Doctor of Business Economics

The Development of an Assessment Framework for Multimodal Freight Transport of Different Cargo-Types in Belgium

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Abstract

Multimodal transport is considered as an important solution to tackle the sustainability concerns of the freight transport system. Multimodal transport is the movement of goods by at least two different modes of transport. Governments set goals and took actions to promote and stimulate multimodal transport. Despite the awareness and actions, the modal split is remaining constant throughout the last decade in Belgium and Europe. A large range of research exists proving the economic and sustainability benefits of multimodal transport, either by comparing transport modes directly, either by focusing on intermodal transport of containerized goods. Yet, other cargo-types are used in the supply chain as well, and they are not considered in research on multimodal transport and transport modelling. The incorporation of different cargo-types in a framework that assesses the economic and sustainability potential of a modal shift of these goods is new and needed in order to address the sustainability challenges which the freight transport sector is facing. This gave rise to the research of this thesis, namely; What is the potential for multimodal transport taking into account different cargo-types in transport modelling?

Cargo-type is the classification, based on its appearance, of a load of goods which is transported or is intended to be transported. Cargo-type can consist of either liquid or solid bulk without packaging, standardized units like pallets or containers, or unstandardized units like parcels. The analysis of the existing literature showed that transport models are generally neglecting the used cargo-type or focusing on one specific cargo-type - generally containerized freight. Meanwhile, transport operations and decisions in the supply chain are in real life influenced by the cargo-type. Costs related to transshipment, inventory and transport are highly affected by it. Different cargo-types should consequently be considered in modal choice analyses.
The second section looks at the potential for a modal shift of different cargo-types, with the development of two models. First an initial feasibility analysis was performed for a modal shift of palletized freight towards the inland waterways. The Location Analysis Model for Barge Transport of Pallets (LAMBTOP) was developed within this PhD to do so. The model identifies the optimal transshipment locations as well as the palletized transport flows which can be cost-efficiently shifted towards inland waterway transport. Firstly, the model is applied for flows of palletized building materials within Belgium. In a second stage, LAMBTOP was extended by considering total logistics costs to include reliability of the transport mode and the depreciation, shelf-life and value of the goods. In addition, the methodology was enlarged to the European scale. In both applications cost-efficient transport flows were found, showing the potential of this market.

The second model, called TRansport Agent-BAsed Model (TRABAM), considers different cargo-types. The model incorporates the cargo-type into the decision process with regards to vehicle and mode choice. The differentiation is made between five cargo-types (liquid bulk, solid bulk, containers, pallets and mobile units), as they all either positively or negatively influence the feasibility of a modal shift. TRABAM contributes to the MATSim freight extension by adding multimodal transport and the used cargo-type to it. By modelling transport flows according to the commodity type and used cargo-type between 4,934 zones subdividing the Belgian territory, TRABAM is more disaggregated than the existing freight models for Belgium. The shipments are generated via regression techniques based on aggregated data and economic and demographic data. The mode choice decisions are taken by the agents in the model, in this case the Belgian carriers. TRABAM considers real world Belgian logistic service providers including their existing vehicle fleet and depot locations. In addition, passenger car flows are imbedded in the model as a base layer during peak-hours. Import, export and transit flows are assigned to agents representing foreign logistic service providers. Each domestic shipment is assigned to an agent that optimize its routing, its stop sequence, its vehicle and mode choice and its departure time via an iteration process. The output consists of information on movements of individual freight vehicles throughout time and space on a one day basis. The multimodal potential for different cargo-types is calculated accordingly. Containers, solid and liquid bulk are showing the highest shares for rail and inland waterway transport (respectively 29,6%, 35,8% and 48,9% of the volume). Pallets on the inland waterways has a potential of 4,3%. When variable costs for road transport would increase by 10%, it leads to a limited increase of 0,8% of the rail and inland waterway transport share for containers. Pallets (+2,4%), solid bulk (+3,9%) and liquid bulk (+5,9%) are more sensitive to the increase in road transport cost. The output is also linked to vehicle-, traffic conditions-, loading rate- and infrastructure-dependent emission factors. Two applications, air pollution in the Brussels Metropolitan Region and off-hour deliveries to Walloon supermarkets – are presented. TRABAM is capable to answer pertinent freight transport research challenges.