National Center for Sustainable Transportation

RESEARCH BRIEF

A Truck Routing Model to Reduce Fuel Consumption and Emissions while Accounting for Parking Availability and Working Hours Constraints

Filipe Vital and Petros Ioannou
Department of Electrical and Computer Engineering, University of Southern California

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Research Question

The transportation sector is responsible for 28% of US greenhouse emissions, with a considerable amount being generated by medium- and heavy-duty trucks. Multiple strategies will be needed to improve efficiency and reduce carbon dioxide (CO_2) emissions in the trucking industry.

Several studies have examined the potential for reducing emissions by choosing truck routes that minimize fuel consumption. However, these "green routing" studies do not consider critical practical factors like parking availability and working hours regulations. When drivers encounter parking shortages because their chosen routes and schedules do not account for parking availability, they are forced to make last-minute changes that make the chosen route more polluting than expected. Similarly, working hours regulations influence the timing of required rest stops, which may force drivers to deviate from initially selected routes and schedules, resulting in fuel consumption and emissions consequences. Therefore, accounting for these practical factors as early as possible during route planning will produce more eco-friendly outcomes. Although truck parking information is not ubiquitous, progress is being made in developing the technology necessary to implement intelligent truck parking systems, and some pilot sites are already in place.

Researchers at the University of Southern California developed a truck routing model that minimizes fuel consumption and reduces emissions while explicitly accounting for parking availability and hours-of-service constraints. The researchers used the model to test various scenarios that reflect the practical constraints faced by drivers.

Key Research Findings

The proposed truck routing model addresses both drivers' needs and eco-friendly goals. It can help estimate the level of emissions reduction that can be expected for different regions and types of vehicles, at what cost, and how they are affected by the region's truck parking infrastructure. It is important to account for these practical constraints when analyzing the impact of policy and investment decisions.

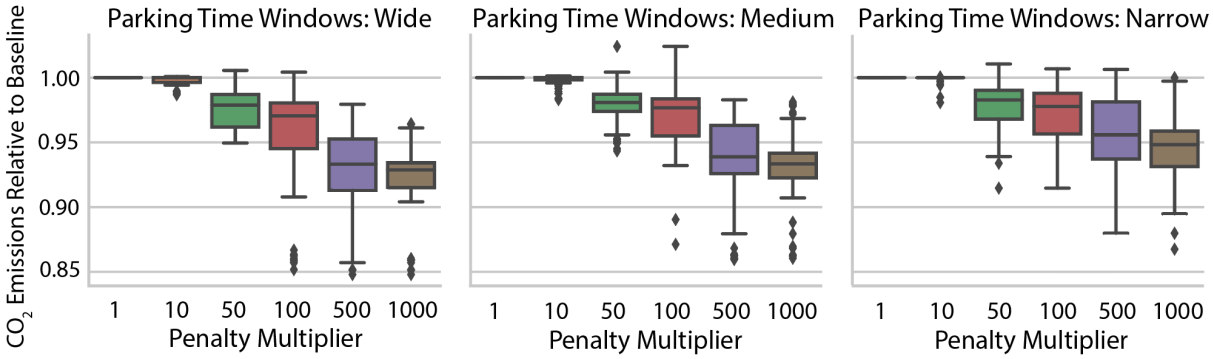

Figure 1. CO_2 emissions as a fraction of baseline emissions under different parking availability conditions. The baseline emissions value for each scenario is the value obtained with penalty multiplier of 1. Higher penalty values increase the priority given to optimizing emissions as opposed to optimizing trip duration.

The trade-off between emissions reduction and trip cost/duration can be significantly affected by truck parking conditions. The scenarios showed CO_2 emissions reductions of up to 5%–8% on average (Figure 1), which come at the expense of increases in average trip duration and average trip cost. However, impacts on trip duration are greatly reduced in scenarios that simulate limited parking availability.

Ignoring uncertainty in parking availability results in inconsistent performance, even during periods when probability of finding parking is high. Scenarios in which drivers were given full information about the probability of finding parking at any time/location significantly improved the model's performance and reduced illegal parking-related risks, but also substantially increased the model's complexity and solve time. Providing full information regarding parking availability but restricting the parking times to high availability time windows can reduce complexity while maintaining consistent, although reduced, performance.

More Information

This research brief is drawn from "Optimizing Fuel Consumption and Pollutant Emissions in Truck Routing with Parking Availability Prediction and Working Hours Constraints," a report from the National Center for Sustainable Transportation, authored by Filipe Vital and Petros Ioannou of the University of Southern California. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/optimizing-fuel-consumption-and-pollutant-emissions-truck-routing-parking-availability.

For more information about the findings presented in this brief, contact Filipe Vital at fvital@usc.edu.

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