

Semi-Annual Progress Report for University Transportation Centers

Federal Agency and Organization Element to Which Report is Submitted: **Department of Transportation, University Transportation Centers**

Federal Grant or Other Identifying Number Assigned by Agency: **69A3551747119**

Project Title: **Center for Transportation, Environment, and Community Health (CTECH)**

Center Director Name: **H. Oliver Gao**

Title(s): **Director, CTECH and Professor**

Contact Information: hg55@cornell.edu/607.254.8334

Submission Date: **April 26, 2022**

DUNS # **872612445** and EIN # **150532082**

Recipient Organization: **Cornell University, 203 Hollister Hall Ithaca, NY 14853**

Recipient Identifying Number: **OSP 79841**

Project/Grant Period: **November 30, 2016 to September 30, 2023**

Reporting Period End Date: **March 31, 2022**

Report Term or Frequency: **Semi-annual**

Signature of Submitting Official:



Date Report Submitted: **April 26, 2022**

Name of Submitting Official: **H. Oliver Gao**

Telephone: **607.254.8334**

Email: hg55@cornell.edu

1. ACCOMPLISHMENTS

What are the major goals of the program?

The goals of the Center for Transportation, Environment, and Community Health (CTECH) are to pursue research and education innovations to support sustainable mobility of people and goods, while preserving the environment and improving community health. It leverages behavioral and economic sciences, information technology, and environmental and transportation sciences and technologies to address critical issues falling under the FAST Act's priority area of Preserving the Environment: greenhouse gas reduction, use of alternative fuels and energy technologies, environmentally responsible planning, and impacts of freight movement.

To address these challenges, the Center organizes its research activities through six thrusts: 1) Behavior, Active Transportation, and Community Health, which studies the links between travel behavior, active transportation, the built environment, and health; 2) New Transportation Technologies and Business Models, which explores how mobility-on-demand services can be used to improve environmental sustainability and human health; 3) Green Multimodal Transportation Systems, which leverages new mobility technologies to promote sustainable and health-enhancing modal integration; 4) Freight Transportation and Community Health, which explores new vehicle technologies and operation paradigms to reduce human exposure to truck exhaust; 5) Data-Driven Transportation-Health Informatics, which leverages Smart City and IoT (Internet-of-Things) technologies to develop community-based and personalized transportation-health indices for promoting healthy mobility choices; and 6) Energy, Technology and Policy Pathways, which studies the impact of different combinations of energy, technology and policy pathways on the environment and community health. The consortium, consisting of Cornell University (Cornell), University of California, Davis (UCD), University of South Florida (USF), and The University of Texas at El Paso (UTEP), aims to advance transportation sustainability in its broader human and environmental contexts through multi-level, multidisciplinary and cross-sector collaborations.

The Center leverages existing strengths of partner universities to create an innovative, multidisciplinary education program capable of training a workforce that will meet the complex challenges at the intersection of transportation, environment, and community health. Beyond the multidisciplinary curriculum designed in parallel with its research, the Center is developing programs to attract motivated undergraduates and high school students to transportation, particularly from underrepresented groups.

CTECH's research targets deliverables in the following areas:

- Advancing methods for the holistic representation of user behavior/response;
- Data-driven cyber-informatics modeling-management models/tools accounting for built environment-users and systems interactions;
- Computationally efficient algorithmic techniques for multimodal transportation systems management and community health;
- Scientific and engineering solutions for large scale integration of community health into transportation policy and planning; and
- Improved transportation-environment-community health nexus by linking fundamental scientific discovery with innovative practices.

The unique aspect of the work is that researchers focus on informing, influencing, and changing policy (i.e., legislation, regulations, programs, ordinances, and protocols) at the nexus of transportation, environment, and community health. Dissemination of research outcomes and education are critical components of technology transfer to subsequently influence policy and human behavior. The main products from our Center's research activities will be in the form of insights, knowledge, tools, and models that are instrumental to our stakeholders and practitioners as well as to policy development and

analysis. The development of technologies to license and/or commercialize can also be outcomes and is highly encouraged.

What was accomplished under these goals?

While providing critical services for the mobility, health, economic well-being, and security of communities, transportation presents challenges that also define modern society, with issues such as accessibility, air quality and energy efficiency, safety, health impacts, equity, and infrastructure vulnerability that must be confronted to sustain healthy living and economic growth. Successful solutions call for innovative cross-disciplinary research and education, and integrated technologies and approaches that meet goals in mobility alongside goals in environmental and health protection. In this reporting period, focused on FAST Act's priority area of Preserving the Environment, CTECH continued to use its fundamental research activities as the driving force to create downstream innovations, practices, and to enhance education programs for workforce development. The Center's activities are organized and the accomplishments reflected along three tracks: 1) the fundamental knowledge track comprises research activities, development of methodologies and tools, and collection and analyses of data; 2) new policy recommendations and innovative practical implications/guidelines that translate and promote research outcomes into transportation, environmental and community health practices/policies; and 3) education, outreach/engagement, and workforce development that trains students and professionals on the findings and insights of the research, as well as the tools used and lessons learned in best practices. We continued to engage stakeholders (government agencies, private industry, the public, etc.) in all of these processes to create broader impacts. Via accomplishments along these tracks, we progress towards our goal of building a unique platform for synergistic and multidisciplinary research and education at the nexus of transportation, environment, and community health, where new opportunities are explored to develop methods, tools, and technologies to support sustainable multi-modal transportation and promote healthy mobility choices.

