European level is explained with the concept of the Trans European Transport Networks,
- Research and development activities in Europe,
- Subsidies on intermodal transport sector,
- Charging and pricing policies,
- Other policies that favour intermodal transport.

This overview shows that various combinations of policy instruments or packages can be formulated along the intermodal transport chain. This requires a close co-operation among the stakeholders in order to create synergies. EU's intermodal policy sets the guidelines for a structured approach to intermodal freight transport. On the other hand, different transport policies are launched in the Member States to stimulate the use of intermodal transport but no integrated formal ex-ante and ex-post evaluation of these transport policies are executed. In this context, intermodal policies will be further analysed with the DSSITP assessment framework.

CHAPTER III

DSSITP ASSESSMENT FRAMEWORK

1 INTRODUCTION

In this chapter the strengths of Operations Research (OR) modeling techniques applicable to decisions related to intermodal transport are explored. To this end a general literature study on the state of the art in intermodal transport research is performed and future prospects for OR in intermodal transport research are identified. Next, the DSSITP assessment framework is developed to perform an ex-ante and ex-post analysis of current and potential policy measures which affect the intermodal transport sector in Belgium. The assessment framework includes three core models necessary to evaluate all relevant transport modes and aggregation levels. The general assessment framework is elaborated in this chapter. For explanation of the core model, the reader is referred to the book "A decision support system for intermodal transport policy" (Macharis et al., 2008), which is published by the DSSITP team and disseminated during the study day last December. . This chapter concludes with an overview on how the assessment framework may be applied to each of the three main groups of policy measures

2 OPERATIONS RESEARCH IN INTERMODAL FREIGHT TRANSPORT

2.1 Literature review

This section gives an introduction into the literature review on intermodal freight transport performed in light of the DSSITP project. For a full description the reader is referred to Caris, Macharis and Janssens (2008). Macharis and Bontekoning (2004) discuss the opportunities for operations research in intermodal freight transport. The authors give a review of operational research models that are currently used in this emerging transportation research field and define the modeling problems which need to be addressed. Their overview covers papers until 2002. Because this is a very young field in transportation research, a significant number of papers on this topic have appeared in recent years. Therefore, an update is provided, focussing on the planning issues in intermodal freight transport research. Crainic and Kim (2007) discuss a number of specific operations and planning issues in intermodal freight transport: system and service design for intermodal transportation networks, container fleet management, container terminal operations and scheduling, national planning.

Planning problems in intermodal freight transport can be related to four types of decision makers, based on the four main activities in intermodal freight transport. First, drayage operators organize the planning and scheduling of trucks between terminals and shippers and receivers. Second, terminal operators manage transhipment operations from road to rail or barge, or from rail to rail or barge to barge. Third, network operators are responsible for the infrastructure planning and organisation of rail or barge transport. Finally, intermodal operators can be considered as users of the intermodal infrastructure and services and select the most appropriate route for shipments through the whole intermodal network.

Each type of decision maker is faced with planning problems with different time horizons. Long term, strategic planning involves the highest level of management and requires large capital investments over long time horizons. Decisions at this planning level affect the design of the physical infrastructure network. Medium term, tactical planning aims to ensure, over a medium term horizon, an efficient and rational allocation of existing resources in order to improve the performance of the whole system. Short term, operational planning is performed by local management in a highly dynamic environment where the time factor plays an important role. The dynamic aspect of operations is further compounded by the stochasticity inherent in the system. Real-life operational management is characterized by uncertainty.

The combination of both classes provides a classification matrix with twelve categories of intermodal operations problems, as depicted in Table 4. The classification is not exhaustive and some decision problems can be faced by several decision makers and can be relevant for the same decision maker at different time horizons. However, the decision problems have been placed in the classification matrix of Table 4 were they are most prominent. Table 4 provides a structured overview of planning problems in intermodal transport involving a single decision level and a single decision maker.

Table 4: Papers involving a single decision level and a single decision maker

Decision maker	Time horizon		
	Strategic	Tactical	Operational
Drayage operator	**Co-operation between drayage companies** Spasovic (1990) Walker (1992) Morlok and Spasovic (1994) Morlok et al. (1995) **Truck and chassis fleet size** -	**Allocation of shippers and receiver locations to a terminal** Taylor et al. (2002) **Pricing strategies** Spasovic and Morlok (1993)	**Vehicle routing** Wang and Regan (2002) Imai et al. (2007) **Redistribution of trailer chassis and load units** Justice (1996)
Terminal operator	**Terminal design** Ferreira and Sigut (1995) Meyer (1998) Rizzoli et al. (2002) Ballis and Golias (2004) Bontekoning (2006) Vis (2006)	**Capacity levels of equipment and labour** Kemper and Fischer (2000) Kozan (2000) Kulick and Sawyer (2001) Huynh (2005) **Redesign of operational routines and layout structures** Voges et al. (1994) Marín Martínez et al. (2004)	**Resource allocation** - **Scheduling of jobs** Alicke (2002) Corry and Kozan (2006) Gambardella et al. (2001)

Network operator	**Infrastructure network configuration** Crainic et al. (1990) Loureiro (1994) Southworth and Peterson (2000) Klodzinski and Al-Deek (2004) Tan et al. (2004) Groothedde et al. (2005) Parola and Sciomachen (2005) **Location of terminals** Meinert et al. (1998) Rutten (1998) Arnold and Thomas (1999) Groothedde and Tavasszy (1999) Macharis and Verbeke (1999) Arnold et al. (2004) Racunica and Wynter (2005) Kapros et al. (2005)	**Configuration consolidation network** Janic et al. (1999) Newman and Yano (2000a) Newman and Yano (2000b) **Production model** Nozick and Morlok (1997) Choong et al. (2002) Lin and Chen (2004) Li and Tayur (2005) **Pricing strategy** Tsai et al. (1994) Yan et al. (1995) Li and Tayur (2005)	**Load order of trains** Feo and González-Velarde (1995) Powell and Carvalho (1998) **Redistribution of railcars, barges and load units** Chih and van Dyke (1987) Chih et al. (1990)
Intermodal operator	n.a.	n.a.	**Routing and repositioning** Min (1991) Barnhart and Ratliff (1993) Boardman et al. (1997) Ziliaskopoulos and Wardell (2000) Erera et al. (2005) Chang (2008) Grasman (2006) Androutsopoulos and Zografos (2009) Caramia and Guerriero (2009)

Source: Caris, Macharis and Janssens, 2008

Note that simple network models do not provide an adequate basis for detailed analyses of transport operations, as the same infrastructure (link or node) can be used in different ways. To solve this problem, the idea, initially proposed by Harker (1987) and Crainic et al. (1990), is to create a virtual link with specific costs for each particular use of an infrastructure network. The concept of super-networks described by Sheffi (1985) that proposes "transfer" links between modal networks, provides a somewhat similar framework. Jourquin and Beuthe (1996) discussed a methodology and an algorithm that create, in a systematic and automatic way, a complete virtual network with all its virtual links corresponding to different possible operations for every real link or node of a geographic network. Tavasszy (1996) also discussed virtual networks and the software that implements them. In this approach, both the modal choice and the assignment steps of the classical four-stage approach (in which generation, distribution, modal-split and assignment are treated as separate steps) are performed at the same time.

Table 5 compiles scientific research in intermodal transport involving multiple decision makers.

Table 5: Multiple decision makers

<table>
<tr><td rowspan="2">Decision maker</td><td colspan="7">Time horizon</td></tr>
<tr><td colspan="5">Strategic</td><td>Tactical</td><td>Operational</td></tr>
<tr><td>Drayage operator</td><td rowspan="4">Macharis (2004)</td><td></td><td rowspan="4">Gambardella, Rizzoli and Funk (2002)</td><td></td><td rowspan="4"></td><td rowspan="4"></td><td></td></tr>
<tr><td>Terminal operator</td><td rowspan="2">Van Duin and Van Ham (1998)</td><td rowspan="2">Evers and De Feijter (2004)</td><td rowspan="2">Bostel and Dejax (1998)</td></tr>
<tr><td>Network operator</td></tr>
<tr><td>Intermodal operator</td><td></td><td></td><td></td></tr>
</table>

Source: Caris, Macharis and Janssens, 2008

Table 6 presents studies that explicitly take into account multiple decision levels. The number of studies that require decisions from more than one decision maker or that cover various time horizons are very limited. This important conclusion has been formulated already by Macharis and Bontekoning (2004). We find that little improvement has been realised in recent years. However, intermodal transport, by definition, involves several decision makers who need to work in collaboration in order for the system to run smoothly. An increased level of coordination is necessary to improve the intermodal transport flow. If intermodal transport is to be developed it will require more decision-making support tools to assist the many actors and stakeholders involved in intermodal operations. A very good attempt at outlining these tools can be found in Van Duin and Van Ham (1998) in which a three-level modeling approach is followed in order to take account of the different goals of the different stakeholders.

