Integrated decision support tool for intermodal freight transport

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INTEGRATED DECISION SUPPORT TOOL FOR INTERMODAL FREIGHT TRANSPORT

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Abstract

Intermodal transport has received an increased attention by federal and regional governments in Belgium with the objective to slow down the rapid growth in unimodal road transport. In this paper, an assessment framework is developed to perform an ex-ante and ex-post analysis of current and potential policy measures to stimulate the use of intermodal transport in Belgium. The assessment framework includes three core models necessary to evaluate all relevant transport modes and aggregation levels. The methodology of the assessment framework is elaborated. Policy measures are described and grouped into three main categories. Finally, the application of the assessment framework on each of the three groups of policy measures is presented.

Keywords: Intermodal transport policies, policy assessment, GIS network model, discrete event simulation

1. INTRODUCTION

The growth of freight transport represents a vital challenge for decision makers that are involved in European transport policy since it has increased by 30% between 1991 and 2001. Freight transport, which is essential to maintain economic growth and competitiveness, reached growth rates exceeding those of the economy. The rapid expansion of freight transport is extensively observed in road freight transport, leading to a further imbalance in modal split and problems of road congestion, environmental concerns and traffic safety. For this reason, intermodal transport has received an increased attention because of its flexibility and its potential to improve the performance of each transport mode by making each option safer, more effective, and environmentally and energy efficient – namely through "co-modality". An intermodal transport chain integrates at least two transport modes (rail/road, or inland waterway/road) in an itinerary between an origin and a destination. In practice this is mostly used for long routes, the main part attributed to rail or inland waterways to reduce the negative impacts of road. Hence, intermodal transport can offer an attractive solution by directing freight transport towards inland waterways and rail.

Belgium is one of the countries, where intermodal transport solutions are observed. The increasing 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 transport. 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 favour 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, as described in section two.

The objective of this paper is to construct the methodology of the DSSITP framework and to give an overview of actual or potential policy measures for stimulating intermodal transport which can be assessed by means of the framework. Section two presents the three models used in the assessment framework developed by the partners (Vrije Universiteit Brussel (VUB), Universiteit Hasselt (UHasselt) and Facultés Universitaires Catholiques de Mons (FUCaM)), respectively: LAMBIT (Location Analysis Model for Belgan Intermodal Terminals), SIMBA (discrete event Simulation model for InterModal BArge transport) and Nodus. Each model is briefly introduced, after which their inputs, outputs and data requirements are described separately to establish their link with the assessment framework. Section two concludes with the development of the DSSITP framework, which explains how the different models are integrated into the assessment framework in order to reach the objectives of the research. In section three, intermodal policy measures are introduced with a focus on Belgium. Furthermore a description is given of how the DSSITP framework is applied to assess these policy measures. Finally, the main conclusions are presented and directions for future research on assessing impacts of policy measures are given.

2. ASSESSMENT FRAMEWORK

Transport policy in Belgium, which is scattered over different policy levels, calls for a need of conducting ex-ante and ex-post analysis. The objective of DSSITP is to develop a general framework to assess 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.

Three core models, Nodus, LAMBIT and SIMBA form the decision support system in DSSITP. The general assessment framework is established with the integration of these models. We will first describe the individual models and then how they are integrated in the overall framework.

2.1. MODEL DESCRIPTIONS

2.1.1. NODUS

Description

Nodus is a Geographic Information System (GIS) based software for strategic multi-modal freight transportation models. In the framework of this research, its database contains the geographic railways', roads' and inland waterways' networks. The locations of the origins and the destinations of the goods are materialised by the centroids of the considered regions. Nodus implements the virtual networks methodology as defined by Jourquin and Beuthe (1996).

Virtual networks represent each transport operation (loading, unloading, transhipment and transit) by a dedicated link with a single cost. Indeed, a given link or node in a physical transportation network can be used in different ways with different costs. This is for instance the case of a road chunk that can be used by different types of vehicles. Nodus assigns the transport demand directly on the virtual network, making it possible to identify the complete transportation chain along with the possibility to achieve modal-split and assignment during one single step, which is a unique feature.