Research projects accomplished during this reporting period cover topics such as transportation technology innovations (e.g., CAVs, urban air mobility, etc.) and implications for energy efficiency and the environment, congestion mitigation measures and public health impacts, and more fundamental social issues such as mobility desert that adversely impact accessibility and wellbeing of underserved populations. In particular, the following research projects were completed.

- Optimizing CAV platoon movements in a signalized road network for travel and energy efficiency
- Assessing the health impact of proposed congestion pricing plan for downtown San Francisco
- Design autonomous vehicle behaviors in heterogeneous traffic flow
- Improving Security and User Privacy in Learning-Based Traffic Signal Controllers (TSC)
- Modeling the Environmental Impact of Urban Air Mobility: Case Study of Tampa Bay Region
- Development of Framework for Identifying Mobility Desert *or* Identifying multi-modal deserts: a multivariate outlier detection approach

How have the results been disseminated?

Formal research related oral presentations during the period are detailed below, followed by other dissemination activities.

12-16-21 Zhang, Y., Korea Transport Institute (KOTI) Forum on Urban Air Mobility at USF: Part of the 34th U.S.-Korea Conference (UKC) on Science, Technology, and Entrepreneurship, **Advanced Air Mobility/Urban Air**, Virtual.

1-1-22 Daziano, R., 2022 TRB Annual Meeting, **On assignment to classes in latent class logit models**, Washington, D.C.

1-11-22 Daziano, R., 2022 TRB Annual Meeting, **Time slows down on a crowded train**, Washington, D.C.

- 1-22-22 Jaller, M., Amazon.com, **Sustainable Freight Transportation Systems**, Virtual.
- 2-13-22 Zhang, Y., NewYork Presbyterian Hospitals, **Evaluating Machine Learning for Implementation – Predicting Postpartum Depression**, New York, New York.
- 3-21-22 Jaller, M., Kern Council of Governments, **How the San Joaquin Valley can implement freight automation technologies to improve quality of life**, Virtual.
- 3-21-22 Jaller, M., University of Hawaii, **Resilience Assessment Framework for Last-Mile Operations Under Disruptions**, Honolulu, Hawaii.
- 3-24-22 Gao, H.O., Cornell Master of Public Health Program, **From transportation to air pollution and public health: are we doing the right thing?**, Ithaca, New York.
- 3-24-22 Gao, Daziano, R., International Steering Committee for Travel Survey Conferences, **Virtual environments for analyzing travel behavior during the COVID-19 pandemic**, Vimeiro, Portugal.
- 3-24/25-22 Zhang, Y., 7th UTC Southeast Regional Conference, **Automated Flight Planning of High-density Urban Air Mobility**, Boca Raton, Florida.
- 3-24/25-22 Zhang, Y., 7th UTC Southeast Regional Conference, **ACES Transportation – From Micro-vehicles Serving Short Trips to eVTOLs Serving Long Trips**, Boca Raton, Florida.
- 3-29-22 Zhang, Y., University of Southwestern Medical Center, **Putting the HER in the EHR** (Electronic Health Records), Virtual.
- 3-30-22 Li, S., TCU Energy Transition Symposium, **Energy Transition Strategies**, Fort Worth, Texas.

On November 2, 2021, Yu Zhang presented in the plenary session of UAS Efforts in Florida at Florida Unmanned Aerial Systems (UAS) Virtual Workshop. It was organized by FHWA, FDOT, and Florida LATP Center. The titled was Comparison of Object Detection Algorithms using Video and Thermal Images Collected from a UAS Platform: An application of drones in traffic management.

On December 8, 2021, Miguel Jaller participated in the STEPS Symposium. It is organized by the Institute of Transportation Studies at UC Davis twice a year to provide research updates to sponsors, agencies, and other communities.

On December 10, 2021, Miguel Jaller hosted a virtual panel discussion about how the San Joaquin Valley can implement freight automation technologies to improve quality of life. Five companies in the automation industry participated, Locomotion, Embark, Perrone Robotics, Boston Dynamics, and SmartPoint. The purpose was to discuss new technology developments and how they relate to potential benefits to specific communities in the San Joaquin Valley.

On December 11, 2021, Qing Lu organized and moderated a virtual webinar which invited Professor Yue Zhongqi from the University of Hong Kong to introduce challenges faced by civil engineers. It was organized by the International Association of Chinese Infrastructure Professionals. There were approximately 80 attendees, about 25% of which were from underrepresented minority groups.

On January 29, 2022, Qing Lu organized and moderated hosted another virtual webinar which invited Mr. Rui Xiao from the University of Tennessee who introduced research on alkali-activated materials. His talk was titled Analytical investigation of phase assemblages of alkali-activated materials in CaO-SiO₂-Al₂O₃ systems: The management of reaction products and designing of precursors. It was organized by the International Association of Chinese Infrastructure Professionals. There were approximately 70 attendees.

USF's Engineering 50th Annual College Expo was held February 18-19, 2022. It is dedicated to introducing, inspiring, and enriching the community in STEM related studies. Xiaopeng Li exhibited their

lab, including the smart vehicle with which they perform their CTECH experiments. Approximately 200 K-12 students participated, over 30% of which were from underrepresented minority groups.

