30

Transportation Service Provider Collaboration: Benefits and Insights

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Background and Motivation
In the U.S., the trucking industry transports 68% of freight tonnage; 8.96B tons of freight over 145B miles annually. However, the industry is not sustainable:
- Trailers are not fully utilized (~43% utilization on average).
- Substantial driver turnover, especially for truckload drivers.
- Approximately 51,000 drivers needed in U.S.

Solution Approach
A discrete time adaptive large neighborhood search (ALNS) heuristic allowing:
- Multiple depots for vehicles.
- No restrictions on the number of vehicle routes or location visits.
- Pick-up and delivery time windows.
- Multiple opportunities to transfer freight between vehicles.

Research Objectives
Explore freight routing and consolidation decisions for collaborating transportation service providers (TSP) by:
- Introducing the transportation service provider collaboration problem (TSP-CP).
- Developing a mathematical model and solution approach to describe the TSP-CP.
- Evaluating the potential benefits of TSP collaboration.

Transportation Benefits
Efficiency gains for FTL and LTL carriers quantified using data from a freight pooling company with 16 FTL carriers and 42 LTL carriers:
- Partnerships of up to four carriers are created based on carrier type, size, and geographic location.
- Primary performance measures include the following:
  (1) distance travelled, (2) empty miles, (3) weighted full miles, and (4) container usage.

Problem Description
Given
- Transportation network
  - nodes and arcs
- Set of discrete time periods
- Set of containers
- Set of loads

Determine
- Routes for loads
- Routes for containers
- Assignment of loads to containers

Objective
- Minimize the following:
  - cost of container routes
  - cost to handle and hold loads

Constraints
- All loads are delivered
- Time windows are considered
- Container restrictions are met
  - start and end at pre-specified nodes
  - capacity is never exceeded
- Node restrictions are met
  - loads are only transferred and held at transshipment nodes

Collaboration Insights
Individual carrier benefits depend on partnership characteristics:
- 2-TSP partnerships
  - FTL carriers benefit the most from collaboration
  - LTL carriers found no benefit from collaboration
- 3-TSP partnerships
  - FTL and LTL carriers receive approximately the same benefit
- 4-TSP partnerships
  - LTL carriers benefit the most from collaboration
  - FTL carriers still benefit on all four performance metrics

Based on the collaborative partnerships, the results also suggest:
- FTL carrier only partnerships received the most overall benefit
- LTL carrier only partnerships received the least overall benefit
- Small carriers benefit substantially more from collaboration

Future Research
Additional research is still required on the TSP-CP and on horizontal collaboration in transportation:
- Modeling the TSP-CP with continuous time
- Allocating benefits of collaboration
- Consolidation and route planning with decentralized control