Figure 1 illustrates the concept for a terminal located at node a, in a multi-modal network that includes inland waterways (W) and rail (R) networks. The figure that follows the mode identification represents the number of transportation means (type of vehicles) that can be used on the link. The graph at the right of the diagram represents the virtual network that can be generated from this small network. Note that the generated graph is directed, since the costs can vary according to this parameter. Loading costs are for instance often different from unloading costs. The bold links represent movements on the geographic network for the different mode/means combinations, whether the real node a is now represented by a lot of virtual links and nodes that correspond to (un)loading, transhipment and transit operations.

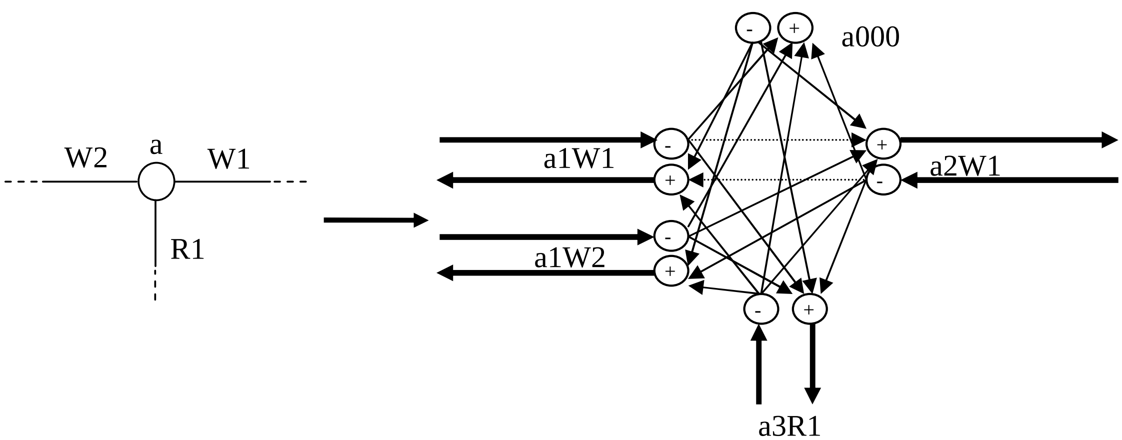

Figure 1 : From real to virtual network

Inputs and data requirements

In order to perform realistic assignments, Nodus needs three kinds of inputs: a digitized geographic network (in this case roads, railways and inland waterways), a transportation demand materialised by an Origin-Destination (O-D) matrix and cost functions for the different transportation tasks , modes and means, including transhipments between these modes.

1. Our network has been adapted from the Digital Chart of the World (DCW), to which inland waterways have been added. The maps were updated and refined for Belgium and validated on the basis of freely available data such as Google Maps®. Even if this method doesn't ensure to identify all the errors, it improves significantly the database. A large amount of shortest-paths were also visualised in order to detect missing links. The network was finally completed with the ferry lines.

2. The O-D matrix has been built at NUTS5 level in Belgium and at NUTS2 for the other European countries for 2000. This work was based on initial matrices for 1995 available at GTM, for the 10 NST-R main chapters of commodities. The initial matrix has been updated using data from NEA at the NUTS2 level for 2000. The update to 2005 data is an ingoing work.
3. The set of cost functions for 2000 was defined on the basis of previous work of GTM, upgraded by means of several external sources.

Outputs and link with the assessment framework

The main interest of Nodus in the framework of the DSSITP project is to provide the total costs along the transportation chain between each O-D pair and to estimate the impact of the implementation of several measures in favour of intermodal transport on the transportation flows and the modal shift.

In a second step, Nodus will be used to propose potential optimal locations for new terminals, according to identified flows on the multimodal network. These locations will further be evaluated in the DSSITP assessment framework.

2.1.2. LAMBIT

Description

LAMBIT is a GIS-based location analysis model (Macharis, 2000 and Macharis, 2004). The two key elements in the model are the GIS networks and corresponding cost functions, which enable to derive realistic estimations. First, the network is established. The GIS network is composed of different layers, namely arcs and nodes (See Figure 2). The arcs include the multimodal network of roads, inland waterways, and railways. The geographic locations of the intermodal terminals and the municipality centers are the nodes. The GIS network is formed once the arcs and nodes are defined and connected to each other.