H. Oliver Gao participated in the Barriers to Electrified Transportation Symposium on March 12, 2022. It was organized by the Cornell Energy Systems Institute, the Cornell Atkinson Center for Sustainability, and the Veho Institute for vehicle intelligence. The goal of the event was to identify critical gaps that are barriers to advancing the field of electric transportation.

What do you plan to do during the next reporting period to accomplish the goals?

No change.

2. PARTICIPATING AND COLLABORATING ORGANIZATIONS

Listed below are organizations that CTECH has partnered with during the reporting period.

Associated Asphalt	Tampa, FL	Other – materials provided for laboratory testing
Bikewalk Tompkins	Ithaca, NY	In-kind Support, Other – provided mailing list to recruit participants
Bird	Santa Monica, CA	Collaborative Research
Boeing	Seattle, WA	Financial Support
C2SMART	New York, NY	Collaborative Research
California Air Resources Board	Sacramento, CA	Collaborative Research, In-kind Support, Other - dissemination
California Department of Public Health	Sacramento, CA	Personnel Exchanges
California Department of Transportation (Caltrans)	Sacramento, CA	Financial Support, Collaborative Research, Personnel exchanges, Other – dissemination and feedback
Center for Urban Transportation Research (CUTR)	Tampa, FL	Financial Support, Facilities, Collaborative Research
Chattanooga Area Regional Transportation Authority	Chattanooga, TN	Collaborative Research
ChemCo Systems	Redwood City, CA	In-kind support, Collaborative Research
City of El Paso	El Paso, TX	In-kind Support, Facilities, Collaborative Research, Other – data source
City of El Paso Parks and Recreation Department	El Paso, TX	In-kind Support, Facilities, Other – data source, feedback
City of Ithaca	Ithaca, NY	Other – task giver, data source, feedback, potential implementer
City of St. Petersburg	St.Petersburg, FL	Collaborative Research In-kind Support, Other – feedback, potential implementer
City of Tampa	Tampa, FL	In-kind Support, Collaborative Research, Other – provide information on their green infrastructure implementation plan and policymaker advisory support
City of Temple Terrace	Tampa, FL	Other – provided stormwater GIS data for the Temple Terrace area
Columbia University	New York, NY	Collaborative Research
Cornell Atkinson Center for a Sustainable Future	Ithaca, NY	Collaborative Research
Cornell University – Transportation, Facilities, and Campus Services	Ithaca, NY	Other – task giver, data source, feedback, potential implementer
Downtown Ithaca Alliance	Ithaca, NY	Other – task giver, data source, feedback, potential implementer
El Paso Metropolitan Planning Organization	El Paso, TX	Collaborative Research

El Paso Water	El Paso, TX	Collaborative Research, Other – data source
Englander Precision Medicine Institute	New York, NY	Collaborative Research
Environmental Defense Fund (EDF)	Washington, DC	Collaborative Research, Personnel exchanges
Florida Department of Health	Tampa, FL	Other – project contributions
Florida Department of Transportation Central Office	Tallahassee, FL	In-kind Support
Florida Department of Transportation District 7	Tampa, FL	Other – project contributions
Ford Motor Company	Dearborn MI	Financial Support, Collaborative Research
Hillsborough Area Regional Transit Authority (HART)	Tampa, FL	In-kind Support, Other – data source, feedback
Hillsborough County MPO	Tampa, FL	In-kind Support, Collaborative Research
Hillsborough County Public Works Department	Tampa, FL	Other – provided GIS data and input on the modeling process
Joint Advisory Committee for improving the air quality in El Paso Sunland Park, and Ciudad Juárez	El Paso, TX	Personnel Exchanges, Other – data source, feedback, potential implementer
Kern Council of Governments	Sacramento, CA	Other – project development support and pilot testing
King County Metro	Seattle, WA	Collaborative Research
Kohn Pederson Fox Architects	New York, NY	Collaborative Research, Personnel exchanges
Lime	San Francisco, CA	Collaborative Research, Other – data sharing agreement, participant recruitment
Lyft	San Francisco, CA	Collaborative Research, Other – data sharing agreement, participant recruitment
New York City Department of Citywide Administrative Services	New York, NY	Other – data sharing agreement
New York City Department of Transportation Design Group	New York, NY	Collaborative Research
New York Metropolitan Transportation Council (NYMTC)	New York, NY	Collaborative Research, Other – data source,
NewYork-Presbyterian Hospital	New York, NY	Collaborative Research
Optimus Technologies	Pittsburgh, PA	Collaborative Research
Pinellas Suncoast Transit Authority (PSTA)	St.Petersburg, FL	Collaborative Research, In-kind Support, feedback, potential implementer
Qualtrics	Salt Lake City, UT	Collaborative Research, Other – data collection
Quantum Consultants	El Paso, TX	Collaborative Research, Other – outreach, subject matter expertise
San Francisco County Transportation Authority	San Francisco, CA	In-kind Support, Personnel Exchanges
Spin	San Francisco, CA	Collaborative Research, Other – data sharing agreement, participant recruitment
Superpedestrian	Cambridge, MA	Collaborative Research, Other – data sharing agreement, participant recruitment
Tampa Bay Area Regional Transit (TBARTA)	Tampa, FL	In-kind Support
Tampa Pavement Constructors/Lakeland Paving	Tampa, FL	In-kind Support, Other – provide aggregate samples for laboratory testing
Texas A&M Transportation Institute	College Station, TX	In-kind Support, Other – consultative

Tompkins Consolidated Area Transit (TCAT)	Ithaca, NY	support Other – task giver, data source, feedback, potential implementer
Uber	San Francisco, CA	Collaborative Research, Other – data sharing agreement, participant recruitment
U.S Green Chamber of Commerce	Solana Beach, CA	Collaborative Research
USF Water Institute	Tampa, FL	Other – data exchanges and technical support
UTEP	El Paso, TX	Financial Support, In-kind Support, Facilities
Venice Hauling	Tampa, FL	In-kind Support
Weill Cornell Medical	New York, NY	Collaborative Research
Wood PLC	Tampa, FL	Other – advice on drainage system modeling

Other collaborators or contacts with involvement in CTECH are listed or described below.