Table 6: Multiple decision levels

<table>
<tr><td rowspan="2">Decision maker</td><td colspan="3">Time horizon</td></tr>
<tr><td>Strategic</td><td>Tactical</td><td>Operational</td></tr>
<tr><td>Drayage operator</td><td colspan="3"></td></tr>
<tr><td>Terminal operator</td><td colspan="3">Vis and de Koster (2003)</td></tr>
<tr><td>Network operator</td><td colspan="2">Jourquin et al. (1999)</td><td></td></tr>
<tr><td>Intermodal operator</td><td colspan="3"></td></tr>
</table>

2.2 Simulation versus optimization

Models for network planning may be classified into two groups: simulation models and optimization models. According to Crainic and Laporte (1997) the main limitation of simulation models is their incapability to generate new strategies requiring an analysis of the entire network with possibly multiple conflicting objectives. On the other hand, simulation models offer the possibility to incorporate more realistic details into the model. The complexity of planning problems in intermodal freight transport is increased due to the inclusion of multiple transport modes, multiple decision makers and multiple types of load units. In the literature review applications of simulation models in intermodal transport are found at all decision levels and for all decision makers. Law (2007) states that in some studies simulation as well as analytical models may be of use. For example, simulation may be applied to check the validity and assumptions made in analytical models. Analytical models may suggest alternatives that can be further analyzed in a simulation study. Simulation models as well as analytical models are applied in the DSSITP research project.

2.3 Future prospects

Intermodal transport has grown into a dynamic transportation research field. Many new intermodal research projects have emerged. An investigation has been made into planning issues in intermodal transport. Two strategic planning problems, terminal design and infrastructure network configuration, have received an increased attention in recent years. Yet the number of scientific publications on other intermodal planning problems, especially at the operational decision level, remains limited or non-existent. Topics such as the allocation of resources to jobs in an intermodal terminal or the determination of truck and chassis fleet size in intermodal drayage operations still need to be tackled. The following themes are interesting for future research:

- Drayage operations constitute a relatively large portion of total costs of intermodal transport. The development of efficient drayage operations can encourage its attractiveness. However, little research has been conducted on intermodal drayage operations. Also the possibility to use electric or hybrid cars for the drayage operations can be analysed (Macharis et al., 2007).
- A tactical planning problem that requires more research attention is the design of the intermodal service network and in particular the determination of an optimal consolidation strategy. Additional insight should be gained into which bundling concepts can contribute to the improvement of intermodal transport operations.
- Research efforts are also needed into the further development of solution methods and the comparison of proposed operations research techniques. Metaheuristics can offer an interesting perspective in view of the increased complexity of intermodal planning problems.
- The main attention until now is given to intermodal transport by rail. In regions with an extensive waterway network, such as Western Europe, intermodal transport including inland navigation is also important. Future research is necessary to improve operations in intermodal barge transport.
- A final research field for the future is the cooperation between actors in the intermodal transport chain. Not many studies take multiple decision makers into account. However, an increased level of coordination is required to improve the performance of intermodal freight transport. Also more integration can be achieved between planning problems at different decision levels.

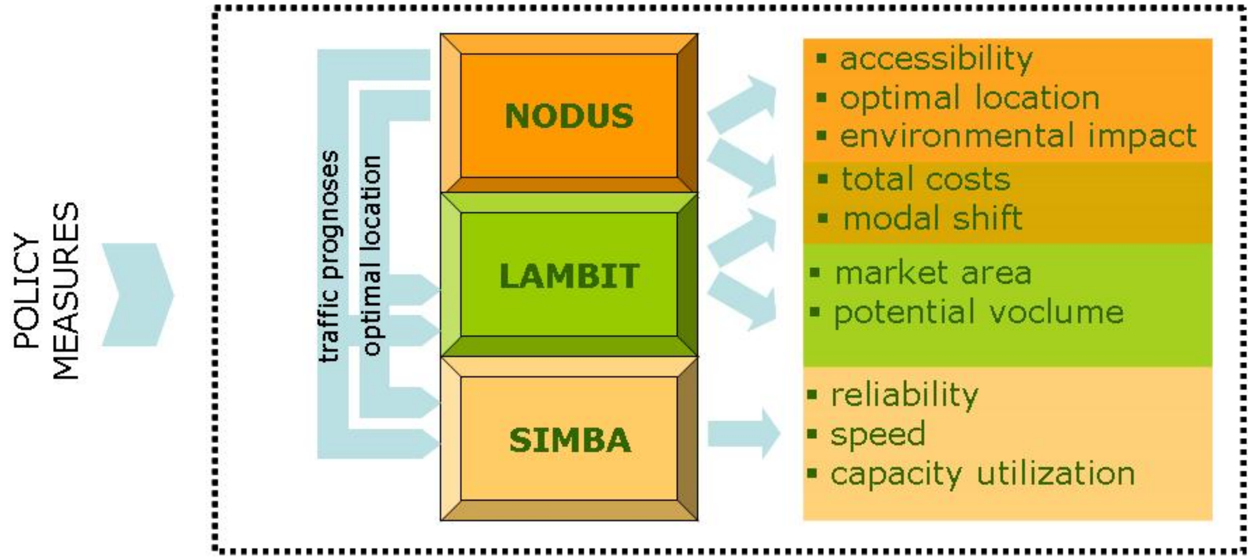
3 DSSITP FRAMEWORK

3.1 Presentation of the DSSITP framework

Belgium is one of the countries, where intermodal transport solutions are becoming increasingly important. The growing attention on intermodal transport from the federal and regional governments is supported by academics. Within the DSSITP (Decision Support System for Intermodal Transport Policy) project, the aim is to develop an assessment framework using three different models that will be capable of assessing policies intended to enhance the growth of intermodal inland waterway and rail transport. Both combinations have a particular market structure and operations, but it is important to analyze them together in order to take care of potential competition distortions. The assessment of transport policy measures is performed on a European scale by Tsamboulas, Vrenken and Lekka (2007). The authors focus on the potential of policy measures to produce a modal shift in favor of intermodal transport. The DSSITP framework intends to take multiple indicators into account when assessing policy measures. The impact of policy measures will be measured on all related transport modes and at multiple aggregation levels.

Three core models, LAMBIT, SIMBA and NODUS make up the decision support system for intermodal transport policy making. The general assessment framework aims to integrate these models. Figure 14 presents the general assessment framework, in which the three models are integrated. Due to the combination of the three models, the analysis of policy measures is performed on multiple levels of aggregation over multiple transport modes. Each model has its specific purpose and outputs. The multimodal freight model NODUS is situated on the highest level of aggregation and constitutes the first step in the analysis of a potential policy measure. The NODUS model provides traffic prognoses which serve as inputs for the LAMBIT model and SIMBA model. The various outputs of the assessment framework are also stated in Figure 14. The NODUS model produces aggregated outputs of the various transport modes, such as their accessibility, environmental impact and share in the modal split. Total costs of an intermodal service are measured. In addition, a module could be developed for NODUS in order to provide optimal locations of terminals. These optimal locations may be introduced in the LAMBIT and SIMBA models. The LAMBIT model is scaled on the Belgian intermodal network. The model analyzes the potential market area of a new terminal and assesses the impacts on existing terminals. It further produces cost indicators and potential modal shifts. The SIMBA model is situated on the lowest level of aggregation and produces detailed output related to the reliability, speed and capacity utilization of the waterway network. With the SIMBA model, the impact of volume increases in the network or the introduction of new intermodal barge terminals can be simulated. Also alternative consolidation strategies may be compared.

Figure 13: DSSITP framework



3.2 Analysis of policy measures

In this subsection a description is given of how the assessment framework is applied to analyze the introduction of a variety of policy measures to stimulate intermodal freight transport. In Table 7, three major categories of potential policy measures are identified. The DSSITP framework aims to assess these policy measures. In chapter 7 applications of the DSSITP framework to various policy measures are elaborated.