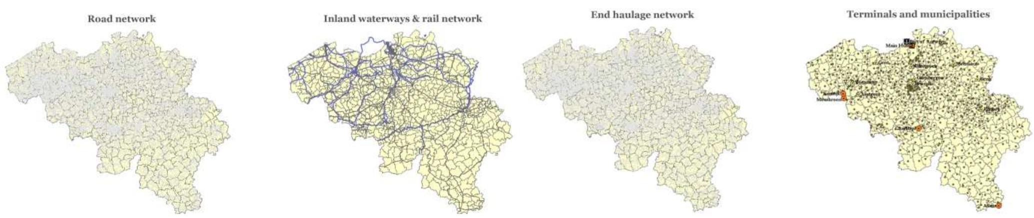

Figure 2: The GIS network

The GIS network has two tasks. First of all, it visualizes the real transportation network including the terminals. Second and vital characteristic of the network is its capability in serving as a database to include cost functions. Once the network is set, the transport prices are calculated based on the real market price structures for each transport mode. The total intermodal transport price is composed of a fixed and a variable part. The fixed costs include the transhipment cost in the port of Antwerp to a barge or a wagon, the fixed cost of the intermodal main haul, the transshipment cost in the inland terminal to a truck and the fixed cost of the post haulage by a truck. The variable costs are the variable cost of the intermodal main haul and the variable cost of the post haulage by truck. The total intermodal transport cost is obtained by adding all of the mentioned fixed and variable costs.

The location analysis model takes the cost structure of intermodal transport into account. Intermodal transport has a lower variable cost compared to that of unimodal road transport. On the other hand, the fixed costs of transport including the transhipments in the inland terminals negatively affect the total transportation costs. Considering the total transport prices and the distance traveled, unimodal road transport is cheaper in the short distances but once the breakeven distance is achieved, intermodal transport offers a competitive alternative.

The location analysis model handles various simulations when the network and cost functions are established. In ArcInfo the shortest path algorithm of Dijkstra is used in order to find the shortest path and the corresponding total transport price from the port of Antwerp to each Belgian municipality via intermodal terminals. Market areas of the intermodal terminals are visualized by highlighting the municipalities for which a certain terminal provides a cheaper price than for unimodal road transport. Furthermore, the potentials of the terminals are calculated by aggregating the amount of containers that are transported to and from these municipalities (making use of NIS (National Institute of Statistic) data) from the port of Antwerp.

It is necessary to indicate that certain assumptions are made in the location analysis model. Apart from the transport prices, other modal choice criteria are also important, such as reliability, speed, frequency, safety and customer satisfaction. As a second remark, the transport costs are only one part of the total logistics costs. Warehousing costs and inventory carrying, administration and order processing costs also affect the total logistics costs.

Inputs and data requirements

The following inputs are necessary for the location analysis model to function:

1. Network layers (roads, railways and inland waterways) which are obtained from the maps of TELE ATLAS and ESRI).
2. The origin-destination matrices that define the port of Antwerp, the inland terminals and final destinations of the municipality centers.
3. Transportation costs which are uploaded in the network layers and nodes.
4. The statistics of NIS which show the container transportation between the port of Antwerp and the municipalities.

Access to reliable data is essential in order to achieve accurate results from the location analysis model. In this respect, the transport prices have a vital role in the functioning of the model. For the inland waterways and unimodal road transport, average prices are calculated from the current market prices, which were obtained from the transport companies. On the other hand, the rail prices are based on the market prices of the rail operators and they differ for each inland terminal.

Outputs and link with the assessment framework

LAMBIT is able to analyse optimal locations for new intermodal terminals by providing their market areas and potentials. First, the current intermodal terminal landscape of Belgium is depicted. Then, future scenarios are shown, with the introduction of new intermodal terminals into the network.

The network model is capable of making ex-ante and ex-post analysis. When conducting future scenarios, ex-ante analysis helps to see the potential of a terminal and its effect on the current terminal landscape. The DSSITP assessment framework will further investigate other restrictions such as the effects on capacity for the new terminal locations.