CARTEEH	College Station, TX	Partner (UTEP)
Cornell-Unibo Center for Vehicle Intelligence	New York, NY	H. Oliver Gao is Co-PI of Cornell-Unibo Center
John Swanson	The Villages, FL	Donor – Biodiesel Project

H. Oliver Gao collaborated with Shanghai Jiao of Tong University on a Cornell China Center proposal and were awarded the 2022 Joint Seed Fund Grant in support of a project titled Spatiotemporal Distributions of Traffic-related Carbon Emission in Near-road Neighborhoods: Measurements and Mitigation.

Miguel Jaller collaborated with Genevieve Guliano at USC in Los Angeles, California on a project with the South East Los Angeles community that they are studying for their current project titled Supply Chain, Mobility, and Accessibility Impacts from Precautionary and Opportunistic Buying Behaviors.

Jaller is also collaborating with Marshall Miller at UC Davis on research identifying the impacts of different technologies for trucks.

Xiaodong Qian, a post-doctoral researcher in the Sustainable Transportation Research Group at Purdue University in West Lafayette, Indiana is working with Miguel Jaller on studying the impacts of transportation and mobility options and accessibility for disadvantaged communities. Jaller is also working with Alan Jenn at UC Davis on research ideas identifying the impacts of truck routing on disadvantaged communities.

Jaller is collaborating with Carlos Paternina-Arboleda, a Professor at San Diego State University, on developing research ideas and proposals for the National Science Foundation.

Yu Zhang was approached by Rose Figueroa, Ph.D., CHFP, Managing Scientist of Explico Engineering, for possible collaborations on e-scooter safety research. They met a few times to discuss a pilot project using go-pro and other devices on e-scooters for a naturalist study.

3. OUTPUTS

Transportation is a demand-driven service that integrates supply of transportation infrastructure and satisfaction of travelers' demand/behavior. As a result, clean and healthy transportation depends on better

understanding and management of clean/healthy transportation infrastructure and travel behavior/decisions. CTECH researchers conducted studies along these two directions and generated important outputs.

Jeffrey Weidner, Alex Mayer, and Kelvin Cheu studied green transportation infrastructure in desert cities, aiming to develop a framework to identify locations where green infrastructure will maximize benefit to the transportation network as well as the community. Building off a loosely maintained list of about 100 sites where nuisance flooding occurs, as informed by citizen requests for manual water removal, an additional 300+ nuisance flooding locations were found through a combination of data collection approaches including assessment of aerial images and manually collected dash-mounted video. This data was combined into a single shapefile for geospatial analysis. Next, transportation-related data (transportation network, crash records, pavement condition) and related community health data (heat island effect) were collected and converted to shapefiles. These are performance indicators for the roadway transportation system. Each performance indicator has been normalized to a single scale and discretized. Currently, a framework to combine the performance indicators, including weighting, is being developed, and will be demonstrated in El Paso, Texas. A community-focused workshop will be conducted in Summer 2022. A senior design team has identified one location of nuisance flooding as the focus of their capstone project and will be designing a green infrastructure focused solution.

On a parallel track for better understanding travelers' demand/behavior, Kelvin Cheu and his team explored the characteristics of faculty and staff parking on university campuses. This project had two parts. Part one of this project reviewed the faculty and staff parking management at four universities: Cornell University, University of California at Davis, University of South Florida, and The University of Texas at El Paso. The spatial distributions of parking zones, types of permits and permit fees for faculty and staff were compared. Part two of this project developed a faculty and staff annual median permit fee model called the Faculty and Staff Base Price (FSBP) model using campus land-use, demographics, economic and climate data gathered from 213 universities. A faculty and staff-based price model, as a linear function of the log of the city's population, average Fall temperature, in-state tuition fee, number of employees and campus population density, has been developed using the Tobit regression technique. The proposed model is capable of recommending different prices for the same parking facility for faculty and staff. The developed model has been applied to four universities in a case study.

The first major output of this research is the summary of the characteristics of the patterns and trends of faculty and staff parking management on university campuses. The research team found two common geographical distributions of parking lots: rings and clusters. Many universities are moving towards License Plate Recognition (LPR) systems for permitting, entry and exit control, and enforcement. Other observations and policies in managing faculty and staff parking have been summarized in the project report.

From this study the characteristics of the patterns and trends of faculty and staff parking management on university campuses serves as a valuable resource for universities' parking policy makers. The estimated FSBP may be used by universities as the starting point in setting the permit prices of individual parking lots and for different types of faculty and staff permits. As a result, University parking managers now have two resources to assist them in justifying parking lot zoning, and setting annual permit prices.

