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## **Improvement opportunities in the operational planning of road transportation in Germany**

Extended Abstract:

The changes of the last decade in the transportation market have created a more competitive and dynamic situation for freight forwarders in road haulage than before. The customers' demands for service have increased leading to product offerings that include door to door service within Europe, tracking and tracing of the shipped goods, and guaranteed delivery times. The freight forwarders are forced to operate in between price competition and the demand for high-service products. As such, better planning methods for freight forwarders have been identified as one method for offering high-service products at competitive prices while still being profitable in the long run for the freight forwarders.

Nowadays, concerns about the CO<sub>2</sub> emissions resulting from transportation processes increasingly influence the daily planning of freight forwarders. This is due to the higher significance of environmental consciousness of both the companies and their customers. The quantity of CO<sub>2</sub> emissions depends on the number of trucks used, their utilization and the distance driven. Thus, daily planning measures to lower emissions are the reduction of travel distances and a better utilization of trucks if it is combined with a reduction in the number of trucks. These going-green efforts go hand in hand with traditional objectives in vehicle routing and scheduling; namely finding distance-minimizing or utilization-maximizing routes and plans. This implies the requirement for optimization techniques to address these issues. In the short term, the optimization will lead to higher utilization of the trucks. In the long term, it helps to reduce the number of trucks required.

As such, improvements in the daily planning of freight forwarders are required from an economical as well as an ecological point of view. Our talk focuses on the integration of advanced options into the classical planning models and methods of freight forwarders. These advanced options are subcontracting and collaborative planning. Both options are extensions to classical problems of vehicle routing and scheduling and aim at higher efficiency and the reduction of driving distances.

Using subcontractors is a form of vertical cooperation in the transportation market that is frequently used and found in practice. The subcontractors are carriers that solely focus on the physical execution of requests for road transportation without offering additional services. As such, the freight forwarders can be seen as their major customers. In Germany, subcontracting is legally anchored and defined in the German Commercial Code (§ 425 HGB). Freight forwarders use the option of subcontracting to meet strong fluctuations in demand as well as to keep the maintenance cost of their own fleet low. Three different options of subcontracting

are commonly distinguished based on the fulfillment cost: payments on tour basis, on daily basis and independent, one-off agreements [Krajewska and Kopfer, 2009; Pankratz, 2002]. We introduce all three options and give a brief overview of their integration into vehicle routing and scheduling. Optimization models including the options of subcontracting are referred to as integrated transportation planning problems [Krajewska and Kopfer, 2009].

A second improvement opportunity is collaborative planning. Collaborative planning can be defined as a coordination of the decision making among individual companies [Sucky, 2002; Stadtler, 2009]. For the transportation market, collaborative planning can be further specified as a form of horizontal cooperation [Bloos and Kopfer, 2011]. It refers to an exchange of requests within the operational planning of different freight forwarders. Usually, the exchange is organized by means of an internal market that uses auction mechanisms. Examples of such markets include settings with combinatorial auctions [Krajewska and Kopfer, 2006, Schwind et.al., 2009] and the Vickrey auction [Berger and Bierwirth, 2010]. Each freight forwarder then has the opportunity to sell its own transportation requests to partners in the collaborative planning and to acquire additional requests from those partners. We consider collaborative planning as an additional option for the operational planning of freight forwarders. Thus, it may be used in addition to integrated transportation planning then creating more efficient plans.

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