2.1.3. SIMBA

Description

A discrete event simulation model is created to support decisions in intermodal barge transport at the strategic level The simulation model covers the hinterland waterway network of a major port in Western-Europe in order to analyze effects of future policy measures for intermodal container transport making use of inland navigation. The operations of the inland navigation network are modelled in detail. This enables us to examine ex-ante what the potential effects of a certain policy measure will be and to take into account interaction effects in container flows.

The intermodal hinterland network of the port of Antwerp serves as the real-world application for the simulation model. Three major components constitute the intermodal network. The first component in the intermodal freight transport network is the inland waterway network. The inland waterway network is made up of terminals, waterway connections and container flows. Entities are defined as barges which originate from the different inland terminals and carry containers in round trips to the various ports. The following regions of origin can be identified in the network. The first group of container terminals is situated along the Albert Canal towards the eastern part of Belgium. A second region of origin is located in the central part of the country, connected to the port of Antwerp by the Brussels - Scheldt Sea Canal. The third group of intermodal container flows originates in the basin of the Upper Scheldt and the river Leie. A second component in the intermodal network is the port area of Antwerp. Two clusters of sea terminals can be identified. Until recently the main center of activity was situated on the right river bank. With the construction of a new dock (Deurganckdok) in the port of Antwerp, a second cluster of sea terminals emerged on the left river bank. Barges may visit sea terminals at the left river bank and right river bank in the same round trip, go to Rotterdam or Amsterdam via the Scheldt-Rhine connection or sail to Zeebrugge via the Scheldt estuary. Table 1 summarizes all origins and destinations of shuttle services. On the right and left river bank, barges queue for handling at the sea terminals. Barges moor as soon as enough quay length is available. The handling time at sea terminals depends on the number of containers that need to be unloaded from or loaded into the inland vessel. In the inland waterway network as well as in the port area multiple locks are present. Therefore, the lock planning constitutes a third major component in the simulation model.

Table 1: Origins and Destinations

Origins	Destinations
Albert Canal	Antwerp: right river bank
Brussels-Scheldt Sea Canal	Antwerp: left river bank
Upper Scheldt and Leie	Rotterdam
	Amsterdam
	Zeebrugge

A number of assumptions are made to translate the actual intermodal network into a discrete event simulation model. The emphasis lays on inland waterway transport. Rail connections in the hinterland network are not taken into account. The model further assumes a homogeneous container type and equal handling time for each container. All main waterway connections between inland terminals and the port area are incorporated in the simulation model. Small waterways without inland terminals are not included in the simulation model of the current situation. Sailing times are assumed to be stochastic and follow a probability distribution. A probability distribution is also used to model stochastic lockage times.

Inputs and data requirements

All intermodal terminals in the inland waterway network are asked for information to identify the container flows. Real data on shuttle services is used as an input for the simulation model, constructed in the simulation software Arena. For each shuttle service the following information is required: which type of barge is used, which destinations are visited and what is the average number of import and export containers for each destination. Container transport interacts with other freight flows. Therefore, the flow of non-containerized goods on the inland waterway network is introduced as an input in the simulation model. These flows affect the waiting times at locks. Information is also necessary on the network connections. The waterway administrators provide information on the number of locks on each waterway, distances between locks, average lockage times, number of lock chambers and size of the chambers. In the port area of Antwerp three clusters of locks connect the inner port area with the sea side. Data is required on the choice of locks when sailing in the port area. The average quay length available for handling inland navigation at sea terminals gives an indication of the service capacity in the port area of Antwerp. The port authority is asked for the average mooring time and time for loading and unloading in order to model the service times of inland container barges in the port area. Finally, an enquiry is made into the turnaround times of vessels and average waiting times at locks in order to verify and validate the model.

Outputs and link with the assessment framework

The SIMBA model produces detailed outputs related to the functioning of the waterway transport network. The performance of the network elements with respect to reliability, speed and capacity utilization is measured. Table 2 gives an overview of performance measures which are generated by the simulation model. The turnaround time of shuttles is defined as the total time necessary for a barge to sail from an inland container terminal to the port area, visit all sea terminals and return to the inland terminal. The turnaround time depends on the waiting times at locks and in the port area. The outputs measured at locks are the percentage of barges that have to wait, the number of barges that have to queue and the waiting time of barges in the queue. In the port area the waiting time before handling is measured, as well as the number of vessels queueing for service. A final group of performance measures concerns the capacity utilization. In the port area this is expressed as the average percentage of quay length occupied. In the hinterland network the average and maximum number of barges on each network connection is recorded.