Additional outcome includes:

- Yiye Zhang's Research Group is still in the development and implementation phase of their new software that will provide patients with health education materials, including information on neighborhood-level resources and infrastructure. They will be delivering these materials to an upcoming clinical trial to assess the impacts, including acceptability and satisfaction with pregnancy.

Publications

Journal publications

- 1) Pourrahmani, E., Jaller, M., Maizlish, N., Rodier, C., Health impact assessment of connected and autonomous vehicles in San Francisco, Bay Area, *Transportation Research Record: Journal of the Transportation Research Board*, 2020, Volume 2674, Pages 898-916, Pages DOI: [10.1177/0361198120942749](https://doi.org/10.1177/0361198120942749).
- 2) Baghestani, A., Tayarani, M., Allahviranloo, M., Nadafianshahamabadi, R., Kucheva, Y., Mamdoohi, A.R., Gao, H.O., New York City cordon pricing and its' impacts on disparity, transit accessibility, air quality, and health, *Case Studies on Transport Policy*, 2022, Volume 10, Issue 1, Pages 485-499, DOI: [10.1016/j.cstp.2022.01.009](https://doi.org/10.1016/j.cstp.2022.01.009).
- 3) Wang, D., Tayarani, M., He, B.Y., Gao, J., Joseph, Y., Chow, J., Gao, H.O., Ozbay, Transportation electrification for climate action goals in the post-pandemic era: an agent-based travel behavior and emission modeling approach, *Global Environmental Change*, Submitted.
- 4) Alogailo, A., Mannering, F., Differences between day and night pedestrian-injury severities: Accounting for temporal and unobserved effects in prediction, *Analytic Methods in Accident Research*, 2022, Volume 33, Page 100201, DOI: [10.1016/j.amar.2021.100201](https://doi.org/10.1016/j.amar.2021.100201).
- 5) Alnawmasi, N., Mannering, F., The impact of higher speed limits on the frequency and severity of freeway crashes: Accounting for temporal shifts and unobserved heterogeneity, *Analytic Methods in Accident Research*, 2022, Volume 34, Page 100205, DOI: [10.1016/j.amar.2021.100205](https://doi.org/10.1016/j.amar.2021.100205).
- 6) Ahmed, S.S., Alnawmasi, N., Anastasopoulos, P.C., Mannering, F., The effect of higher speed limits on crash-injury severity rates: A correlated random parameters bivariate tobit approach, *Analytic Methods in Accident Research*, 2022, Volume 34, Page 100213, DOI: [10.1016/j.amar.2022.100213](https://doi.org/10.1016/j.amar.2022.100213).
- 7) Hou, Z., Zhang, X., Zhang, H.M., A Comparative Study of Freeway Travel Times from Four Data Sources, *Transportation Research Board*, 2022, Awaiting Publication.
- 8) Alharthai, M., Lu, Q., Elnihum, A., Elmagarhe, A., Laboratory Evaluation of the Use of Florida Washed Shell in Open-Graded Asphalt Mixtures, *Materials*, 2021, Volume 14(22), Page 7060, DOI: [10.3390/ma14227060](https://doi.org/10.3390/ma14227060).
- 9) Rossetti, R., Daziano, R., How does self-assessed health status relate to preferences for cycling infrastructure? A latent class and latent variable approach, *Transportation*, 2022, Pages 1-16, DOI: [10.1007/s11116-022-10266-z](https://doi.org/10.1007/s11116-022-10266-z).
- 10) Islam M., Mannering, F., A temporal analysis of driver-injury severities in crashes involving aggressive and non-aggressive driving. *Analytic Methods in Accident Research*, 2020. Volume 27, Page 100128, DOI: [10.1016/j.amar.2020.100128](https://doi.org/10.1016/j.amar.2020.100128).
- 11) Tang, H., Zhang, Y., Mohmoodian V., Charkhgard, H., *Automated flight planning of high-density urban Air mobility*, Transportation Research Part C: Emerging Technologies, 2021, Volume 131, Page 103324, DOI: [10.1016/j.trc.2021.103324](https://doi.org/10.1016/j.trc.2021.103324).
- 12) Mahmoodian, V., Zhang, Y., Charkhgard, H., Hybrid Rebalancing with dynamic hubbing for free-floating bike sharing systems, *International Journal of Transportation Science and Technology*, 2021, In Press, DOI: [10.1016/j.ijtst.2021.08.002](https://doi.org/10.1016/j.ijtst.2021.08.002).
- 13) Guo, Y., Zhang, Y., *Understanding factors influencing shared e-scooter usage and its impact on auto mode substitution*, Transportation Research Part D: Transport and Environment, 2021, Volume 99, Page 102991, DOI: [10.1016/j.trd.2021.102991](https://doi.org/10.1016/j.trd.2021.102991).
- 14) Mahmoodian, V., Dayarian, I., Saghand, P.G., Zhang, Y., Charkhgard, H., *A Criterion Space Branch-and-Cut Algorithm for Mixed Integer Bilinear Maximum Multiplicative Programs*, INFORMS Journal on Computing, 2022, Published online in Articles in Advance, DOI: [10.1287/ijoc.2021.1097](https://doi.org/10.1287/ijoc.2021.1097).

Books or other non-periodical, one-time publications

Nothing to report.

