# Optimising load planning and container routing in intermodal rail transport

# Valorisation

In this addendum, a discussion on the practical relevance of this academic thesis is presented. As emphasised in the introduction, an important challenge to the transport sector and, by extension, the supply chain is the sustainability of the entire system. The environmental impact of our current transport system is high, with producers and consumers often separated geographically by larger distances. In order to achieve a more sustainable transport system, the full cost of transport should be accounted for. Despite the fact that vehicles on the road are becoming greener due to reduced emissions, external costs of congestion and, related to that, costs of pollution increase. A modal shift of transport flows from unimodal road to intermodal transport may relieve congested highways and reduce the environmental impact.

In an ideal transport network, multiple complimentary transport modes and connections should be available. In that way, the most appropriate route can be selected for each transport request at a specific moment in time. This requires flexible and real-time planning, which poses a number of challenges for planners. In this context, adequate decision support and fast planning algorithms with real-life characteristics are needed to support a synchromodal vision. Innovative support systems should be available to help planners decide in a more complex environment. The number of research papers focusing on synchromodal transport and its prerequisites is rising. 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.

In order to stimulate intermodal transport, on the one hand, additional costs should be reduced, while on the other hand fast planning algorithms with real-life problem characteristics should be available to accommodate decisions in a complex intermodal planning environment. This thesis offers two intermodal planning tools which can be used by intermodal operators in order to minimise total transport costs and maximise service capacity utilisation, which in turn results in decreasing costs of the transport system.

The *first contribution* of this thesis is the introduction of an integrated intermodal routing problem. After a transport order is received, planners must assign each load unit to an intermodal long-haul service to maximise the overall network capacity utilisation, and local drayage routes must be established to transport load units between load and unload locations and the transhipment terminals for long-haul transport. Usually, these decisions are made in a sequential way. As the level of integration of different transport modes and decision levels influences the attractiveness of intermodal transport, an integrated intermodal routing problem is proposed. By taking local truck routing and long-haul transport planning decisions simultaneously, the aim is to reduce total transport costs. In a *second contribution*, the intermodal routing model is applied to a real-life intermodal network to support the analysis of the impact of tactical service network design decisions made by an intermodal operator. Insights will be presented on how to best utilise a given service network, in order to reduce total transport costs and synchronise available services to the expected demand of orders. The approach aims at reducing the number of road kilometres and increases bundling opportunities by maximising the long-haul capacity utilisation. In this way, it contributes to the modal shift towards intermodal transport and a more sustainable transport system.

At a more operational level, train load planning is concerned with the assignment of load units to specific locations on intermodal trains, accounting for real-life loading restrictions in order to maximise the on-train capacity utilisation. As including these real-life aspects are key to deciding which load units will be assigned to which location, the *third contribution* is the introduction of an exact and heuristic algorithm with real-life train load problem characteristics. It can be used as a decision support tool to provide human planners with a number of load plans from which they can choose the best one for a specific moment in time. Early-stage planning assistance during the booking process may improve the overall capacity utilisation of the available rail services.

Decisions on these two planning problems, intermodal routing and train load planning, influence the throughput of the intermodal transport system and aim at minimising overall transport costs while accounting for customer service requirements. Fast decision support by means of planning algorithms are 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.