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Design and Management of Freight Transport Networks: Intermodal Transport and Externalities

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This is a summary of the author's Ph.D. thesis supervised by Sabine Limbourg and defended on May 29, 2017 at the University of Liège, Belgium. The thesis is written in English and is available from the author upon request at martine.mostert@ulg.ac.be and from http://hdl.handle.net/2268/211640. This work develops new intermodal freight transport models which take into account the negative impacts of transport on its environment.

A literature review on transport externalities and their valorization methods highlights the small number of studies related to the general modeling of transport externalities through dedicated mathematical formulas. However, the latter are important for identifying the key parameters that influence transport competitiveness in terms of externalities. This is demonstrated by analyzing two external cost functions for road and rail. The location of intermodal terminals, where the flow transfer between road and a more environmentally friendly mode occurs, stands out from the environmental perspective as one of the most important competitiveness factors of intermodal transport regarding road.

An innovative mathematical model for the location of terminals and allocation of flows between road and intermodal rail and inland waterways (IWW) transport is developed. The model is based on a bi-objective formulation which evaluates the trade-offs between transport operational costs and CO_2 emissions. Economies of scale of intermodal transport are integrated thanks to nonlinear functions. The model is applied to the Belgian network. Results indicate that terminal locations are relatively stable, whatever the optimized economic or environmental objective. The type of terminal located changes according to the followed strategy. Minimizing CO_2 emissions leads to an increased use of intermodal transport.

The impact of transport on air pollution is also evaluated. On the Belgian case, an economic optimization of transport operational costs is compared

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to an environmental optimization of transport air pollution external costs. The intervention of public authorities through a taxation policy for trucks is also studied. Results show that the introduction of road taxes leads to a more intensive use of intermodal transport than in the absence of taxes. The maximum intermodal market share is observed when air pollution external costs are minimized.

Finally, intermodal transport is often modeled as a "road-rail/IWW-road" combination. A new model which considers other intermodal chains is applied on experimental data at the European level. The model allows to choose between any direct transport by one mode (road, rail or IWW), and any intermodal transport of up to three modes. Results indicate that several connections may benefit from the use of other combinations of modes than the "road-rail/IWW-road" combination.