Other publications, conference papers, and presentations

- 1) Yen, C-C., Gao, H., Zhang, H.M., Deep Reinforcement Learning Based Platooning Control for Travel Delay and Fuel Optimization, The 25th IEEE International Conference on Intelligent Transportation Systems (IEEE ITSC 2022), October 8-12, 2022, Virtual.

Policy Papers

- 1) Cole, C., Droste, M., Knittel, C.R., Li, S., Stock, J.H., Policies for Electrifying the Light-Duty Vehicle Fleet in the United States, *MIT CEEPR Working Paper Series*, 2021, <https://ceepr.mit.edu/workingpaper/policies-for-electrifying-the-light-duty-vehicle-fleet-in-the-united-states/>.

The decarbonization of the light-duty vehicle (LDV) fleet in the United States is an important policy priority for the coming decades. This paper investigated the potential for government policy to accelerate the transition of the LDV fleet to electric vehicles. The research group considered several forms of government policy: subsidized construction of charging stations, refundable tax credits for electric vehicles, and a tradable permit system for vehicle manufacturers. Their objective was to evaluate forms of these policies that are capable of achieving a target 50% sales share of zero-emissions vehicles by 2030. Their results indicated that charging station subsidies are extremely effective relative to alternative proposals, as measured by impact for a given fiscal expenditure.

- 2) Chen, P., Yang, X., Zhang, Y., Teleworking and Trip Reduction During the Coronavirus Pandemic, *Travel Behavior and Society*, Submitted.

Numerous research studies have studied the impact of the Coronavirus pandemic on travel behavior. This study further examines the rebound effect between telecommuting and trip frequency reduction, addresses mobility challenges, and transportation equity concerns among different socioeconomic groups by using large U.S. cities for empirical analysis. For method, this study corrected sampling biases with the SMOTE resampling approach and captured endogeneities among correlated dependent variables using multivariate mixed models. Results suggest (1) the level of telecommuting and trip frequency reduction greatly varies across the selected cities; (2) the rebound effect between telecommuting and trip reduction frequency no longer holds during the Coronavirus season; (3) many transportation equity issues are involved for people of different genders, ages, races, ethnicities, employment statuses, incomes, and expenditures. To promote equity and ensure the productivity of our civil society, special attention should be given to females, the elderly, people working in private sectors, and low-income households.

Website(s) or other Internet site(s)

Websites <http://ctech.cee.cornell.edu/>, <https://urbano.io/>, and <https://www.hbuddy.org/> are continuously being updated.

New methodologies, technologies, or techniques

The expansion of the battery electric vehicle (BEV) market requires considerable changes in the supply of electricity to fulfill charging demand. To this end, understanding the spatiotemporal distribution of BEV charging demand at a micro level is crucial for optimal electric vehicle supply equipment (EVSE) planning and electricity load management. The Gao Research Group developed an Agent-based Travel and Charging Behavior Model for Forecasting High-resolution Spatio-temporal Battery Electric Vehicle Charging Demand. The model integrates the activity-based BEV charging demand simulation model, which considers both realistic travel and charging behaviors and provides high-resolution spatio-temporal demand in real-world applications. Moreover, a novel charging choice model is incorporated which provides more realistic demand modeling by allowing critical non-linearities in random utility to better describe observed charging behaviors. The results of a case study for the Atlanta metropolitan area implied that work/public charging has a substantial potential market, which can comprise up to 64.5% of the total demand. Out of multiple charging modes, demand for direct-current fast charging (DCFC) is prominent at work/public locations, and it makes up the largest portion of the non-residential demand in all simulation scenarios. Moreover, charging behaviors have significant impacts on the demand distribution. Peak power demand for use of level-2 chargers is 49% to 91% higher among high-risk-sensitive users than among risk-neutral users. Users' preferences for fast charging rates can change

the DCFC demand from 36.4% of the total demand to 53.7% of the total. This study helps to qualitatively analyze the factors that figure in charging demand and their impacts on the demand distribution. The results can be directly used in EVSE planning and electricity load prediction.

Miguel Jaller's Group developed a text analytics approach using dictionary-based clustering, word counting data, and discrete regression modeling to identify the relationship between demand behaviors and supply issues affecting the supply chain resilience during the initial stages of the COVID-19 pandemic around the world.

Qing Lu's Research Group developed the design of incorporating Florida's seashell into open-graded asphalt mixture as an option to reduce the environmental impact of pavement. They determined the optimal content of seashell in mixtures of various aggregate gradations.

Inventions, patents, and/or licenses

None to report for this period.

Other products, such as data or databases, physical collections, audio or video products, application software or NetWare, analytical models, educational aids, courses or curricula, instruments, equipment, or research material