Table 7: Policy measures

Categories	Policy measures
COSTS	Subsidy Internalization of the external costs Taxes and pricing Decrease in canal dues
INFRASTRUCTURE	Public private partnerships and new terminals Capacity increase Intermodal network Standardization of the transport units
SERVICES	Frequency Broadening of working hours Consolidation strategy Intelligent transport systems

3.2.1 Costs

One of the most common policy measures in promoting intermodal transport is through intermodal costs. Both federal and regional governments establish subsidy schemes to promote the growth of intermodal transport. The DSSITP framework may make ex-ante and ex-post assessment of cost related measures. Subsidies can be included into the cost functions used by NODUS and then the goods are assigned taking into account such changes. The data for modal split in terms of quantities, flows and total costs will be compared with the one from the baseline scenario in order to consider if the modal share has significantly increased for waterways and/or rail thanks to subsidies. Statistical tests will be useful in order to determine if the hypothesis that the average μ_1 for baseline scenario is different from μ_2 for the assignment including the subsidies.

Based on current market prices the LAMBIT model will visualize the changes in the market area of intermodal terminals when a subsidy is introduced to the individual transport modes. The LAMBIT model will further conduct ex-ante analysis for the internalization of the external costs. External costs for each transport mode will be internalized to show real total costs of transportation.

The outputs of the NODUS model and LAMBIT model serve as an input for the SIMBA model. When analyzing the impact of cost measures for intermodal barge transport, the SIMBA model is applied in the final stage. Volume increases due to a modal shift towards barge transport may have an impact on the waterway network. SIMBA analyzes the emergence of bottlenecks in the infrastructure network. Capacity utilization of locks, quays and network connections is measured.

3.2.2 Infrastructure

Infrastructure related policy measures include the construction of new terminals and intermodal network extensions. The DSSITP framework will analyze the introduction of new terminals in an integrated way. NODUS will serve to identify new terminals' optimal locations on the inland waterway network. Furthermore, NODUS will provide an insight in the modal shift due to the installation of a new intermodal terminal. The optimal locations from NODUS will be inputs for the LAMBIT model. The proposed locations will be assessed in the LAMBIT model and their market areas will be shown. Furthermore, market potentials for new terminals will be shown based on the container statistics that are transported by road. The LAMBIT model will visualize not only the market areas of new terminals but also their effects on the current terminal landscape. A new barge terminal may be added to the current hinterland network in the SIMBA model. The optimal location, determined by NODUS, serves as an input. NODUS and LAMBIT determine the volume attracted by the new barge terminal. This serves as an input in SIMBA in order to model shuttle services provided by the new terminal. The new hinterland network is compared with the current situation to deduct the impact on the infrastructure network. An overview of infrastructural investments needed to operate the new terminal at full capacity may be given. Also other infrastructural investments in the waterway network can be analyzed with SIMBA. This case is further explored and applied in chapter 7.

3.2.3 Services

SIMBA can be applied to analyze alternative consolidation strategies in intermodal barge transport. Consolidation of freight can be organized in the hinterland network or in the port area. With SIMBA different scenarios for implementing a consolidation network can be compared with respect to a potential reduction in turnaround time of inland vessels and an efficiency improvement in the handling of inland vessels in the port area. Possible hub locations will be added to the inland waterway network of the LAMBIT model in order to assess the impacts of the inland hub on the intermodal terminal landscape. Market areas and potentials of the hub will be provided as vital indicators in assessing location decisions.

4 CONCLUSIONS

Modeling problems in intermodal freight transport are more complex due to the inclusion of multiple transport modes and multiple decision makers. An insight is given into the research field and modeling issues that still need to be tackled. A combination of simulation and optimization models is necessary to deal with this increased complexity in intermodal transport. In this chapter the methodology of the DSSITP framework is introduced. The latter will provide a decision tool for the stakeholders thanks to its capability to assess the changes due to political measures. The DSSITP framework is formed by three core models, each one having its own functions, which are complementary in order to analyze these changes. The application of the framework on three major categories of policy measures is described. For a full description of the three core models and their specific applications, the reader is referred to the book "A decision support system for intermodal transport policy", which is published by the DSSITP team and disseminated during the study day last December. In the next chapter, we will focus on the application of the DSSITP assessment framework.

CHAPTER IV

SIMULATION OF POLICIES

1 INTRODUCTION

In this chapter, the DSSITP assessment framework is applied to two cases. The first case is the location of a new intermodal barge terminal. The optimal location is searched by the NODUS model, the market area is analysed using the LAMBIT model and the impact on the performance measures is calculated by the SIMBA model.

The second case considers possible price measures to stimulate intermodal transport. A means for this is to grant subsidies for each container handled by a Belgian intermodal terminal. Subsidy schemes are already applied in Belgium. The impact analyses of the subsidies on modal split and freight flows at the terminals are performed by the NODUS model. The LAMBIT model is used to analyse the impact on the market area of intermodal terminals.

2 IMPACT OF AN ADDITONAL TERMINAL

2.1 Introduction for case 1

In this first case study, the optimal location for an additional container terminal along the Belgian waterways will be computed, and its impact on the market area and its performances assessed.

Within the DSSITP project, some scripts where developed in NODUS in order to implement an optimal location algorithm. The theoretical background involved will first be outlined. This will be followed by a brief description of the digitised network that was used. The obtained result (the new optimal location) and its potential impact on the modal shift are then discussed.

Once the optimal location determined and the global impact of its implementation estimated, the second step of this case analyses the market area of the identified new terminal location. This result will be achieved using the LAMBIT model.

Finally, the SIMBA model will be used during a third step in order to estimate the impact of the newly located terminal on the performances of the transport system.

2.2 Step 1 : Optimal location of a new terminal using NODUS

2.2.1 Optimal location of a new terminal

One of the possible policy measures to increase freight flows using the intermodal mode is the opening of new container terminals on inland waterways or connected by rail. Such a terminal must be well located in order to reach this goal, which means that it will be chosen following a set of criteria as the geographic distribution of freight flows and their costs for transhipment. To achieve this work, an algorithm using these parameters has been implemented. It locates new terminals taking the existing ones into account and considering the terminals as hubs. It is the p-Hub Median problem (p-HMP) first formulated by O' Kelly (1987). In the standard multiple-hub network problem (see O'Kelly and Miller (1994) for the different problem classes), three constraints are traditionally identified: it is assumed that all the hubs are connected directly to each other, that there is no direct connection between non-hub nodes, and that the non-hub nodes are each connected to a single hub. The inter-hub links consolidate the total flow coming from the origin hub (or any of its spoke nodes) to the destination hub (or any of its spoke nodes). The location of the hubs must be chosen from the set of nodes, *N*, considered as potential locations. Economies of scale can be associated with the transportation system between the hubs. The objective is to minimise the total transportation cost. Other problem formulations are available, but this one has been chosen because it enables to take explicitly into account the costs for pre- and post-haulage by road in addition to the cost of the main haul, which is an advantage when locating terminals in an intermodal context. The formulation used for the p-HMP is the one by Ernst *et al.* (1996) that considerably reduces the needed computing time. The objective function of this problem tends to minimise the generalised cost (1) which comprises the costs for pre- and post-haulage by road plus the main haulage using the waterways (including possible economies of scale) and the transhipment at the terminals. The problem can be formulated as:

Inputs:

p = number of terminals to locate
h_{ij} = flow between origin i and destination j
O_i = total flow from node i
D_i = total flow to node i
χ = relative cost of pre-haulage
α = inter-hub discount ($0 \leq \alpha \leq 1$)
δ= the relative cost of post-haulage
C_{ik} = unit cost for route between node i and terminal located at node k
C_{km} = unit cost for route between terminals located at nodes k and m
T = transhipment cost at terminal

Decision variables:

X_{ik} = *1* if node *i* is assigned to the terminal located at node *k* $\forall i,k \in N$
0 otherwise
$Y^i_{km} \geq 0$ is the traffic from node *i* that passes by terminals located at nodes *k* and *m* $\forall i,k,m \in N$

Minimise:

$$\sum_{i\in N}\sum_{k\in N} C_{ik} + .T_k .X_{ik}(\chi O_i + \delta D_i) + \sum_{i\in N}\sum_{k\in N}\sum_{m\in N} \alpha C_{km}.Y^i_{km} \quad (1)$$

