Impact of Dual-Toll Pricing in Hazmat Transportation considering Stochastic Driver Preferences

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Hazardous Material (Hazmat)
- Explosives
- Gases
- Flammable Liquid and Combustible Solid
- Flammable Solid, Combustible and Explosive When Wet
- Oxidizing Material and Organic Peroxide

Solution Algorithm- Multiple Toll case
- We assume there are multiple tollable links in the network.
- For each tollee link (ij), we are interested in finding a regular toll $\alpha_i$ and a hazmat toll $\beta_{ij}$. The set of decision variables is ordered as $\{\alpha_1, \beta_{ij} : (i, j) \in E \}$. We propose a heuristic algorithm for solving the dual toll pricing model with stochastic driver preferences to the case of multiple regular or hazmat links.

A cyclic algorithm, which aims to sequentially solve single toll problems, is proposed. In each iteration, either a regular toll or a hazmat toll is being optimized while the other toll is set to its unexplored value.
- In every two iterations of the above algorithm, we set the optimal values of the regular and hazmat tolls of a certain link and then continue with the next link.

Case Study: Sioux Falls Road network
1. To explore computational efficiency and convergence of the algorithm.
- We run Cycle Algorithm for the Sioux Falls network for different combinations of network characteristics (i.e., number of OD pairs, number of the 8 shortest paths, number of potential dual links, and number of suitable tollee links for regular vehicles and hazmat trucks).

2. To study the impact of the dual toll pricing versus single toll pricing.
- By Single Toll Pricing, we mean only hazmat toll pricing. The regular driver takes the shortest path towards their destination.
- We consider 150 OD pairs for regular trucks and 10 OD pairs for hazmat, 20 shortest paths and 17 candidate paths, while varying the number of suitable tollee links 1, 2, 4 and 8.

3. To compare the optimal set of dual tolls of a certain link in single toll and dual toll pricing.
- The risk value comparison for single and dual toll pricing.
- For every pair of the two graphs the risk of network in the dual toll case is less than the single toll case.

Conclusions & Future Research
- Number of OD pairs, dissimilar links and relevant links in the network greatly impact computational time.
- As in toll pricing on more congested sawdust, the total risk value decreases. Without considering the cost associated with tollee tolls, toll pricing can obviously ensure ranker road transportation.
- Setting tolls for both regular and hazmat links are more effective than just hazmat toll pricing.
- Dual toll pricing not only provides flexible solutions for network regulators but also suggests acceptable characteristics to users. For example, it can be used to steering drivers to more safer roads.
- One of the limitations of the problem is to study dynamic dual toll pricing which allows the regulator to set dual tolls in a time-sensitive basis.

References