A Model for Emissions Reduction Evaluation in Urban Pickup Systems: A Heterogeneous Fleet Case Study

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Abstract
As commercial vehicle activity grows, the environmental impacts of these movements have increasing negative effects on society, particularly in urban areas. Using a local search tool based on the 11 and 2-ops heuristics, a case study was examined to explore the trade-offs between cost, service quality, and emissions of an urban delivery system. While many policies which focus on reducing emissions are more expensive than those that focus only on cost-reduction, implementing the best available solution to the case study examined also improves existing routing; therefore reducing emissions by an average of almost 6%, while reducing costs by an average of 9%. This research offers a novel approach for including emissions into fleet assignment and vehicle routing, and for analysis of the contribution of urban pickup and delivery systems to urban emissions. This tool will enable evaluation of the impact of a variety of internal policies on these fleet attributes.

Q3: Practical applications for fleet managers
Managers of small fleets of vehicles are less likely to use optimization tools to determine the routing of their vehicles, and instead will rely on simple rules of thumb.

ASSIGNING VEHICLES
• Vehicles within a heterogeneous fleet should be assigned customers in increasing emissions order.
• Vehicles with lower emissions should travel the furthest distances.
• Within the case study, ordering vehicles by emissions as opposed to capacity results in emissions reductions of:
  • 16.91% for morning routing (7 routes)
  • 45.07% for afternoon routing (5 routes)

DRIVER BREAKS
• Avoid breaks within the routing.
• If breaks are unavoidable, schedule along the route to eliminate the need to return to the depot mid-tour, which would still reduce distance traveled and emissions.

Fleet Upgrade
Since we began our study, the UWMS has replaced its unleaded fuel vehicles with hybrid/electric mail trucks.
Five new trucks with hybrid-electric technology were purchased through a grant received to replace older unleaded fuel trucks.
Fleet manager estimates a decrease of at least 50% in fuel costs.

Conclusions

CASE STUDY
• Simple rerouting reduces emissions and cost
  • emissions: average reduction of 6%
  • cost: average reduction of 9%
  • UWMS fleet is underutilized - fleet could be reduced from 7 vehicles to 4 vehicles

URBAN PICKUP SYSTEMS
• Operational changes can reduce emissions while only increasing costs minimally, or not at all
  • Cost and emissions savings can be found with service quality reductions
  • Cost and emissions increase as vehicles encounter increased durations of congestion
• Managers of small fleets of vehicles can use simple rules of thumb to improve emissions within vehicle routing.