Clustering Heavy Duty Truck Failure Modes for Proactive Safety Inspection and Efficient Operations of Commercial Vehicle Fleets

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Abstract

Planned or unannounced roadside inspections ensure truck safety while limiting operation efficiency and fleet mobility. So fleet owners are finding ways to be exempt from roadside inspections to maximize operational mobility for their companies. However, the Federal Motor Carrier Safety Administration claims that roadside inspection effectively reduces commercial vehicles' traffic accidents, given that defective truck equipment is a cause of many significant truck accidents. Researchers also found that states keeping a vehicle safety inspection program have significantly fewer crashes than states without such programs. Keeping the safety inspection programs with a minimum impact on the mobility of commercial vehicle fleets, therefore, becomes a practical challenge between safety and efficiency.

This research examines commercial vehicle fleets' safety-efficiency tradeoff by analyzing historical inspection records of multiple commercial motor carriers and inferring risks scores of having only annual inspections. We propose a proactive inspection system that suggests targeted inspection and preventive maintenance plans for given vehicles or fleets according to the failure modes of the vehicles and the deterioration patterns of fleets. A clustering algorithm identifies different failure modes among vehicles and carriers and their evolution under a time scale. We expect this clustering algorithm will help provide potential component failure modes to drivers and fleet managers to avoid repetitive out-of-service violations. Inspectors can target key components when performing roadside inspections with this algorithm. A simulation study shows that such historical-data-driven inspection and proactive maintenance can save inspection time and unforeseen costs for carriers while keeping low crash rates for large trucks.