Constraints:

$$\sum_{x\in N} X_{kk} = p \quad (1.1)$$

$$\sum_{k\in N} X_{ik} = 1 \;\; \forall i \in N \quad (1.2)$$

$$X_{ik} \leq X_{kk} \ \forall i,k \in N \ (1.3)$$

$$\sum_{m \in N} Y_{km}^{i} - \sum_{m \in N} Y_{mk}^{i} = O_i X_{ik} - \sum_{j \in N} h_{ij} X_{jk} \quad \forall i,j,k,m \in N \ (1.4)$$

$$X_{ij} \in \{0;1\} \ \forall i,j \in N \ (1.5)$$

$$Y_{km}^{i} \geq 0 \ \forall i,k,m \in N \ (1.6)$$

The algorithm finds *p* optimal locations in a set of determined potential locations on the network (1.1). Another constraint is that each centroid (aggregated origin or destination point of the freight) must be connected to only one terminal in order to reduce the size of the problem (1.2). In constraint (1.3), a centroid cannot be assigned to a terminal if the latter is not activated as so. Equation (1.4) is the divergence equation for commodity *i* at node *k* in a complete graph, where the demand and supply at the nodes is determined by the allocations X_{ik}. The latter enables to keep the flows at the terminals. Constraints (1.5) and (1.6) are standard integrity constraints.

Each (*i,j*) pair in a *p*-HMP is analogous to a demand point in a *p* median problem (*p*-MP) in which the demand nodes are assigned to the nearest facilities. As it may not be ideal to assign the demand nodes to their nearest hub, the *p*-HMP relaxes this constraint.

In the application set up in the framework of the DSSITP project, 11 existing terminals were taken into account including those located into the ports of Antwerp and Zeebrugge. They were added to 50 other potential locations (N=61) on the Belgian inland waterways and then the p-HMP was applied to this case in order to find one additional new optimally located terminal. These 50 potential new locations were selected homogeneously on the waterways network. Note that only network connections with a gauge at least equal to 1350T was taken into account.

2.2.2 Network database

A network model able to assess the impact of the addition of a new terminal was developed. We used the origin-destination (OD) matrices for the year 2000, produced by NEA Transport Research and Training. The matrices give information about the type of commodity being transported, classified according to the Standard Goods Classification for Transport Statistics/Revised (NST/R chapters). Only the figures for NST/R Chapter 9, containing the demand for containers amongst other manufactured products, are taken into account in the model. The database contains region-to-region relations at the NUTS 2 (Nomenclature of Territorial Units for Statistics) level, for the area of the EU25, plus Norway and Switzerland, and at the NUTS5 level for Belgium. The matrix provided by NEA is at the NUTS2 level. Therefore, in order to obtain figures at the communal (NUTS5) level for Belgium, an older matrix (1995) available at the NUTS5 level was used to disaggregate the matrix for 2000.

A digital representation of the networks for the different transportation modes (roads, railways and inland waterways) is also needed. The railway and road networks were taken from the Digital Chart of the World (DCW) and updated. The DCW is an Environmental Systems Research Institute, Inc. product originally developed for the US Defence Mapping Agency (DMA) using DMA data. The inland waterways network was digitised at the Group Transport & Mobility (GTM) research lab.

Finally, the borders of the NUTS 2 regions were provided by Geophysical Instrument Supply Co (GISCO) and a centroid for each region was located at the centre of the most urbanised area of the zone. These centroids are taken as the origins or destinations for the commodities. The same was done at the NUTS5 level for Belgium.

All these separate layers were finally connected together by the creation of "connectors" from each centroid to each modal layer. The complete set of layers can be considered as a geographical graph, comprising about 110 000 edges and 90 000 vertices.

A validation of the network model, comparing assigned flows and real counts along the networks was performed. The complete results and the used methodology are too long to be explained in this chapter. The quality of the assignment can however be considered as satisfactory, taking into account the fact that the demand data is nearby 10 years old. However, the methodology is robust and can be applied easily to newer data, if it were available.

2.2.3 Results

An optimal location was found at Roucourt on the Nimy-Blaton-Péronnes canal (Figure 15). Note that a new terminal is currently planned in this region, in Vaux.

An analysis of the changes induced by the opening of such a terminal was further performed. It is indeed possible to estimate the impact on the modal split, on the total generalised transportation cost on the network and on the amount of containers handled at the existing terminals when Roucourt is introduced in the NODUS network model.

Figure 14: Existing terminals and optimal terminal location

The modal share for intermodal transport (Table 8) increases by 2.87% in tons while road-only transport decreases by 0.07%. Expressed in tons.km, the modal share increases by 0.78% for waterways, and decreases by 0.02% for road. The total generalised cost on the network decreases by 0.05% with the additional terminal. The amount of containers handled at the terminals increase for all the existing terminals except for Avelgem from which Roucourt seems to catch some market. This is probably due to their relative close locations on the network. Indeed, Roucourt can deserve an area in Hainaut that is normally assigned to Avelgem. The total increase can be explained by the fact that the new terminal covers a new area currently not yet exploited by the existing terminals.

Table 8: Impact of Roucourt on the modal split

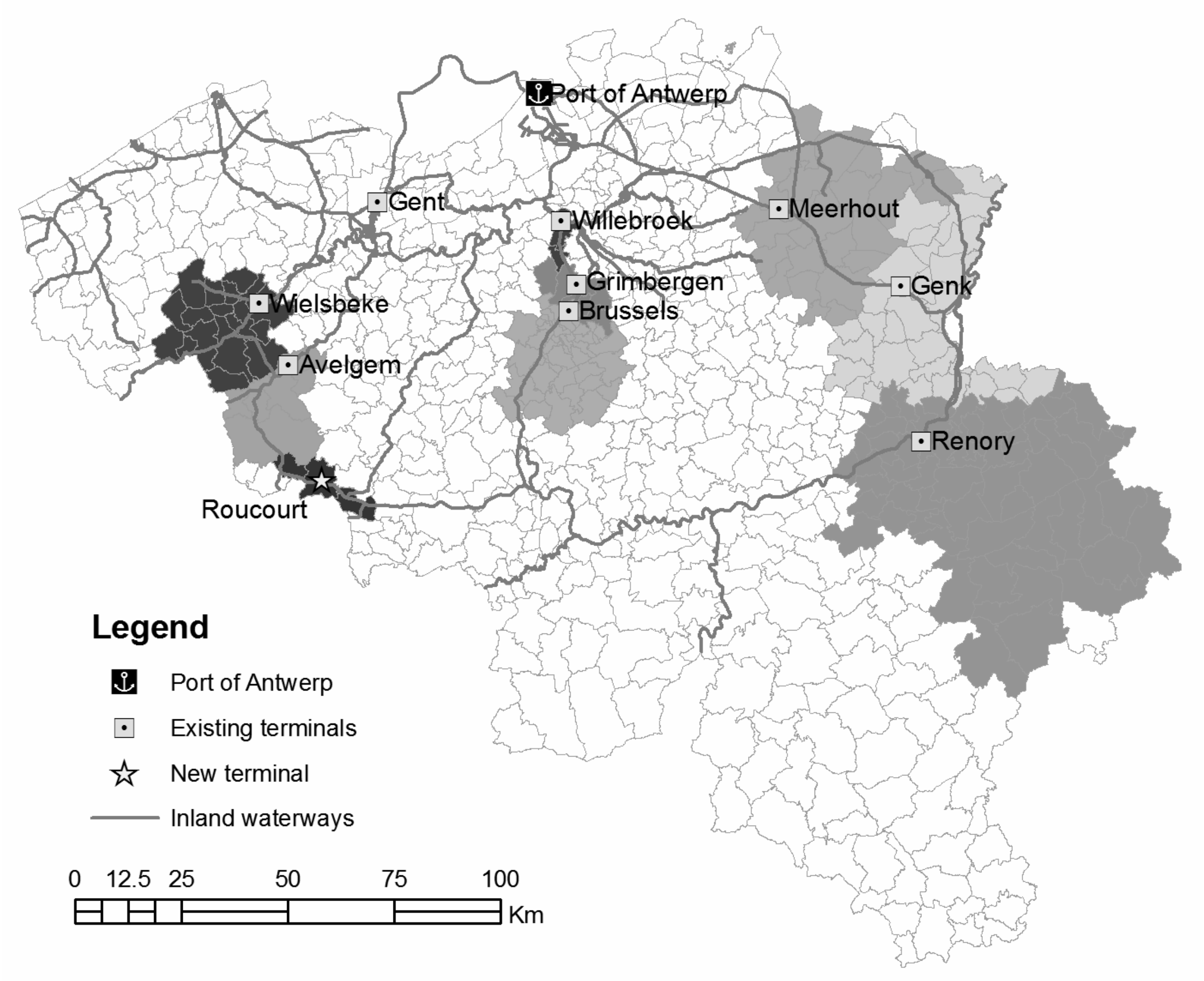
Mode	**Relative difference**
Tons	
Road	-0.07%
Rail	-0.18%
Water	-0.09%
Intermodal	+2.87%
Tons.km	
Road	-0.02%
Rail	-0.10%
Water	+0.78%
Generalised cost	-0.05%

This new terminal influences the distribution of freight flows in favour of intermodal transport. Even if the relative difference seems to be weak, it represents several millions of tons transferred from road to waterways, which can be considered as a good evolution towards a sustainable transport system.

