Optimising load planning and container routing in intermodal rail transport

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PHD THESIS

Optimising load planning and container routing in intermodal rail transport

Hilde Heggen

This is a summary of the author's PhD thesis supervised by An Caris, Kris Braekers (Hasselt University, Belgium), Stan van Hoesel and Andre Berger (Maastricht University, The Netherlands). The thesis was defended on June 19, 2019 at Maastricht University as a results of a double-degree programme with Hasselt University as main institution and Maastricht University as partner institution. The thesis is written in English and is available from the author upon request at `hilde.heggen@uhasselt.be`. This work deals with decision support in the context of intermodal rail transport by studying two planning problems, integrated intermodal routing and multi-objective train load planning.

With the rising focus towards more sustainable transport systems, intermodal transport is a promising alternative for unimodal road transport. However, it also presents a number of challenges for intermodal operators and planners who are in charge of executing transport planning in an increasingly dynamic environment. As multiple transport modes and decision makers are involved, intermodal transport is more complex. Moreover, the level of integration of different transport modes and decision levels influences the attractiveness of intermodal transport. Innovative and integrated transport systems reflecting real-life problems should be developed in order to provide adequate decision support tools for intermodal planners and support a synchromodal vision. However, a gap between academic research and practice can be observed, because real-life characteristics of intermodal transport companies are ignored. Therefore, the focus of this thesis is on decision support for human planners at the operational decision level during the planning process of intermodal rail transport.

This dissertation aims at offering intermodal planning support in order to minimise total transport costs and maximise service capacity utilisation, which in turn decreases costs of the transport system. Two decision support tools are proposed by means of fast planning algorithms which include real-life characteristics. These concepts are inherent to the synchromodal vision in order to encourage a modal shift away from unimodal road transport. After a literature review on intermodal routing and vehicle routing in intermodal transport, two problems usually considered separately, an integrated intermodal routing problem is presented. Both a mathematical formulation as well as a large neighbourhood search heuristic algorithm are presented for the sequential and the integrated version of the problem. In the integrated version, operators are dedicated to the integrated nature of the problem. By including information of local vehicle routes in the assignment of transport requests to long-haul routes through a

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service network, better-informed decisions can be obtained. Insights are presented on how such integrated approach can be used for decision analysis in practice by means of a real-life case.

With transport requests assigned to intermodal routes through an intermodal rail service network, they should be assigned to specific locations on an intermodal train. This is the train load planning problem. It includes detailed loading restrictions, as omitting relevant loading constraints could result in infeasible solutions. Both an exact and a multi-directional local search heuristic solution approach are presented. Multiple objectives and additional real-life loading constraints are included, resulting in multiple feasible train load plans. Routes might still change for some transport requests and information about future orders should be accounted for. By providing multiple plans, planners can select the most appropriate load plan at a specific moment in time. The problem is applied to a real-life case to demonstrate advantages for practitioners.

Decisions on these two planning problems, intermodal routing and train load planning, influence the throughput and efficiency of the intermodal transport system. Fast decision support by means of planning algorithms is provided for improved, more efficient planning. Results contribute to a better understanding of the way in which intermodal operators can maximise their service network's transport capacity based on the expected demand of transport orders, and lead to an increased transport capacity utilisation and a minimisation of total transport costs.

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