

Pickup and delivery selection problem

T. Maes, A. Caris, K. Ramaekers, G. K. Janssens, and T. Bellemans

Hasselt University, Transportation Research Institute,
{tabitha.maes, an.caris, katrien.ramaekers,
gerrit.janssens, tom.bellemans}@uhasselt.be

Abstract

This paper focuses on the modelling of carrier decisions within an activity-based freight transportation model. To model freight transport, the different actors who are included in the decision making process have to be represented. One of these actors is the carrier. This paper formulates the decisions of the carrier as a selective pickup and delivery problem. To be able to better represent the influence of carrier decisions on the logistic module within an activity based freight transportation model. The objective is to maximize the profit gained, by selecting transport requests. A local search heuristic is presented to solve the problem.

Keywords: Logistic decisions, Freight transport modelling, PDSP

To represent logistic decisions within an activity based freight transportation model, decisions of a carrier have to be modelled. A carrier faces the daily problem of optimally scheduling his transport orders. Each day a carrier receives transport requests from his clients, which have to be executed within a certain time period. To obtain a maximal profit the carrier has to group certain orders and create an optimal sequence of pickup and delivery tasks. The assumption mostly made is that all requests have to be fulfilled. In reality a carrier can refuse a transport order, when he believes this order is not profitable. In our activity-based freight framework (Maes et al., 2011) only current requests are taken into account and the possible loss of future requests is ignored. If a request is accepted it will generate revenue when the transport is completed. When a carrier has to decide whether a certain request is accepted, the problem is defined as a Pickup and Delivery Selection Problem (PDSP).

In a PDSP not all transportation requests have to be fulfilled. A carrier receives transportation requests during the entire day. When new requests are received a decision has to be made, whether the carrier will take the responsibility of the transport or not. Unknown requests of the future cannot be taken into account when considering the current request. Hence, the PDSP is modelled as a static planning problem. In literature this problem is not often investigated, but several variations on the problem exist. Two main

bodies of routing literature are relevant for the PDSP. On the one hand Vehicle Routing Problems (VRP) with profit and on the other hand literature around Pickup and Delivery Problems (PDP). The PDP is more relevant to the problem presented, however profit maximization has been more applied to VRP. PDSP can be seen as a variation of these problems.

To be able to formulate a PDSP model some key characteristics related to this problem are presented. First of all, not all requests have to be accepted and every fulfilled request results in a profit. Every request has a time window for pickup and delivery, only hard time windows are considered. Pickup has to occur before delivery of each request (Precedence constraint). Pickup and delivery have to be performed by the same vehicle (Pairing constraint). Multiple homogenous vehicles are used with a limited capacity. Departure and arrival of the vehicle are in a depot of the carrier. All requests consist of less-than-truckload shipments. The objective is to maximize profit gained from executing selected requests. A travel cost is assigned to each kilometre.

An initial solution is created by a parallel insertion procedure based on the earliest time window of the pickup node. The insertion heuristic results in an initial solution which is feasible and can be optimized later by an improvement heuristic. Five local search heuristics are created to alter the initial solution. First the REORDER operator is applied to find a better route for requests already excepted. The EXCHANGE and SHIFT operator try to find better combinations of requests by exchanging either two requests between routes or by moving a single request to another route. Moreover, the SHIFT operator may reduce the number of vehicles used. In a fourth step, the INSERT operator is used to accept more requests by inserting unserved requests into routes. In a last step the SWITCH operator improves the current solution by replacing low profit requests with unserved requests that lead to a higher profit.

Benchmark data from Li and Lim (2001) are used to test the local search heuristic. The heuristic is strongly influenced by the number of routes created by the insertion heuristic. A further analysis is necessary to see the strength of the different local search operators separately. Future work will focus on improving the heuristic to obtain better results and further testing on extensive data sets.

References

- [1] Li H. and Lim A.: A metaheuristic for the pickup and delivery problem with time windows. *Proceedings of the 13th IEEE International Conference on Tools with Artificial Intelligence*, 2001, pp. 160-167.
- [2] Maes T., Ramaekers K., Caris A., Janssens G.K. and Bellemans T.: Simulation of logistic decisions within a freight transportation model. *Proceedings of the 9th Industrial Simulation Conference*, 2011, pp. 185-191.