2.3 Step 2 : Market area and potential of the new terminal using LAMBIT

With the LAMBIT model the market area and potential volume of the new intermodal terminal in Roucourt can now be analysed. The optimal location, which NODUS provided, is included as an additional inland waterways terminal in the LAMBIT model. Figure 16 visualises a small market area for the new terminal, based on the current market prices. A terminal in Roucourt, takes 3 municipalities that are currently served by unimodal road transport.

Figure 15: Market area of the new terminal

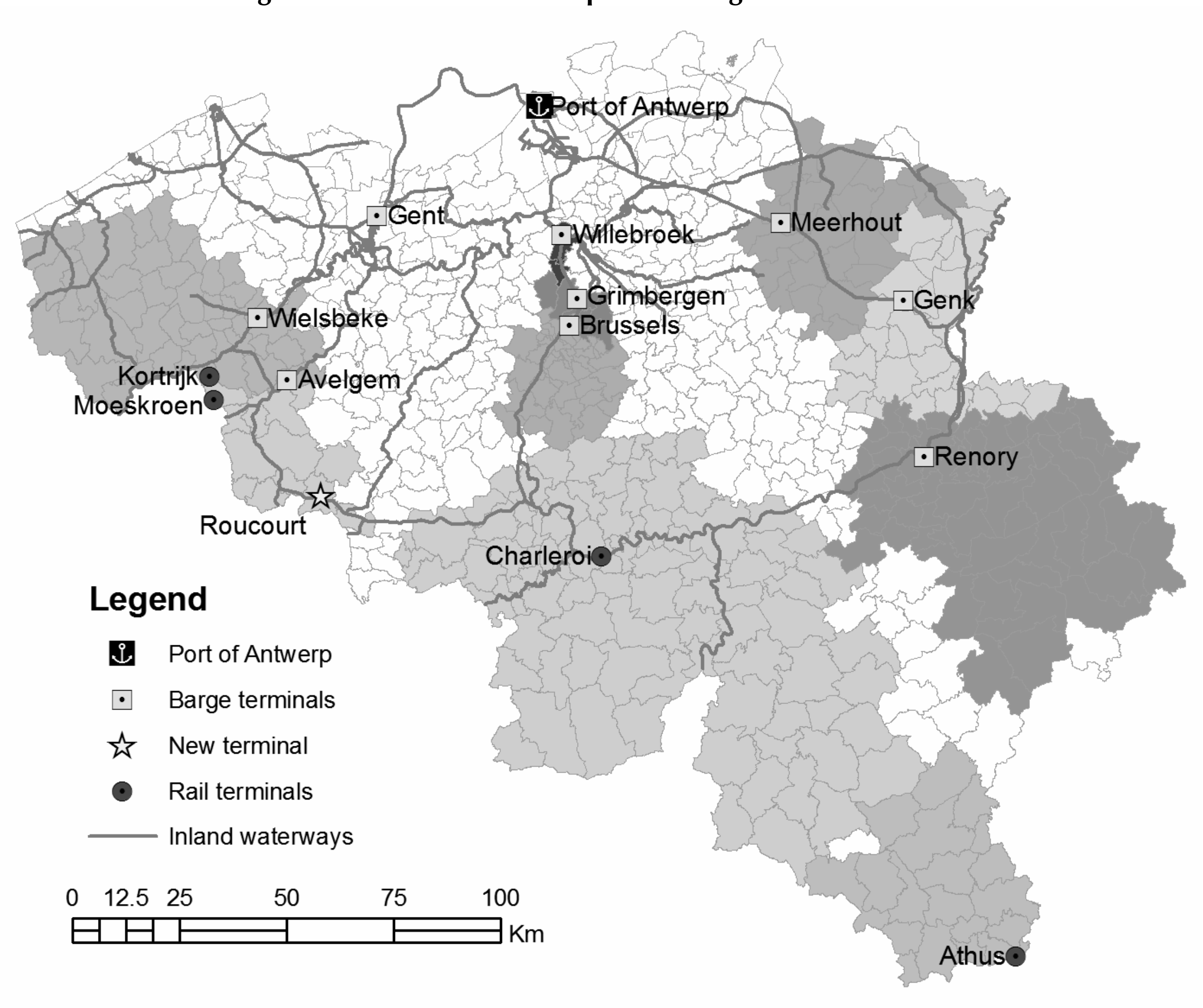


The new terminal in Roucourt is 28 km away from the terminal in Avelgem. In order to assess a possible common market area problem, in Figure 17 both of the terminals are shown. Although the terminal in Roucourt is located in proximity with the terminal in Avelgem, it attracts municipalities, that are outside the market area of Avelgem. This situation complements the outcome of NODUS, that showed that the new terminal influences the distribution of freight flows in favour of intermodal transport.

Figure 16: Market area of terminals in Avelgem and Roucourt

However, taking also the rail/road terminals into account, we see that in the current situation a new terminal in Roucourt is not able to take any market area (Figure 18). The barge terminals in Wielsbeke, Avelgem and the potential new terminal in Roucourt lose their market area to the rail terminals in Kortrijk and Moeskroen. This is due to a common market area between the terminals and the effect of the rail subsidy, from which the two rail terminals benefit. The rail terminals thus offer lower prices compared to inland waterways and unimodal road transport.

Figure 17: Terminal landscape including the rail terminals



2.4 Step 3 : Impact on waterways network performance using SIMBA

In this subsection, the SIMBA model is applied to analyse the impact of the new intermodal barge terminal in Roucourt on the waterways network. The impact on network characteristics such as average and maximum waiting times at locks and in the port area can be measured. Potential bottlenecks and necessary capacity investments may also be deducted. The location and volume of a new intermodal barge terminal are deducted from the results of the NODUS model and LAMBIT model. The container volume of the new terminal location is deducted from the proportional market area of the new location compared with the current market area of existing terminals. The results of NODUS show that the terminal of Roucourt will have more or less the same size as the terminal in Gent and one third of the volume of Avelgem. A potential volume of 7,000 containers per year with the port of Antwerp as origin or destination is assumed. Vessels will sail via the Upper Scheldt to the port area in Antwerp. The Nimy-Blaton-Péronnes canal is navigable for vessels up to 1350 tons. As the terminal currently does not exist, assumptions have to be made regarding the service schedule offered to customers. Vessels of size 32 TEU and 66 TEU sail in a roundtrip to the port area. Three departures are equally distributed in a weekly schedule. Vessels may visit both clusters of sea terminals on the right and left river bank in a single roundtrip. As the new terminal is situated in the southern part of Belgium, it takes almost a day to sail from the hinterland to the port of Antwerp. Barges depart in the morning of day 1 in Roucourt and arrive at sea terminals in the morning of day 2. No changes are made to the schedules of the existing inland terminals. A separate random-number stream is dedicated to each source of randomness in the model in order to synchronise the current and new situation as much as possible.

Performance measures relevant for the comparison of the current and new situation can be calculated. Ten simulation runs of 672 hours are performed. Table 2 gives the average turnaround times of all inland terminals, expressed in hours in the current and future situation. Inland vessels may only sail to Antwerp (Antw) or they can make a combined trip to Antwerp and Rotterdam (Rdam) or Amsterdam (Adam). The standard deviation is mentioned between brackets next to the average turnaround time. From Table 9 may be concluded that the introduction of a new terminal has no influence on the turnaround times of existing terminals. Shuttle services offered by the terminal in Roucourt incur a turnaround time of 63.31 hours.