- Yiye Zhang's Research Group started a data curation of articles that can be used as health educational materials for pregnant patients. This resource includes over 300 articles on diet, exercise, and mental health. Articles were selected following a literature review process.
- Qing Lu's Research Group improved the prototype of a low-cost test device that was developed in the previous phase to measure the sound absorption of pavement specimens in the laboratory. The device can now produce measurements comparable to those from the standard device and has been used in their lab testing on asphalt mixture specimens.
- Ricardo Daziano's Research Group developed a dataset containing responses to a stated preference experiment from a panel of New York City residents (N=801) and the accompanying estimation code in R.
- Francis Vanek and his co-authors (Albright, Angenent, Ellis, and Dillard) published the fourth edition of "Energy Systems Engineering: Evaluation and Implementation, 4th edition (2021)" McGraw Hill, New York. There are two chapters on transportation, 15 and 16, Transportation Energy Technologies and Systems approach to transportation Energy, respectively.
- Miguel Jaller incorporated findings on automation and sustainability, and the impacts of new technologies on community health, as part of a course titled "Travel Demand Modeling".
- Miguel Jaller incorporated health, vulnerable community, and transportation related topics in the COSMOS program, a summer, high school student program that Jaller teaches at UC Davis.
- CTECH faculty at UTEP are advising a senior design capstone group that is attempting to design a green transportation infrastructure solution to a severe nuisance flooding location in the community.
- Qing Lu incorporated environmental and health impacts of pavement materials and design in teaching the graduate level course "Pavement Design". A transportation graduate student was the TA for the course.
- Ricardo Daziano used the dataset on how health affects cycling decisions in assignments for the course "Microeconometrics of Discrete Choice".
- Yu Zhang invited eight guest speakers from different transportation related consulting and engineering firms to deliver lectures to students in her undergraduate course, "Transportation Engineering II", during the spring of 2022. The goal was to promote understanding of the current needs and opportunities in the transportation industry.

T2 Plan Output One – Dissemination activities – number of seminars and/or webinars – goal of 8 annually.

CTECH’s “Impacts of Transportation and Urban Systems on Health and the Environment” webinar series hosted two speakers. On January 28, 2022, Jean-Daniel Saphores, Professor, Department of Civil and Environmental Engineering at UC Irvine presented a talk titled “Not Your Father’s Heavy-Duty Trucks: Electric trucks as a substitute for new road infrastructure”. Electrification of trucking combined with connected and automated technologies promises to cut the cost of freight transportation, reduce its environmental footprint, and make roads safer. If electric trucks are powerful enough to cease behaving as moving bottlenecks, they could also increase the capacity of existing roads and reduce the demand for new road infrastructure, a consequence that has so far been understudied. To explore the potential traffic impacts of replacing conventional heavy-duty drayage trucks with electric and/or connected trucks, they performed microscopic traffic simulations on a network centered on I-710, the country’s most important economic artery, between the San Pedro Bay Ports and downtown Los Angeles, in Southern California. In addition to a 2012 baseline, they analyzed twelve scenarios for the year 2035, characterized by three levels of road improvements and four types of heavy-duty port trucks (HDPT). Their results showed that 1,000 hp electric/hydrogen trucks (eTs) can be a substitute for additional road capacity in busy freight corridors. While CACC-connected conventional HDPTs would only slightly increase network speeds, replacing conventional HDPTs with eTs and improving selected I-710 ramps should be sufficient to absorb the forecast increases in drayage demand for 2035 without adding a controversial lane to I-710. Their results highlighted the importance of accounting for the traffic impacts of new vehicle technologies in infrastructure planning and suggested shifting funding from building new capacity to financing 1,000 hp electric connected trucks in freight corridors until the market for these vehicles has matured.

On February 18, 2022, Fatemeh Ranaiefar, Senior Associate at Fehr & Peers gave a talk titled “Data analytics for Warehousing Transportation Analysis”. She talked about how demand for warehouse space is hitting record highs, and how it doesn’t appear to be abating anytime soon. Demand was up 22% year-over-year in 2021. Logistics and parcel delivery are driving this growth. The 1,800 individual future tenants that participated in a study need over 600 million square feet of space” [9th annual Industrial Tenant Demand Study, published by JLL Industrial]. While all these facilities are called “industrial warehouses”, they can be very different in terms of their hours of operation, volume/type/length of truck trips generated, level of employment and impacts on the local transportation network. In recent years vacant lands and closed department store buildings in urbanized areas have been transformed into sorting facilities, last mile delivery, or fulfillment centers. These are dynamic facilities, such that their traffic patterns can change drastically as they respond to demand and requirements of the supply chain.

She discussed how we used Big Data to review the traffic patterns of a sample of these warehouses across United States from rural areas to dense urban cores, both pre and post the COVID-19 Pandemic and discussed the following questions:

- What is the transportation typography of warehouses (trip generation, trip length distribution, peak and off-peak operation)?
- How Big Data can support transportation planning for cities hosting major warehousing operation? What are the gaps in the data?
- How warehousing uses can be accounted in transportation demand and forecasting?
- What do growth and changes in warehousing operation mean for roadway design and maintenance, multimodal planning and safety, and access for trucks?

T2 Plan Output Two – Dissemination activities – number of journal and/or conference papers published – goal of 15 annually.

Twelve journal articles, one conference paper, and two policy papers were published this period. Details