Table 2: Performance Measures

Shuttles	Turnaround time
Locks	total number waiting (%) number waiting in queue waiting time in queue
Port area	number waiting in queue waiting time in queue
Capacity utilization	quay length network connections

The simulation model will be used to analyze policy measures related to intermodal transport by barge. It will allow to detect future bottlenecks (locks, canals, terminals) in the infrastructure of the network. To this end various scenarios of increasing transport volumes can be modelled. Capacity expansions are investigated. Economic instruments intended to stimulate intermodal transport by barge, such as subsidies and premiums for new intermodal terminals, effect the volume of containers transported. The impact of such policy measures on container flows in the intermodal hinterland network and the port area of Antwerp is simulated. New bundling concepts and policies related to the consolidation strategy may also be analysed.

2.2. INTEGRATION OF MODELS

Three core models, Nodus, LAMBIT and SIMBA make up the decision support system for intermodal transport policy making. The general assessment framework integrates these models. In Section 2.1, the methodology and capability of the individual models was presented, and inputs and outputs of the models are determined. In this section, the interactions among them are defined.

Deriving from the analysis of the core models, a general assessment framework is developed. Figure 3 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 3. 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 model. 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. In Section 3, 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.

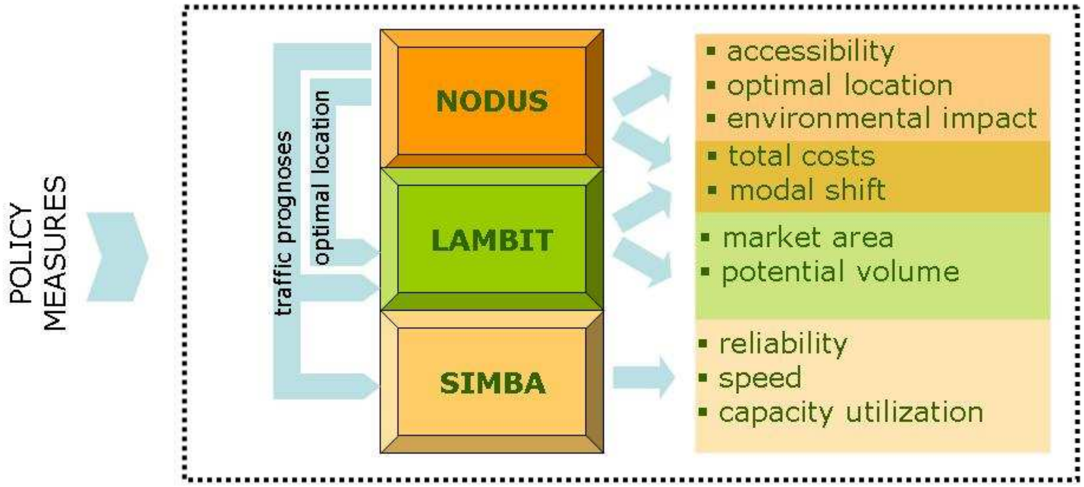

Figure 3: The general assessment framework

3. POLICY MEASURES

This section introduces policy measures aiming to promote intermodal freight transport, which will be analyzed with the assessment framework in further stages of the research. First, existing policy measures in Belgium will be defined. Next, the methodology within the DSSITP framework for the possible policy measures will be described.

3.1. INTERMODAL POLICIES IN BELGIUM

Belgium is one of the countries, where intermodal transport is promoted by many policy measures for various levels. Intermodal policies in Belgium will be described for each transport mode.

3.1.1. Inland waterway transport

Liberalization of the inland waterway transport sector in Belgium limits the role of the federal government. Regional governments, namely the Flemish and the Walloon governments, develop policy measures in order to promote inland navigation. One of the main policy measures of the Flemish government is directed towards infrastructure development. The public private partnership program 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 program, which establishes the support of the European Commission until 2010 (N 550/01 and N 344/04), realized a 66.5 percent growth in inland waterways transport over the previous 5 years (Promotie binnenvaart, 2006).