Table 9: Average turnaround times current situation and after introduction new terminal

Shuttle services	Current		New terminal	
Gosselin Deurne – Apen	15.10	(0.32)	15.20	(0.41)
Gosselin Deurne – Rdam	21.21	(0.09)	21.26	(0.07)
Gosselin Deurne - Apen + Rdam	22.44	(0.46)	21.64	(0.88)
WCT Meerhout – Apen	29.09	(0.46)	28.84	(0.41)
WCT Meerhout – Rdam / Adam	38.20	(1.07)	38.30	(0.46)
WCT Meerhout - Apen + Rdam / Adam	41.59	(0.42)	41.75	(0.56)
Haven van Genk – Apen	38.70	(0.53)	38.84	(0.66)
Haven van Genk – Rdam	45.07	(0.46)	45.03	(0.54)
Haven van Genk - Apen + Rdam	50.30	(0.95)	49.87	(1.05)
Renory Luik – Apen	46.47	(0.31)	46.28	(0.38)
IPG Gent – Apen	20.24	(0.53)	20.55	(0.69)
IPG Gent – Rdam	35.43	(0.49)	35.28	(0.32)
RTW Wielsbeke – Apen	38.63	(0.51)	38.77	(0.36)
RTW Wielsbeke – Rdam	49.29	(0.91)	49.04	(1.10)
AVCT Avelgem – Apen	41.98	(2.13)	42.09	(1.99)
AVCT Avelgem – Rdam	57.53	(0.90)	58.21	(1.16)
AVCT Avelgem - Apen + Rdam	62.82	(0.48)	62.57	(0.41)
TCT Willebroek – Apen	14.74	(0.19)	14.79	(0.13)
TCT Willebroek - Apen+Rdam	35.47	(0.36)	35.36	(0.36)
Cargovil Grimbergen – Apen	20.91	(0.17)	21.07	(0.38)
Cargovil Grimbergen - Rdam	38.17	(0.38)	38.24	(0.11)
BTI Brussel – Apen	21.74	(0.29)	21.76	(0.29)
BTI Brussel – Rdam	40.61	(0.83)	40.84	(0.99)
BTI Brussel - Apen + Rdam	40.63	(0.36)	40.78	(0.45)
Batop Herent – Apen	21.98	(0.27)	21.80	(0.14)
Roucourt – Apen	/		63.31	(0.70)

Table 10 summarises the performance measures in the port area. The average and maximum waiting time before handling, expressed in hours, are given for the sea terminals on the right and left river bank. Next, the average and maximum utilisation of the quays on the right and left river bank and at the hub are measured.

Table 10: Performance measures in port area

	Current		New terminal	
	Avg	**Stdev**	**Avg**	**Stdev**
Avg Waiting time port area				
RO	0.06	0.02	0.08	0.02
LO	0.05	0.02	0.05	0.02
Max Waiting time port area				
RO	4.37		7.72	
LO	3.98		3.97	
Avg Capacity utilisation				
RO	0.1666	0.0017	0.1715	0.0015
LO	0.1742	0.0017	0.1786	0.0019
Max Capacity utilisation				
RO	0.9834		0.9834	
LO	0.9850		0.9850	

Following Law (2007), paired-*t* confidence intervals are constructed to compare the results. Table 11 presents the 95% confidence intervals for which the difference between the introduction of a new terminal in Roucourt and the current situation is significant. The average handling time in both clusters of sea terminals on the left and right river bank increases slightly due to the introduction of a new terminal in the waterways network. An increase of 0.5% is only a minor effect. No large impact is to be expected in light of the small market area of the new inland terminal. However, the analysis clearly demonstrates the possibilities of the SIMBA model and the DSSITP framework. The framework is able to quantify ex-ante the impact of policy measures that stimulate the emergence of new intermodal terminals.

Table 11: Comparison current and new situation

Avg Capacity utilisation	95% Confidence interval
Quay RO	0.0005; 0.0094
Quay LO	0.0002; 0.0084

2.5 Conclusions for case 1

The combination of the models allows to analyse in depth the location of intermodal terminals. The NODUS optimisation model shows that in the current terminal landscape Roucourt might be the most interesting choice. Verification of the potential market area by the LAMBIT model shows that the terminal will make new municipalities open for intermodal transport that are currently served by unimodal road transport. Although a small market area exists for the new terminal, it complements a market for intermodal transport together with the terminal in Avelgem. If also the rail/road terminals are taken into account, we see that it will be difficult to compete with the rail mode in that area. The SIMBA model shows that the introduction of a new terminal has no influence on the turnaround times of existing terminals.

3 IMPACT OF SUBSIDIES

3.1 Introduction for case 2

Another option that can be used to stimulate intermodal transport is to decrease the costs linked to the transport operations at the terminals. A means for this is to grant subsidies for each container handled by a Belgian intermodal barge terminal. This kind of measure is applied in Belgium in both Walloon, Brussels and Flemish regions but at different tariffs for each (Table 12). At a federal level, a subsidy is designed for intermodal railway transport. The subsidy for the transport of a container from the Port of Antwerp to each rail terminal is based on a fixed part (20 Euro per container) and a variable part (maximum 0.40 Euro per kilometre).

Table 12: Subsidy schemes for intermodal transport in Belgium

Reference	Subsidy amount	Region	Type	Moment of Introduction
N 4/2004	12€ for a 20 feet container 18€ for a 30 feet container 24€ for a 40 feet container	Wallonia	Inland waterways	From 2004- (no end date)
N 720/2006	12€ for a 20 feet container 18€ for a 30 feet container 24€ for a 40 feet container 27€ for a 45 feet container	Brussels	Inland waterways	Introduced 2007-2009
N 682/2006	17.5€ for each full Container	Flanders	Inland waterways	Introduced 2007-2009 Not implemented yet (November 2008)
N 249/2004	20€ + 0.40€/km	Federal	Railway	Extended 2005-2008

The impact of these regional subsidies can be analysed by the combination of the NODUS and the LAMBIT model.

3.2 Step 1 : Impact analysis using NODUS

As said, the Walloon Government Decree of 12/2/2004 grants a subsidy for each container transhipped according to its size fixed at 12€ per twenty-feet container and at 24€ per forty-feet container. Calculations are made to convert it to a value per ton taking into account the average load of a container (15 tons for twenty-feet and 25 tons for forty-feet) and the proportion between twenty-feet (65%) and forty-feet containers (35%) plus the rate of empty returns (80%). These assumptions are taken from a set of interviews of Belgian stakeholders. This leads to a subsidy of 1.07€/ton in Wallonia. The Flemish Government grants a subsidy of 17.5€ per container. This leads to a subsidy of 1.429€/ton in Flanders. During the interviews, questions were also asked about the handling costs at terminals. A value of 2.15€/ton (without subsidies) appears to be a good average proxy for these costs. Thus, values of 1.08€/ton in Wallonia and 0.72€/ton in Flanders can be used when the subsidies are taken into account.

As it reflects the existing situation, the reference scenario that was set-up in NODUS, and that was already used for the first case study, includes the subsidies. In order to estimate the impact of these subsidies on the market shares for the different transportation modes, another run of the network model was performed, during which the different subsidies were not included any more.

It appears that the subsidies for the transhipment at the terminals have an important impact on intermodal transport. Indeed, the tons loaded on the network using combined transport decrease by 49.52% and the ones transported by truck-only increase by 1.35% (Table 13) when there are no more subsidies. Expressed in tons.km, the decrease on waterways is less impressive because intermodal transport uses partly road transport for pre- and post-haulage, but remains quite high with 13.75%. In this case, road transport decreases only by 0.46%.

Table 13: Impact on modal split in scenario without subsidies

Mode	Relative difference
Tons	
Road	+1.35%
Rail	+2.06%
Water	+1.74%
Intermodal	-49.52%
Tons.km	
Road	+0.46%
Rail	+0.90%
Water	-13.75%
Generalised cost	+0.53%

There is thus no doubt that the current subsidies have a clear impact in favour of intermodal transport.

