Distance-based mileage fees could be tested through shared-mobility providers

Gas tax revenues are expected to decline in future years as vehicles become more fuel efficient and more electric vehicles enter the market. An alternative to the gas tax—the distance-based user fee (DBUF)—has been proposed by national studies and experts, but concerns about data privacy, equity, and administrative costs have mostly limited its use to pilot projects in the United States.

Students prepare Scott County for connected and automated vehicles

Connected and automated vehicles (CAVs) are attracting growing attention from researchers, transportation agencies, and the public at large. This past semester, CAVs were also the focus of a U of M course that centered on how Scott County, Minnesota, could prepare for a future with CAVs.

The course—Public Affairs 5211: Land Use Planning—was offered by the Humphrey School of Public Affairs with support from the U of M’s Resilient Communities Project (RCP). Scott County is one of RCP’s community partners for the 2018–2019 school year.
Researchers at the University of Minnesota’s HumanFIRST Laboratory are constantly working to better understand driver behavior—and to use that understanding to prevent injurious and fatal crashes. One of the key tools assisting them in this mission, the immersive driving simulator, recently got an update.

On December 18, the lab held an open house to allow stakeholders and others interested in human factors research to view and test the newly overhauled simulator. Lab director Nichole Morris led small tours into the simulator room, where guests could take a seat inside the new Ford Fusion cab being used as a motion base. A set of hydraulic arms attached to the car allow it to rock forward, backward, and to either side, giving a sense of motion when the driver turns the wheel. A smooth arc of projection screens around the car allows the researchers to build a virtual environment for the driver to interact with.

“It takes people a bit to really acclimate to the simulator, and it’s going to feel like the strangest rental car you’ve ever driven,” Morris said.

The upgrades began in 2017 and were funded in part by a Research Infrastructure Investment Program grant from the U of M’s Office of the Vice President for Research. Updates include the new motion base and improved hydraulic system as well as a new computer system, projectors, and the seamless screen outside the vehicle for a more immersive environment.

Once drivers get a feel for it, the simulator allows Morris and her team to conduct a variety of research. The simulated worlds, for example, are often geo-specific, meaning they are recreations of actual roadways in Minnesota. This is beneficial for agencies like the Minnesota Department of Transportation because it lets researchers study specific locations and see how people perform in response to modifications such as innovative signage or infrastructure changes.

The simulations can also be used to test new technologies, including connected and automated vehicle systems, and to examine situations that would otherwise be dangerous—such as driving while intoxicated, medicated, distracted, or fatigued.

“We’ve got one [project] coming up where people will be here for almost 36 hours and driving every four hours,” said Peter Easterlund, simulation manager at the lab. Fatigue, he points out, is critical to study because there is currently little known about how to detect it. “At some point,” he said, “fatigue is just as dangerous as drinking.”

To collect data for these projects, the simulator has a series of five infrared cameras and a GoPro mounted inside the car that can track the eye and head movements of the driver. When a threat—like a veering bicyclist—presents itself on the simulator screen, researchers can use the eye trackers to determine, among other things, how quickly the driver notices the threat.

Colonel Matt Langer from the Minnesota State Patrol was one of the volunteers who drove in the simulator at the open house. The system has definitely had a lot of effort put into it to make it as realistic as possible, Langer said, and he likes that it allows testing to be done in a situation where nobody can get hurt.

“As a traffic safety professional, I’m interested in what the University of Minnesota is doing—things related to the human factors, and what we can learn to help people become better drivers,” Langer said.
In real estate, location is everything. But in determining how useful a public transit system is, the location of bus and train stops isn’t the only factor—a line will have limited usefulness if it runs infrequently or doesn’t connect to other parts of the transit system.

To better study this relationship, researchers from the U’s Global Transit Innovations (GTI) program have designed an app that compiles and maps data on transit service frequency. The app contains service frequency data for a total of 42,173 routes and 973,356 stops in 50 countries.

