Chapter 6

Minimizing Empty Truck Loads in Round Timber Transport with Tabu Search Strategies

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ABSTRACT

In Central Europe transportation accounts for an estimated 30% of the total costs of round timber and is an essential element of cost. In this paper, Tabu Search based methods for solving the Timber Transport Vehicle Routing Problem (TTVRP) are presented. The TTVRP uses solutions of preceding optimization problems as input that are obtained with standard solver software. The presented methods differ with respect to the considered neighborhood and the static or dynamic setting of their parameters. They are verified with real life data in extensive numerical studies and compared to the results obtained with the solver software Xpress. It is shown that the methods are capable to generate good solutions in reasonable computing time.

INTRODUCTION

The forest sector has experienced extensive development in recent years. In Central Europe small- and medium sized wood-processing companies are more often displaced by larger ones, which use high-technology equipment and have a higher productivity. The ongoing liberalization of markets opens up new supply areas for round timber and also new sales markets for wood products. These developments increase the wood demand per facility and the transport distances. To enable a stable and cost-efficient supply of round timber to these facilities, it is necessary to apply some new sophisticated planning concepts.

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In Central Europe transportation accounts for an estimated 30% of the total costs of round timber and is therefore an essential element of cost. This percentage can also be found in related literature. Murphy (2003) states that log transport accounts for 20 to 30% of the seedling to mill-door discounted costs in New Zealand. Favreau (2006) mentions that transport is the biggest cost item in round timber costs in Canada; he estimates that it is more than 30% of the round timber costs. In Germany the transportation costs from wood storage locations to industrial sites are estimated to be 30% of the price of round timber by von Bodelschwingh (2001). Palmgren, Rönnqvist, and Värbrand (2003) present absolute cost values and state that forestry companies in Sweden spend up to US$ 270 million a year on transporting logs from harvesting locations to customers.

In Austria approximately 25 million cubic meters of round timber are further processed at sawmills. A considerable amount is directly delivered by log-trucks. Flisberg, Liden, and Rönqvist (2009) state that log-truck scheduling has traditionally been a manual process performed by transport planners responsible for a small number of trucks over a specified and limited region. The same is true for companies the author has worked with in Austria. This highlights the need for efficient decision support systems in round timber transport to obtain optimal routing decisions.

Gronalt, Chloupek, Greigeritsch, and Häuslmayer (2005) give a description of the forest-wood supply chain and its elements. The material flow starts at the forest. The trees are cut down, and the stems are brought to wood storage locations. From there, the round timber is transported directly to the industrial sites or transshipment points. These transports are typically carried out by log-trucks. Figure 1 shows this first part of the wood supply chain.

The information flow in the wood supply chain involves different actors, such as forest owners, shippers, representatives of industrial sites, and wood retailers. Important information include time schedules for harvesting operations, quantities, assortments, prices, capacities, weather forecasts, and geographic information.

In order to reduce transportation costs in the forest-wood supply chain it is necessary to look at this problem from a tactical and operational viewpoint. At first it must be determined which industrial sites should be supplied by which wood storage locations. This problem can be easily formulated as Standard Transportation Problem (TPP). Epstein, Rönnqvist, and Weintraub (2007) state that the TPP formulation is the basis for many other more complicated and integrated models in round timber transport.

After the wood flows are determined, detailed transport orders can be deduced, which define a certain transported quantity between a wood storage location and an industrial site. Guaranteeing a stable supply of round timber is an important factor for wood-processing companies. Therefore, the transported quantities to each industrial site have to be evenly distributed among each day of the planning horizon. On the other hand, carriers wish to have an evenly distributed workload in terms of covered kilometers or hours per day in order to avoid inefficient utilization of their fleets. Hence, an efficient distribution of transport orders should be ensured by suitable optimization models. This model is introduced as Timber Transport Order Smoothing Problem (TTOSP) (Hirsch, 2006). The TTOSP can be used to guarantee an evenly distributed workload either for the carriers or for the industrial sites. If these actors cooperate, it is also possible to use a model which optimizes the workload of both simultaneously.

After the transport orders are allocated to specific days, the next step is to assign them to log-trucks and link them in an efficient manner. Because of their specific construction, log-trucks can usually not be used for backhauls. Therefore, one can assume that every move between two transport orders is performed with an empty log-truck. Since the full truck movements are predetermined, the objective is to minimize the