A second group of policy measures aims at inland waterway transport costs. In order to promote the growth of inland waterway transport, a reduction of canal-dues is established. In May 2007, the EC authorized another Flemish measure to grant a subsidy of 20 Euros for each container transhipped in a Flemish inland container terminal from or to an inland waterway vessel (N 682/06).

Similar initiatives are also developed in Wallonia and Brussels. 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). 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 terminals such as the transhipment infrastructures. The government decision also aims to modernize the fleet. In addition to the investment aid, a subsidy of 12 Euros is foreseen for containers that are transhipped in a Walloon inland container terminal from or to an inland waterway vessel (OPVN, 2006). A similar subsidy scheme is also valid for the port of Brussels. Inland waterways sector receives a subsidy of 12 Euros for containers that are transhipped to the port of Brussels (N720/06).

3.1.2. Rail transport

With the aim of increasing the modal share of intermodal rail transport, the federal government subsidizes national rail transport within Belgium. An annual subsidy of 30 million Euros for the period 2006-2007 is granted by the Belgian Government to the intermodal operators, which offer transport services within Belgium of minimum 51 kilometers. The subsidy is composed of a fixed part (20 Euros) and a variable part (maximum 0.40 Euros per kilometer). This aid scheme, which has been approved by the European Commission (N 249/2004) is used for assisting the rail transport to compete with the lower tariffs of unimodal road transport in order to offer alternative intermodal transport services to the hinterland of the port of Antwerp.

3.2. DSSITP FRAMEWORK

In Table 3, the policy measures are grouped in three categories. The DSSITP framework aims to assess these policy measures. In further stages of the research, possible cases will be developed.

Table 3: 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

In this paper, the methodology behind the DSSITP framework in assessing policy measures will be presented. Policy measures will be introduced into the DSSITP framework and assessment will be done based on the indicators, such as optimal location, modal shift, market area and reliability (see Figure 3).

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

Transport policies are strictly connected to transport investments, which require heavy investment costs. This leads to government involvement in infrastructure projects. Traditionally, European transport infrastructure is funded by public investment considering all the social costs and benefits. (Vrenken et al., 2005).

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. These are chosen among a sample of potential locations selected because of their proximity to O-D nodes which doesn't exceed 50 km on the network. The method used to detect optimal nodes for new terminals is a *p*-Hub Median Problem (*p*-HMP) with Ernst and Krishnamoorthy (1996) formulation which tends to find locations for which the inter-terminal links are consolidated. Such a configuration presents different advantages because the same quantity of destinations can be disserved using fewer vehicles due to the consolidation of the flows on itineraries between hubs. Then, these flows of goods are dispatched by services with higher frequency and capacity. Moreover, the *p*-HMP gives the possibility to take into account the costs for pre- and post-haulage plus the one for waterways in intermodal transport compared with the p-Median Problem (*p*-MP) which considers the general costs only. Although it is a *p*-HMP which is used to locate them, the

new terminals won't be considered as hubs because they don't gather enough flows through them, but their configuration on the network will be based on the same principle.
Once the new terminals are designated, the transshipment will be allowed there and the combined transport will be modelized. It will be done by enabling two more means for road (pre- and post-haulage) and five more means for waterways which correspond to the water part in intermodality (one by initial mean for waterways taking into account the economies of scale). The unit costs of transshipment will be included and assessed according to the quantities of goods that pass through the terminal. Then, the obtained values of modal split can be compared with the one assessed without the new terminals and analyzed in order to specify if a significant change is observed. To do so, statistical tests of comparison are considered to know if the hypothesis that flows are higher for waterways with the new terminals is right or not.

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.

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

The rapid expansion of freight transport is extensively observed in road freight transport, leading to a further imbalance in modal split and problems of road congestion, environmental concerns and traffic safety. For this reason, intermodal transport has received an increased attention, namely through "co-modality".

Belgium is one of the countries where intermodal transport solutions are observed. Several policy measures were introduced to stimulate intermodal transport. Within the DSSITP 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 transport.

In this paper 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. Furthermore, intermodal policies with a special focus on Belgium are identified to be implemented in different scenarios and assess their impacts on the intermodal landscape. Finally, it may be possible to determine key policies for stimulating intermodality.

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