“If we just look at where transit routes and stops go, it’s deceiving to a certain point,” says Yingling Fan, professor at the Humphrey School of Public Affairs and principal investigator of the project. “Some of those routes and stops do not provide any service during the weekends and are very infrequent.”

To better visualize where transit vehicles stop, how often they stop, and how far a person can travel on them, the researchers designed the Service Frequency App—a website where users can view interactive maps of route and schedule data from transit agencies all over the world. It is useful for both the public, who can use it to find homes and jobs with transit access, and for researchers and practitioners, who can analyze the data and help design better transit systems.

Upon entering the main portal, users are shown a global map that displays the locations of transit providers in different cities. Blue rectangles box out the “service extent” of each provider. Up close, transit routes are marked out in shades of green based on stop frequency. The more often a bus, train, or other transit vehicle stops along a certain route, the darker the shade of green.

Users—particularly researchers—have the option to download the data that inform the maps. Originally, the U of M researchers gathered the data from a site called TransitFeeds, which formats the data as text files. For the app, the researchers compiled the data so that they can be viewed as a whole, which makes it easier to compare to other factors such as distribution equity.

“You potentially can overlay population distribution on top of the map,” Fan says, “and then see, for example, whether specific population groups actually have lower transit access.”

Eric Lind, research and analytics manager at Metro Transit, says the app provides a good summary of one layer of the transit system. This can be combined with other data for a more complete understanding of transit usefulness, which can help planners make decisions. “For me it’s more of a question-generating tool, which can be very useful,” Lind says. “It will tell you [at a minimum] the potential for someone who can access that stop to get somewhere else.”

Researchers have finished processing the data, and the app is available for public use. Fan says she aims to update the data on a yearly basis and continue adding features that make the app more user-friendly.

The app, a user guide, and the methodology report can be accessed at gti.umn.edu.
Zero may seem like an impossible goal—especially when it comes to traffic-related deaths. But a new road map can help state, local, and tribal agencies and private industry turn that goal into a robust movement to make zero a reality.

The comprehensive suite of tools, dubbed A Road Map for Implementing the Toward Zero Deaths (TZD) National Strategy on Highway Safety, is now available for free on the National TZD website. Developed by a multidisciplinary team led by CTS, this new guidance highlights what is necessary for a successful TZD program while accounting for unique jurisdictional characteristics.

“The road map is designed to move TZD from an idea to a powerful movement supported by stakeholders and partners from multiple disciplines,” says Carlos Braceras, president of the American Association of State Highway and Transportation Officials (AASHTO). “States, communities, and organizations that use these and other resources…will be well-positioned to make zero a reality.”

The new suite of tools includes:
- A road map guidance document that identifies the essential elements for effectively implementing and sustaining a TZD program, action step checklists, and best practices.
- Two online self-assessment tools focused on program development and implementation and on stakeholder involvement. The tools identify a continuum of tasks to help organizations determine the status of their TZD program and move it forward.
- A how-to guide for implementing


The tools are available at tpec.umn.edu.

New road map aims to make zero deaths a reality
Innovative engineering solutions are necessary to improve the durability and extend the life of transportation infrastructure. On their own, however, they are insufficient for addressing our nation’s nearly trillion-dollar repair and capital backlog. Strategic financial management practices must be combined with engineering solutions to improve decision making about long-term infrastructure investment in the United States.

U of M researchers led by Zhirong (Jerry) Zhao are providing the expertise needed to inform these financial decisions. Zhao, an associate professor in the Humphrey School of Public Affairs, launched the Institute for Urban and Regional Infrastructure Finance (IURIF) in 2017 to advance research and engagement on strategic issues of infrastructure investment across urban and rural areas. The institute promotes and amplifies multiple areas of expertise, including state and local public finance, infrastructure sustainability, and urban and regional affairs. IURIF’s goal is to address critical challenges in the collective provision of transportation infrastructure across geography and boundaries.

