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1 Introduction

In a growing globalised context and consumption economy freight transport is of crucial importance. Being able to understand the drivers of freight flows makes it possible to forecast freight flows in the future and to calculate the impact of different policies on freight traffic. It will put policymakers in the position to get a better insight in the way the transport of goods comes about. Still, freight demand modeling is lacking behind on the efforts made in passenger transport models. The development of a comprehensive and reliable freight transport model is needed.

This paper explores the options for an innovative freight transportation model for Flanders. Flanders is the northern part of Belgium and has an ideal position when it comes to logistics. It is key region in the blue banana and is located in the heart of the Golden Triangle in Europe. The main port of Antwerp is the second largest seaport of Europe and creates a great share of freight traffic. This paper is organized as follows. In the next section recent developments in freight transportation modeling are presented. Section 3 gives an overview of freight models that already exist for Belgium, after which the missing elements of these models are exposed in section 4. Section 5 gives key elements that have to be incorporated into the new freight transportation model for Flanders to improve model results and forecast ability. Finally some conclusions will be drawn.

2 Recent developments in freight transportation modeling

To give an idea of the emerging trends in freight transportation modeling, an overview of the main developments in literature is given.

Today, most state-of-the-practice models in freight transport are still four-step models, where the focus is on individual trips. These models have as main disadvantage, that they are looking at the aggregated flows between zones and cannot model flows at a more detailed level. For that, they are missing out on the behavioral aspects behind transport and are having errors due to aggregation. The importance of incorporating logistics decisions and behavioral aspects in a freight transportation model is widely recognized (Tatineni & Demetsky (2005), Tavasszy et al. (1998), MOTOS (2006) and Liedtke (2009)). Some of the more recently developed four-step models are already incorporating logistic components (Tavasszy et al. (1998), SCENES Consortium (2000) and Yin et al. (2005)). However, these models are on an aggregated level and aren't taken into account aspects of the different agents.

One of the main differences between modeling freight and passenger transport is that there are more actors involved in the decision making process. First there are firms who are sending and receiving goods, shippers who are responsible for the organization of the consignment and modes and the last group are carriers who undertake the movement (Ortúzar & Willumsen, 2001). Next to this, there are several other firms responsible for the transshipment, storage and custom facilities. The economic transactions between suppliers and consumers, and the logistics operations that actually deliver the goods, are the two main drivers behind the rapidly evolving patterns of freight movements (Yin et al., 2005). Therefore, more attention has to be paid to the different actors.

Recent trends in freight modeling are moving to agent-based models, which focus on each freight agent separately. Therefore they are better able to model their individual operational decisions and their interactions concerning logistics and transports. Furthermore a disaggregated approach is applied, by looking at trips and decisions on a microscopic scale and no longer to aggregate flows between different zones. This enables the understanding and representation of roles that each actor plays in the freight transportation system, as also the interactions between actors. Besides, it's possible to incorporate changes in actors and their interactions over time. These elements are of fundamental importance in the development of more behavioral models for the freight system (Roorda et al., 2010). The disaggregated approach of these models, together with the representation of the different actors, enables better modeling possibilities for logistics decisions.

3 Existing freight transportation models in Belgium

In this section four different freight transportation models of Belgium will be presented. To our knowledge, these are the only models documented in Belgium. The geographical area has been extended to Belgium, as only one model is developed only for Flanders (TRITEL). First the four-step models are presented in chronological order, to end with MOBILEC, a land-use interaction model with a main focus on economic\transport interactions. These models include little or no logistic decision making and are all situated at the aggregated level.

The Walloon Freight Transportation Model (WFTM) is developed in the nineties for the French speaking part of Belgium, Wallonia. It is used to develop a freight transportation plan for 2010. Expected changes in the infrastructure and O-D matrixes were introduced at a very detailed level, from which a set of scenarios was built. These scenarios include, one for the specific changes for each transportation mode and one in which the external costs of transport were taken into account (Geerts & Jourquin, 2001). The model makes use of the NODUS software that automatically generates the virtual network. In this network each virtual link corresponds to a specific operation (moving, loading/unloading, transshipping and transiting) and all transportation modes and means are interlinked. This makes it easy to attach specific cost functions to each virtual link (Jourquin & Beuthe, 1996).

The next model is a four-step model for Flanders made by TRITEL (Verkeerscentrum Vlaanderen, 2006). The proposed model provides the possibility to integrate logistic centers into the road matrix in the form of Transport Logistic Nodes (TLN). Road relations are split into direct and indirect flows, where the indirect flows uses the TLNs. This may allow a more precise representation of the flows in reality and better results in the assignment step (Verkeerscentrum Vlaanderen, 2006). Due to the representation of TLNs the model makes a step towards integrating logistic aspects.

PLANET (Desmet et al., 2008) is developed by the Belgian Federal Planning Bureau. It models both passenger and freight transport in Belgium. PLANET is able to produce medium- and long-term projections of transport demand in Belgium, as also simulations of the effects and cost-benefit analyses of transport policy measures. The core of PLANET is a traditional commodity-based, four-step transport model. The four steps are transport generation, trip distribution, modal and time choice and vehicle stock. Furthermore there are three modules next to the four-step transport module. A policy module generates alternative scenarios to compare with the business-as-usual scenario and a macro module provides macro-economic projections for each zone. The last module is the welfare module that computes effects of transport policy measures on welfare.