Without subsidies, some terminals would become less attractive (Table 14). It is certainly the case for Wielsbeke, Gent, Grimbergen, Willebroek and Brussels where container flows disappear in our model when subsidies are not applied. Note that, in the model, intermodal transport is used only when it is the cheapest solution, computed from and to the centroid of each municipality. A much more disaggregated origin-destination matrix, at the firm level for instance, would certainly give less abrupt results. Moreover, the pure cost is not always the only factor that is taken into account by the shipper. Taken these remarks into account, these results however show how subsidies, which correspond to about half of the original transhipment cost, are important to stimulate the use of intermodal transport.

Table 14: Impact on flows (in tons) at the terminals in scenario without subsidies

Terminal	Relative difference
Zeebrugge	-25.64%
Antwerpen	-30.97%
Wielsbeke	-100.00%
Gent	-100.00%
Grimbergen	-100.00%
Willebroek	-100.00%
Renory	-75.72%
Genk	-55.11%
Meerhout	-96.89%
Brussel	-100.00%
Avelgem	-99.73%

3.3 Step 2 : Market area analysis using LAMBIT

In LAMBIT, a reference scenario was set up with the rail (subsidised) and barge terminals (non-subsidised) in order to show the impact of the subsidies for barge transport. In the different regions, subsidies for barge terminals are then included in the model and the simulations are run.

Figure 19 visualises the impact of subsidies on the intermodal terminal landscape. In this scenario, a growth in the market areas of intermodal terminals is achieved (Table 15). Regional subsidies on inland waterways result in an increase for the market area of barge terminals in terms of the number of municipalities. The subsidy enables the terminal of Gent to offer an alternative to unimodal road transport. Furthermore, the terminals of Avelgem and Wielsbeke regain market area from the rail terminals of Kortrijk and Moeskroen. In other words, rail terminals lose market area except for the terminal in Athus. Overall, a growth in intermodal transport's market area in terms of the number of municipalities is achieved thanks to the subsidies for containers handled at barge terminals. Market areas of the terminals with their reference scenario are provided in Table 8.

Figure 18: Subsidy scenario for the current situation

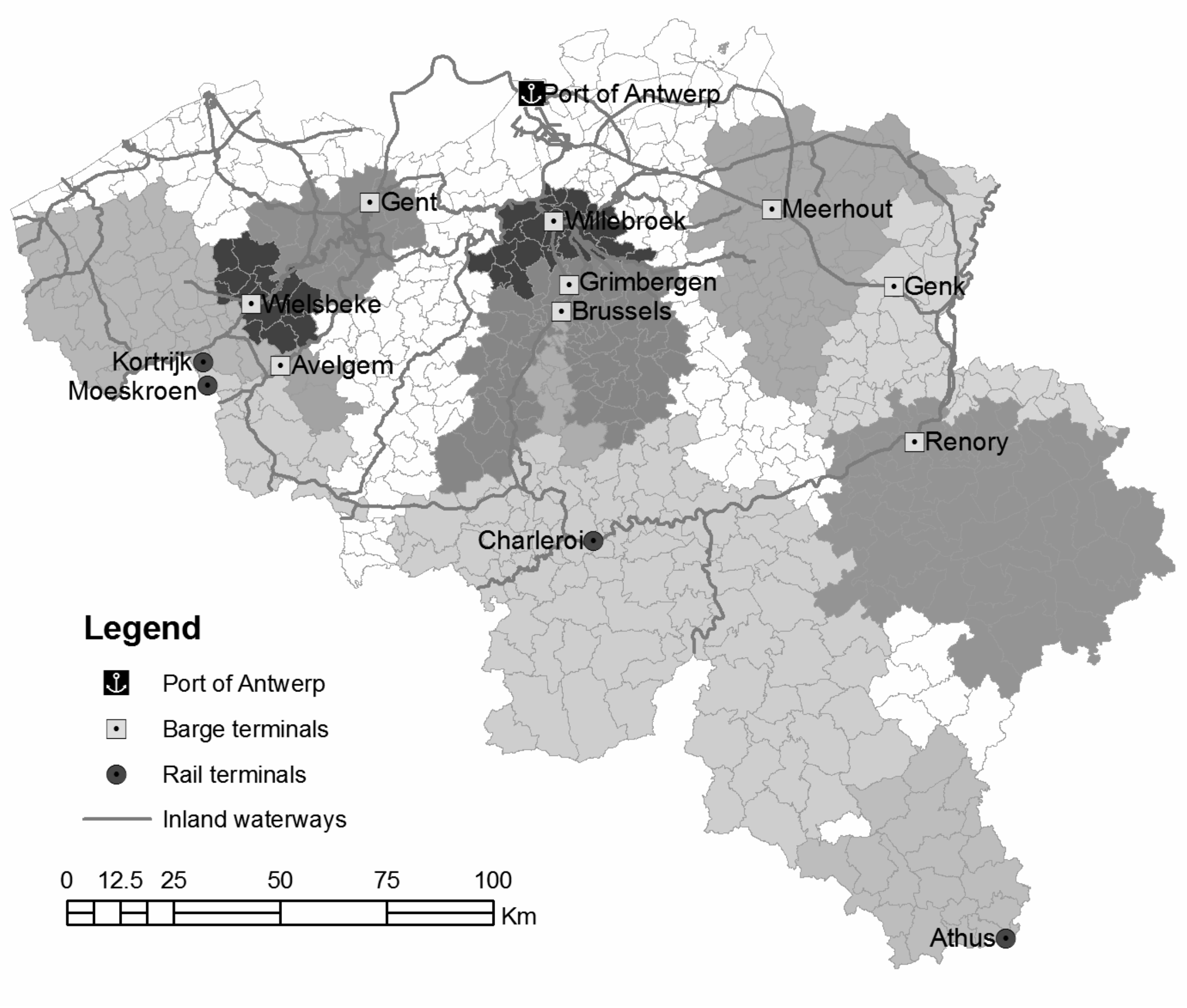
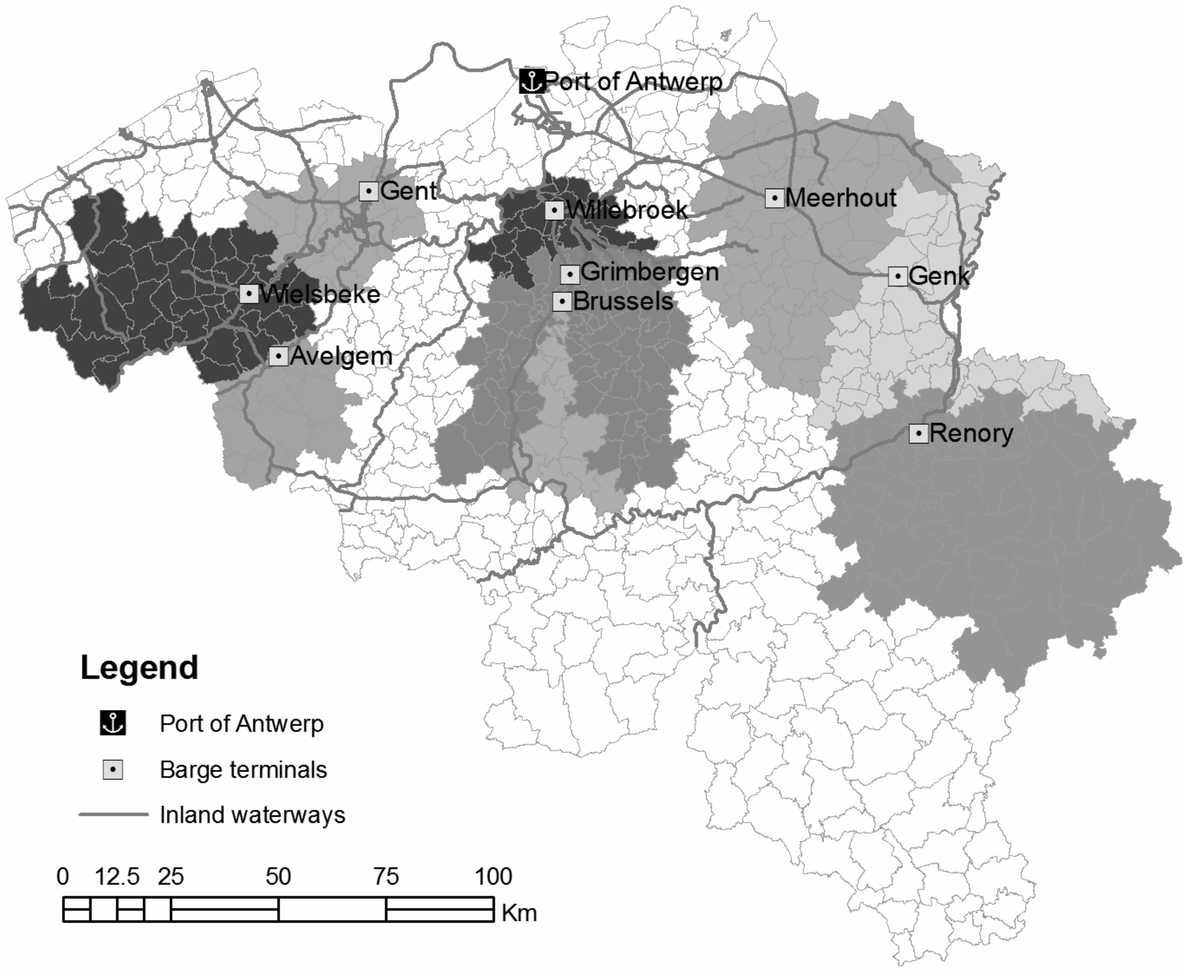