Zhao’s team has analyzed new revenue sources (see related article on page 1) and developed the Minnesota Transportation Finance Database, which integrates data about transportation finance mechanisms and shows changes in transportation spending over time and geography (see page 4). This view of infrastructure investment can support decision making by showing where contributions come from and where they are allocated.

“In the most recent analysis of funding from 2010–2015, for example, we observed that local governments fund a significant proportion of transportation infrastructure, primarily through property taxes,” Zhao says. “This information can be used to understand how changes in property tax could affect local transportation infrastructure.”

Other studies have looked at public-private partnerships, value capture (a mechanism to capture some of the value resulting from transportation investments), and the impacts of transportation investment on economic development.

This information is essential for transportation agencies in their asset management practices. In 2016, the Federal Highway Administration issued a final rule requiring states to develop asset management plans for the National Highway System and establish minimum standards for states to use in developing and operating bridge and pavement management systems. “In the years since the final rule was issued, DOTs have evolved from defining parameters for asset management to developing transportation asset management plans that support decision making about infrastructure investment,” says Tim Henkel, MnDOT assistant commissioner and chair of the TRB Standing Committee on Transportation Asset Management.

“Going forward, agencies especially need help with understanding cross-asset decision making and the implications of broader transportation goals on asset management.”

Other University of Minnesota researchers, such as professors Catherine French and Mihai Marasteanu of the Department of Civil, Environmental, and Geo-Engineering (CEGE), are contributing to the engineering practices that will make bridges and pavements more durable. French and others in CEGE have monitored structural health and studied how bridges respond to traffic, the environment, and other conditions over time. Pavement researchers including Marasteanu have explored new materials, designs, and applications for asphalt and concrete pavements, especially under Minnesota’s cold weather conditions.

“Combined, the University of Minnesota offers the expertise needed to find engineering and financial solutions to meet the infrastructure needs of Minnesota and the nation,” Zhao says.
The course was also supported by CTS as part of a research project led by Professor Thomas Fisher of the Minnesota Design Center and Humphrey School assistant professor Fernando Burga. The project is one of five that received seed funding from CTS last year to explore topics including CAVs, equity, and shared mobility.

Burga, the class instructor, says CAVs are a new field that is ripe for research. "Nobody really knows what's going to happen, so this offers an opportunity to envision and do new things," he said.

Working with Scott County gave the students a chance to gain real-life experience with stakeholders. Scott County, in turn, was able to give feedback and gain valuable insights on the changes that might come with CAVs in infrastructure and the ways people live, play, and work.

“This technology is coming,” says Lisa Freese, transportation services director of Scott County. “We know that this is a few years out in the future, but we need to start thinking about how we do these projects.”

On December 7, the 25 students from the class presented their work at a poster session held in the Humphrey School atrium. Each of the six projects was presented as a series of posters that walked viewers through the methodologies, results, and other aspects of the students’ work.

One project—Shared Mobility for All?—focused on the relationship between CAVs and Scott County’s senior citizen population. The team conducted pilot surveys and interviews with a variety of people who would be directly affected, including seniors and social workers. Shanda Hunt, one of the students, says the data visualization skills she developed will be applicable to her position as a public health librarian at the U of M.

Another project explored how CAVs might be used for freight transportation. Students conducted three site visits and did background research to better understand port operations and existing local and national freight issues. Other projects explored CAV relationships with pedestrian safety and looked at how CAVs might connect rural residents to the Twin Cities.

“Every one of these projects offers key takeaways from which Scott County can learn,” says Mike Greco, RCP director.

RCP, housed within the U’s Center for Urban and Regional Affairs, connects local government agencies with U of M students and faculty to advance community resilience and student learning.

The existing TZD Strategic Communications Plan. It identifies elements needed to promote TZD adoption, offers guidance for targeting partners, and discusses how to train and use ambassadors.