A model that does not follow the traditional four-step structure is the MOBILEC (MOBILity\EConomy) model described in van de Vooren (2004). It was first used for the Netherlands after which it was adapted for Belgium and later an expanded for the entire Benelux. The model belongs to the category of land-use transportation interaction models. The model differs from other transport models, where mostly either the economy influences transport or transport influences the economy. MOBILEC is a dynamic, interregional model that describes the interaction between transport and economy together with infrastructure and other regional features. Regional income determines the investments in infrastructure and wages have an influence on employment rates and purchases. This has an impact on traffic, which then again influence regional product and employment.

These four models use the 10 NST/R (standard goods classification for transport statistics - revised) commodity categories to divide their freight flows. The zoning for Belgium is done at a NUTS3 level, which corresponds to the 43 'arrondissements'. Furthermore, they all focus on the three main transport modes: road, rail and inland waterways. The TRITEL model contains an option for combined transport and in PLANET the evolution of maritime, air and pipeline transport is imposed exogenously.

4 Missing elements in the existing regional models

When comparing the models for Belgium with the international trends in freight transportation modeling, it become clear that they are running behind.

A disadvantage of the freight transportation models discussed in the previous section is that they are lacking elements of logistic organization. In the model of Flanders (Verkeerscentrum Vlaanderen, 2006) a first attempt is made by including the TLN for truck transport. Also the NODUS software allows representations of logistics by including transshipping and transiting, as well as inter-modal combinations. A better link with the freight distribution industry is required to overcome this weakness. This would include the modeling of shipment size, use of distribution channels, consolidation options, tour planning, use of intermodal transport, etc. Furthermore, the choice of receiver or sender could also be modeled and represented in a contract market. This leads to the opportunity of simulating changes in the logistic chain and allows representing the influence of long term contracts and negotiation power.

An important point in freight transportation is the interaction between the different actors in the decision making process. It involves a complex relation between shipper, receiver and carrier of the goods. This interaction between actors is not presented in existing freight models for Flanders, as they all model freight flows at an aggregated level. This does not allow a detailed representation of the different actors involved. Due to the modeling at an aggregated level, no explicit link exists between the activities that induces transport and the transport flows itself.

5 Key elements for an innovative freight model

In light of the missing elements in the freight transportation models for Belgium, there is a need for a more comprehensive model that includes logistical elements. The objective is to develop an agent-based micro simulated model for Flanders. Liedtke & Schepperle (2004) state that having a model for the transport of goods at a microscopic level, would be a significant improvement for transport forecasts and the assessment of policy measures at any point in process, due to its ability to map individual reactions.

First of all, the characteristics of freight transport have to be taken into account. The main characteristics are heterogeneity, physical factors, operational factors and dynamic factors (Ortúzar & Willumsen, 2001). When modeling at a micro level, it is possible to look at individual instead of aggregated flows. This gives the opportunity to include individual firm characteristics and detailed representation of commodity groups. When looking at single movements of goods, more information of a shipment may be represented that would go lost in aggregated data. Furthermore, production rates of firms may be included to take account for the changes in the demand pattern of customers, like in the TAPAS model (Davidsson et al., 2008).

As a starting point the relationship with the economy has to be included. Disaggregate models start from a detailed microeconomic background of the different commodity groups. The behavior of shipper and carrier that is modeled helps to determine how much and in what way commodities will be moved. Transport can be considered as a part of the logistics process and a production factor. Companies consider their output as the arrival of finished goods at their destination. For this not only labor and capital is necessary, but also transport becomes important as production factor (Meersman & Van de Voorde, 2008). This allows the analysis of the relation between an economic activity and the resulting transport movement.

When developing an activity-based model great care has to be paid to the choice of agents involved in the model. The actors most widely used in literature are shippers, receivers, carrier and forwarders or transporters (Liedtke (2009), Wisetjindawat et al. (2007) and Boerkamps et al. (1999)). Another more detailed representation exist in the model framework of Roorda et al. (2010), who differentiates between business establishments, firms and three types of facilities (commodity production, business service and logistics service). The way these agents interact with each other and how they are involved in the decision making process is of key importance in developing a micro simulated activity-based model. This allows to include pricing mechanisms and to take into account long- or short-term contracts between agents. An opportunity exists to simulate market interactions and pricing negotiations. Furthermore, more attention has to be paid to logistic decision making. What are the responsibilities of each agent and on what may he have an influence?

By explicitly simulating the different agents involved in the decision making process in an agent-based model, the logistics decisions and chains may be represented. When it comes to logistical processes some main items have to be included, like modeling shipment size and an appropriate mode and vehicle type choice. It gives the opportunity to incorporate inventory management at the customer and vendor site, to include warehouse management at distribution centers and to simulate terminal operations. To optimize distribution chain flows the location of distribution center may be included in the modeling process. A close follow up of all these interactions is requested to have a more realistic image of freight transport flows.

6 Conclusions

In this paper the options for a new innovative freight transportation model for Flanders are presented. The most import elements that have to be included in the new model are a better representation of logistic decisions and freight agents. The objective will be to introduce an agent-based micro simulated model for Flanders.

Further research has to be conducted to study the possible agents that may be introduced and how they will interact with each other. Also the possibilities for incorporating the logistic elements have to be examined. Finally, research has to be done to collect the necessary data.

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