Table 15: Market areas of terminals: Subsidy scenarios

	Barge and rail terminals		Barge terminals	
	Current situation (The number of municipalities)	Subsidy scenario (The number of municipalities)	Current situation (The number of municipalities)	Subsidy scenario (The number of municipalities)
Road	260	161	400	263
Meerhout	24	44	24	44
Gent	0	18	0	18
Wielsbeke	0	13	19	41
Willebroek	3	22	3	22
Avelgem	0	5	8	14
Renory	60	60	60	60
Genk	30	41	30	41
Grimbergen	6	62	6	67
Brussels	39	13	39	19
Athus	19	19		
Charleroi	90	86		
Kortrijk	45	33		
Moeskroen	13	12		
Total	589	589	589	589

Another subsidy scenario is developed (Figure 20) to assess its impact only on the inland waterways market area. Therefore, a reference scenario with non-subsidised barge terminals is included in LAMBIT. The simulation of regional subsidies leads to an increase of 23.3% of the market area of intermodal transport. All barge terminals except Renory and Brussels increase their market areas. While the terminal in Renory maintains its market area, the terminal in Brussels has a decline. This is explained by the regional differences in the degree of subsidies. The terminal in Grimbergen will enjoy the subsidy scheme of the Flemish government (17.5€), which is more than the subsidy scheme for the terminal in Brussels (12€). Thus the terminal in Grimbergen takes market area from the terminal in Brussels. In Table 8, the market areas of the barge terminals are summarised.

Figure 19: Subsidy scenario for the barge terminals



3.4 Conclusions for case 2

In this case, the impact of subsidies on the market area of intermodal transport was analysed. NODUS provides an idea of the impact of subsidies on the modal split and flows at the terminals, whereas LAMBIT is used to visualise changes in the market area of terminals. The results in NODUS and LAMBIT show that the introduction of subsidies indicates a growth in the market area of barge terminals.

In conclusion, we can claim that intermodal transport is very sensitive to changes in transhipment cost. A policy, based on subsidies such as those proposed in Belgium, can be considered as effective to promote this mode of transport. However the different subsidy schemes at the federal level for rail transport and in the three regions for barge transport should be complementary and be coordinated.

4 CONCLUSIONS

This chapter presented the policy assessment within the DSSITP assessment framework. The DSSITP framework is applied to two cases. The first case is the location of a new intermodal barge terminal. In this first case study, the optimal location of a new terminal is determined in NODUS, which also estimates the global impact of its implementation. Taking the optimal location as an input, the LAMBIT model analysed its market area. Finally, the SIMBA model is used to estimate the impact of the new terminal on the performance of the transport system.

The second case aimed to analyse the effect of subsidies. In NODUS, a scenario without subsidised inland waterways transport is performed to show the impact on modal split and freight flows at the terminals. The LAMBIT model is used to analyse the impact on the market area of terminals.

The two case studies clearly demonstrated the possibilities of the DSSITP framework. Ex-ante impacts of the policy measures of installing a new terminal and formulating subsidies can be assessed with the DSSITP framework. The interactions with the models in an integrated manner contribute to develop effective policies to promote the growth of intermodal transport.

CONCLUDING REMARKS

Intermodal transport is gaining increased policy attention thanks to the possibilities to lower costs, decrease the environmental pressure and congestion, and by providing an alternative way to ship containers to the hinterland. Its market is growing the last couple of years although in absolute numbers road transport is still the most dominant mode for hinterland traffic. Several new terminals were started up and a vicious circle is created between the larger volumes of containers that need to be handled in the seaport and these satellites in the hinterland.

Policy measures can help to further increase the market share of intermodal transport. Policy measures may include amongst others, the provision of intermodal infrastructure, research and development activities, subsidies, charging and pricing policies. Various combinations of policy instruments or packages can be formulated along the intermodal transport chain. This requires a close co-operation among the stakeholders in order to create synergies. EU's intermodal policy sets the guidelines for a structured approach to intermodal freight transport. On the other hand, different transport policies are launched in the Member States to stimulate the use of intermodal transport. However, no integrated formal ex-ante and ex-post evaluation of these transport policies is executed. The DSSITP framework is set up to fill this gap. It provides a decision tool for the several (and numerous) stakeholders to assess the changes due to measures induced by public authorities.

The DSSITP framework is built around three core models, each one having its own functions, which are complementary in order to analyse these changes.

The multimodal freight model NODUS is situated on the highest level of aggregation and can provide global traffic prognoses on the modal networks which can serve as inputs for the LAMBIT and SIMBA models. The NODUS model produces aggregated outputs of the various transport modes, such as their usage of the infrastructures, accessibility, environmental impact and share in the modal split. Total costs of intermodal services can thus be calculated. In addition, a module is developed for NODUS to provide optimal locations of terminals, which uses the estimated flows on the networks as input. These optimal locations can then be introduced in the LAMBIT and SIMBA models.

The LAMBIT model is scaled on the Belgian intermodal network. The model analyses the potential market area of a new terminal and assesses the impacts of this new terminal on existing terminals. It further produces cost indicators and potential modal shifts.

The SIMBA model is situated on the lowest level of aggregation and produces detailed output related to the reliability, speed and capacity utilization of the waterway network. With the SIMBA model, the impact of volume increases in the network or the introduction of new intermodal barge terminals can be simulated. Also alternative consolidation strategies may be compared.

The combination of NODUS, LAMBIT and SIMBA can thus be considered as a top-down integrated framework, able to produce a useful insight of the intermodal chain. The application of the DSSITP framework is demonstrated by analysing two alternative policy measures. The first application introduces an optimally located additional barge terminal in the current multimodal network. A second analysis measures the impact of subsidy measures on the use of intermodal freight transport solutions. These two case studies are to be considered as examples of the use of the framework. Indeed, the models can be used to analyse a broad range of other problems such as the evaluation of external costs related to intermodal transport, the impact of a new infrastructure or the analyses of alternative consolidation strategies in intermodal barge transport.

What we can conclude from the applications analysed so far, is first that the terminal landscape in Belgium is already quite dense and that it is difficult to find new interesting locations without disturbing the existing ones and with enough potential traffic. The current topology of existing terminals seems to be close to the optimal one. There may be some place for one, or maximum two, additional locations.

Second, subsidies can indeed help to increase the market share of intermodal transport. The current policy can significantly reduce the transhipment costs for the user, making intermodal transport much more attractive. However, one have to keep in mind that the current situation with a rail/road policy at the federal level, different inland waterways/road policies in the three regions and no coordination between these policies creates inefficiencies in the transport system. A coordinated policy, taking into account the locations of the intermodal terminals should be created. Also a coordinated policy in terms of spatial planning should be set up so that the location is being optimised from a broader perspective and not just decided on a local level. Indeed, intermodal transport can only be viable on medium or long distances, making region-only policies rapidly inefficient, at least at the Belgian scale. Moreover, Belgium can not be considered as an isolated area, because imports, exports and transits, for all modes, are very important.

We are convinced that intermodal transport remains one of the keys to improve sustainable freight mobility and that the further use of the DSSITP framework would help to assess new initiatives in the near future.

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