- A PowerPoint presentation for use by partners and ambassadors that complements the how-to guide.
- Three online tutorials that address the benefits of partnering, provide tactics for connecting with and engaging different types of partners, and highlight how states and communities are working with partners to promote TZD efforts.
- Project partners included Jacobs, HDR Inc., MBO Engineering, and Pam Fischer Consulting. Humphrey School associate professor Kathy Quick also contributed her expertise to the project, leading the development of the online self-assessment tool focused on stakeholder involvement. In addition, the team gathered input from state and local transportation officials and advocates from across the United States.

To build awareness of the new road map and provide tools to implement the TZD national strategy, the project team will host a biweekly webinar series beginning on January 30, as well as a series of workshops held in conjunction with national conferences. Learn more and sign up to receive email notifications about the upcoming events at cts.umn.edu/nationalTZD.

This work was sponsored by AASHTO in cooperation with the Federal Highway Administration and was conducted under the NCHRP, which is administered by the Transportation Research Board of the National Academies of Sciences, Engineering and Medicine.
In recent studies being conducted for the Minnesota Department of Transportation (MnDOT), U of M researchers reviewed lessons from DBUF pilots in six states (including four projects in Minnesota) and explored the possibility of testing a DBUF system through collaboration with shared-mobility providers.

The research was led by a team from the Humphrey School of Public Affairs: Frank Douma (director, State and Local Policy Program), Jerry Zhao (associate professor), Camila Fonseca (research associate), and Patrick Haney (research assistant).

“This DBUF project is very promising and unique in terms of its approach,” says Ken Buckeye, MnDOT’s project manager. “It is focused on where personal travel trends are taking us in terms of technology and social-demographic patterns, and it is attempting to develop an efficient and viable model for backfilling a funding gap created by reduced fossil fuel consumption.”

Under the existing model, the gas tax is charged to wholesalers, who in turn add the cost to each gallon sold; administrative costs are relatively low. In a DBUF system, users pay a fee based on the vehicle-miles traveled rather than the gallons of gasoline purchased.

The researchers found that under most state pilots, mileage must be tracked and turned in, which raises data privacy and security issues. “Tracking mileage also has higher costs of implementation, operation, enforcement, and compliance—estimates range from 6 to 10 percent of total revenue collected,” Zhao says.

The pilots studied used a range of technology options to capture mileage data. In most cases, GPS-enabled technology was used to track where mileage occurred. “This potentially allows billing for different levels of government, but it is much more invasive privacy-wise,” Fonseca says.

A key finding from the study is that privacy concerns decreased over the course of the pilots. “Participants tend to be more accepting when they understand the need for revenue generation and they do not see themselves as winners or losers after participating,” Fonseca says. “For example, participants in the Iowa study changed from a 42 percent positive impression of a mileage-based user fee to 70 percent at the conclusion of the study.”

The research team is exploring collaboration with shared-mobility providers as a way to reduce the number of fee collection points and gain potential efficiencies in collection costs. “These companies already have this technology in their vehicles and track mileage as part of their business,” Haney says. “Administering the fee becomes far easier and cheaper when there’s only a handful of providers and data can be aggregated. And an important outcome of this model is that drivers would not be directly monitored.”

A long-term, incremental transition to a DBUF system prepares the way for fee collection from shared automated vehicles, and the model could be adapted to privately owned vehicles equipped with appropriate technology. “Administrative efficiency could be more comparable to the costs of administering the motor fuel tax,” Haney says.

Researchers have completed a proof-of-concept and modeled pricing options. Efforts are continuing to engage users and other stakeholders and secure partnerships with car-sharing companies to take part in this project, Zhao says.
Distance-based mileage fees could be tested through shared-mobility providers.

New app MAPS OUT the ‘where’ and ‘when’ of TRANSIT STOPS.

Students prepare SCOTT COUNTY for connected and AUTOMATED VEHICLES.

UPGRADED SIMULATOR showcased at HUMANFIRST LAB open house.

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