CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-7081: Understanding the Impact of Autonomous Vehicles on Long-Distance Travel Mode and Destination Choice in Texas

Background

Long-distance trips constitute an important part of Americans' inter-city travels, with more than 7 billion person-trips over 75 miles (one-way) in 2017. Passenger and freight long-distance trips are a key component of the nation's traffic volumes, congestion levels, emissions, crashes, and pavement damage. Although in 2017 only 2.5% of all US person-trips were long-distance, they comprise 43.3% of total US person-miles. Moreover, trucks carry about 2 trillion ton-miles of freight around the US each year, with most of that freight moving long distances.

As autonomous vehicles (AVs) are expected to become increasingly available in coming years, their travel, trade, emissions, cost, and other implications need to be anticipated by TxDOT and partnering agencies. Population growth shifts in mode choice in a market where AVs are widely available, and changes in freight costs due to automation all have the capacity to significantly alter travel destination choice, roadway volumes, and rail and airport usage. However, predicting these changes is a difficult endeavor. Researchers looked to prior research on AV acceptance and anticipated technology cost and utilized new survey results and the latest related data sources to create travel demand and freight models that allow TxDOT to prepare for an increasingly automated future.

What the Researchers Did

Researchers simulated US transportation systems and forecasted the impacts of AVs and shared AVs (SAVs) on destination and mode choices of long-distance passenger and freight trips within the US, targeting a future 20+ years from now. They created demand sub-models for vehicle ownership, trip timing/scheduling and frequency, trip purpose and travel party size, plus mode and destination choices. Datasets used include a survey designed and administered as part of this project (with 1,004 adult Americans responding to roughly 70 questions), the 2016/2017 National Household Travel Survey data, the Federal Highway Administration's journey travel skim data (for cost and time values between 4,486 zones across the US), the Bureau of Transportation Statistics DB1B air travel data, and the Environmental Protection Agency's Smart Location data (for land use information on 84,000+ US Census tracts). Researchers used high-performance computing to generate a 10% synthetic (microscopic) US population of 12.1M households and 28.1M individuals across 73,056 census tracts to microsimulate passenger travel shifts in the presence of AVs and SAVs.

For freight forecasts, researchers used the Freight Analysis Framework (FAF5) and US Commodity Flow Survey (CFS), partitioning commodities into 13 economic sectors for parameterization of 13 nested-logit mode-and-origin (of commodity) choice models. Automated trucks (ATrucks) were assumed to operate at 50% of the cost of traditional human-driven trucks (HTrucks) despite an upfront cost for automation technology. Researchers anticipate ATrucks can operate 24 hours a day (minus refueling/recharging), but also have an onboard attendant who can oversee the freight's security, facilitate loading/unloading, and perform other productive tasks. Such operations changes mean freight carriers see a 25% savings that provides benefits for long- distance travel, specifically peaking for freight travel between 500 and 750 miles.

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What They Found

This research indicated that travelers who are male, have higher annual incomes, or hold at least an associate's degree make more long-distance trips. As the number of vehicles in the household increases, so does the frequency of long-distance trips. The summary of the survey responses from 1,004 individuals (45% Texans and 55% other US residents) indicated that Texans were about 40% more willing to travel long-distance with AVs in contrast to US respondents for scenarios where the use of AVs imposes 0–50% increases in travel time. A majority of Texans (60%) would not change their destination if using an AV, but about 20% would decide to visit a farther place. The detailed simulations suggest dramatic shifts in mode choices in a future where AVs are readily available. In the 2040 target year, assuming a technology premium price of $3,500 (on top of new- vehicle purchase price), 78% of US households are estimated to own at least one AV. While long- distance mode choices prior to AV availability are 72.5% personal car, 18.5% rental vehicle, and 9.1% airplane, these are simulated to shift to 57.2%, 12.0%, and 3.0% respectively, with AVs taking the remaining 27.8%. As more people move from air travel to AVs (especially for trips up to 500 miles long), person-miles traveled (PMT) per capita is expected to drop by 6%, even though overall travel demand and total PMT is anticipated to rise (as trips under 75 miles become longer trips, and those with driving disabilities start taking AVs for all sorts of journeys).

For freight, a significant shift from rail transport to trucking is predicted, mainly because of automation's cost savings. Ton-miles are predicted to rise most in the 1,000- to 1,500-mile freight market. ATrucks are expected to carry most of the load in longer-distance markets, with HTrucks handling more journeys that are under 250 miles.

What This Means

Results indicate major changes in mode choices and destinations for both passengers and freight. If Texas wants to keep traffic moving and safe, then lowering energy use, emissions, and cost, as well as policies that increase dynamic ride-sharing (real-time carpooling), right-sizing of vehicles (in shared and private fleets), and drivetrain electrification are important for both self-driving and human-driven vehicles. Allowing only managed fleet AVs to ride empty (and no more than, e.g., 20% for SAV fleets), adding credit-based congestion pricing to all bottleneck points (using on-board dongles), enacting emissions-based fees and higher fuel taxes (since Texas has some of the lowest in the world, and they have been static for over 30 years), and advocating for transit- sponsored SAV systems (provided by privately managed fleet owners) with dynamic ride-sharing can avoid the gridlock that could result from making "driving" easier while also making the Texas network much more efficient.

To help ensure TxDOT and its partners use the project models in future planning, investment, and policy efforts, the research team recommends that passenger and freight-based travel equations and parameters (and various input files, like network distances and travel times, export demand volumes by industry, and weight per container by industry) be added to a user-friendly TransCAD- based package for use by transportation planners, and that the team host training sessions for TxDOT staff and stakeholders (like MPO staff and their consultants, across the state and nation). In this way, TxDOT and its partners can run hundreds of diverse simulations over the coming years, thereby implementing this research work fully, while adding new forecasts and values for infrastructure maintenance and expansion, traffic management, and trade and travel support across the state and nation.

For More Information

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