Location and market area of rail-road terminals

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The European transport policy has focused on sustainable transport solutions. One of its objectives for freight transport is to restore the balance between modes and to develop intermodality. Among the various types of intermodal transports, this research is concerned with rail-road container terminals embedded in a hub-and–spoke network. These terminals will further be referred to as hubs.

Hub-and-spoke networks have been implemented in a number of transportation systems when it is favourable to consolidate and disseminate flows at certain locations called hubs. The efficiency of such a network depends on the location of the hubs. The problem is to find the optimal hub locations and to allocate the remaining nodes to these hubs. This problem is known as the *p*-hub median problem (*p*-HMP) where *p* is the number of hubs to locate.

This location-allocation problem is proved to be NP-hard. The time needed to solve it increases as the number of nodes exponent three. Thus, in order to model rail-road transport on the trans-European networks, a subset of nodes that can be considered as good potential locations is needed. We applied the *p*-HMP to a set of potential locations obtained by both spatial aggregation of demand nodes using hierarchical clustering methods and by a flow-based approach which takes the flows of commodities and their geographic spread into account. They showed that the latest method gives better results and that is why it is retained to determine a set of potential locations.

The set of potential locations is used as input for an iterative procedure. One of the main contributions of this research is to propose this iterative procedure based on both the *p*-HMP and the multi-modal assignment problem. Moreover, the objective function of our *p*-hub median formulation includes the costs for pre- and post-haulages by road, trans-shipment (according to the number of handled containers into account) and rail haulage. Furthermore, in the *p*-hub median problem, the total demand is assigned to the hubs. In this research however, the demand can be assigned over all the transportation modes, with the possibility (but not the obligation) of using the trans-shipment facilities.

Finally, we presents a methodology able to compare road and rail-road intermodal market areas that takes the network structures, the operation costs and the location of the rail-road terminals into account. This methodology is applied to the optimal configurations obtained by the resolution of the *p*-HMP and the *p*-hub centre problem (*p*-HCP) for the whole trans-European network. Indeed, *p*-HMP has an efficiency goal by minimizing the total transportation cost. The hub network design obtained by this method can sometimes lead to unsatisfactory results when worst-case origin-destination pairs are separated by a very large distance. Therefore, the *p*-HCM meets the equity objective by minimizing the maximum cost of a combined transport.