Integrated Operational Transportation Planning in Theory and Practice

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1 Introduction

Outsourcing (subcontraction) makes use of external entities as an alternative to the usage of own resources (self-fulfillment). The arising 'make-or-buy' decision combining the two clusters of self-fulfillment and subcontraction evolves in a complex reference analysis among items involved [13].
In particular, considering the integrated operational transportation planning, the 'make-or-buy' decision also applies to the logistic branch. In practice freight forwarders face great demand fluctuations regarding transportation volume [1], while their own vehicle fleet is associated with high maintenance costs. The remedy is to reduce capacity of the own vehicle fleet far under the varying total demand limit. Instead, additional outside carriers are involved in order to gain enough transportation resources for covering the demand. Together with engaging an external forwarder, the methods of payment for its service (types of subcontraction) are defined. Furthermore, planning methods for three arising tasks are established: assignment to the execution mode and cost optimisation within each mode. In the following sections we present how these decisions can vary in theory and practice. Section 2 investigates the frames for modelling the integrated operational transportation planning problem. Section 3 introduces different theoretical and practical types of subcontraction. Section 4 compares theoretical with practical planning methods.

2 Modelling the Integrated Operational Transportation Planning Problem

There are only a few theoretical proposals for modelling an integrated operational transportation planning problem. They all assume that an order is a pickup-and-delivery request describing a single transportation demand, which results in a direct transportation process of carrying a less-than-truckload

packet. The aim is to minimize the total costs of request fulfillment, which is the sum of costs in the self-fulfillment and subcontraction cluster. The research for self-fulfillment is focused on the widely known pick-up-and-delivery-problem-with-time-window-constraints (compare [2]). The round tours are constructed, whose length results from routing and scheduling of vehicles. The homogeneous ([8] [11]) alternatively heterogeneous ([1] [12] [9] [3]) vehicle fleet is stationed in one depot (except for [3]) and each vehicle has the same predefined vehicle capacity. The tariff rate per distance unit, possibly time unit ([8] [3]), and additionally fixed costs per vehicle ([1]), provide a basis for cost calculation. Such modelling assumptions for the self-fulfillment cluster correspond to the reality in many freight forwarding companies.
In contrast to self-fulfillment, there exists no unique way to calculate the execution costs of requests in the subcontraction cluster.

3 Different Types of Subcontraction

The models of integrated operational transportation planning proposed so far incorporate different types of subcontraction. Further subcontraction models have been introduced in literature as separate problems or have arisen from our practical analysis.
Firstly, the theoretical approaches are the subject of consideration. The easiest method among those approaches simply shifts requests representing a sale of a single request independently from all the other requests to an external freight carrier ([1]). The requests are then forwarded on uniform conditions, based on a fixed fee per distance unit, for the distance between the pickup and delivery location.
A more complicated method assumes complete tours to be shifted to subcontractors ([9] [12]). The applied method of cost calculation corresponds to the cost calculation for the self-fulfillment cluster. The difference between the two approaches consists in the used terms of hiring vehicles. In [12] it is assumed that the vehicles of the external freight forwarder are leased in the short term if they are needed. Thus, a variable number of vehicles is possessed and only an exploited part of maintenance costs (percentage of working times of vehicles and drivers) is covered. In [9] a part of vehicles is rented permanently, i.e., they cannot be returned, while the other part is leased at short notice and sent home if the number of requests decreases. As the maintenance costs for the vehicles from the first group have to be fully covered, the minimal number of hired vehicles is aimed by the usage of punishment costs.
Requests can be forwarded independently of each other, where the costs of subcontracting the requests are adjusted to the effort in case of self-fulfillment ([3] [11]). Hence, the freight cost calculation results from isolated price assessment for each request on the basis of a fixed tariff, multiplied with the adjustment parameter defined for different criteria (distance, weight). In the approach of [11] an additional round route for an artificial vehicle is constructed. All the