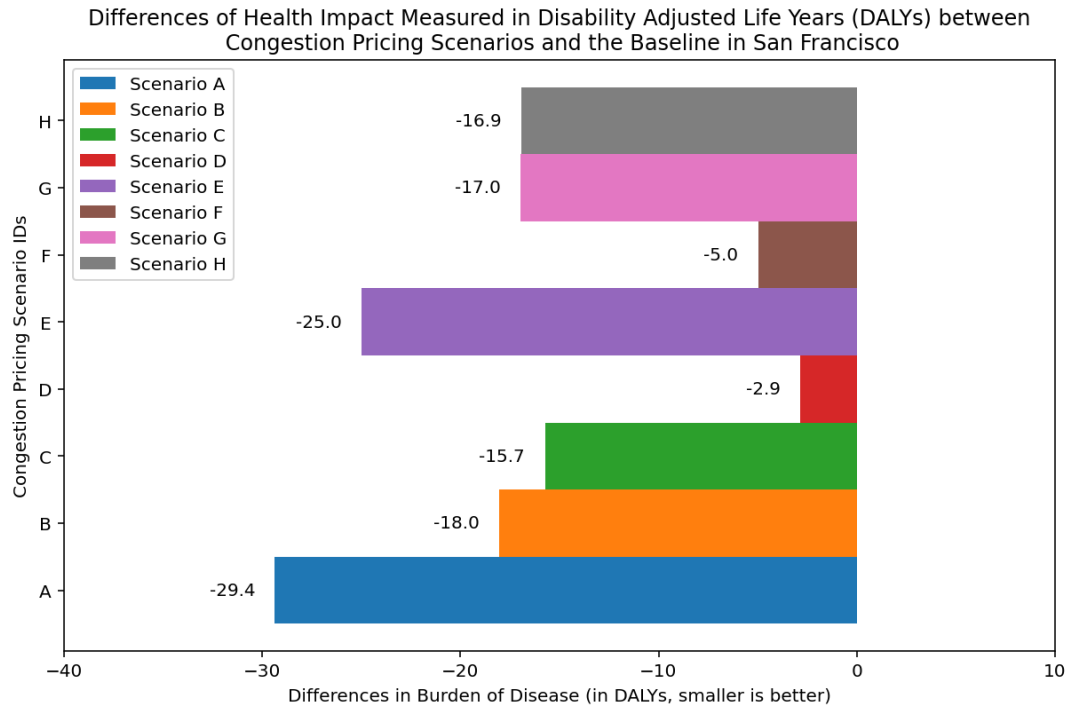
are above in section 3.

4. OUTCOMES

To mitigate the growth of traffic congestion, the San Francisco County Transportation Authority (SFCTA) plans to adopt congestion pricing in downtown San Francisco. Congestion pricing can affect individuals' mode choices, trip routes and travel times, which in turn affect vehicle emissions and an individual's exposure to them, as well as an individual's physical activities during travel. A recent study led by Professor Michael Zhang analyzes the health impacts of the proposed congestion pricing scenarios considered by SFCTA, using the trip and tour level data provided by SFCTA's travel forecasting model, and the Integrated Transport and Health Impact Modelling (ITHIM) framework. The research team compared the eight proposed congestion pricing schemes with the baseline scenario (no-congestion pricing) and analyzed the health effects from three pathways: physical activity (PA), fine inhalable particles matter (PM) exposure, and road traffic injuries (RTI) using the Integrated Transport and Health Impact Model (ITHIM). Various health effects are summarized in a single measure: Disability Adjusted Life Years (DALYs). One DALY represents the loss of the equivalent of one year of full health, and a lower DALY value indicates a health benefit.

Figure 1 shows the difference of the DALY values between the proposed congestion pricing scenarios and the baseline scenario. A negative value indicates an improvement over the baseline, and the larger the difference (a more negative value) is, the greater is the improvement. It should be pointed out that the DALY values for all scenarios are relatively small, largely due to the fact that congestion tolls are only charged during peak hours and the portion of the population affected by congestion pricing is relatively small in the study area. Comparatively, Scenarios A and E (which charge a lower fee, waive the charges to low-income travelers, and do not have additional charges for TNC trips) perform better than other scenarios. This is largely attributed to a larger reduction in vehicle miles traveled (VMT) that these two scenarios produced. In fact, examining the DALY values from the three pathways, the reductions come from mainly the air pollution exposure and traffic injury pathways, which is the result of VMT reductions.

Transportation is an important contributor to public health, but the public health dimension is often ignored in many transportation decisions. This research, through a case study, sheds lights on how congestion pricing can affect public health, and can be used to enhance the awareness of public health impacts in transportation decision making.



Scenarios A: \$5.50 bidirectional, 100% on Very Low and 50% on Low income
Scenarios B: \$8.50
Scenarios C: \$10.00, income discounts 50% on Very Low and 50% on Low
Scenarios D: \$10.50, income discounts 100% on Very Low and 50% on Low; \$10.50 for TNC trips
Scenarios E: \$12.00, income discounts 100% on Very Low and 50% on Low
Scenarios F: \$12.50, income discounts 100% on Very Low, 67% on Low and 33% on Moderate; \$12.50 for TNC trips
Scenarios G: \$12.50, income discounts 100% on Very Low and 50% on Low; resident discount 50%
Scenarios H: \$14.00, income discounts 100% on Very Low and 50% on Low; resident discount 50%; \$1.75 for bridge toll

Figure 1. Differences of Health Impact Measured in Disability Adjusted Life Years (DALYs) between Congestion Pricing Scenarios and the Baseline Scenario in San Francisco.

On technology fronts, connected autonomous vehicles (CAVs), which enable information sharing between vehicles and infrastructure with extremely low latency, facilitate the development of vehicle platooning for both freeway and urban traffic. By organizing vehicles into platoons and properly controlling their motion in the presence of traffic signals, one can potentially achieve sizable reductions in traffic delay, emissions and fuel consumption in urban traffic. Conventional platooning control algorithms, however, require complex computations that are generally time-consuming and not amenable for real-time operations. In this project led by Michael Zhang, researchers designed an innovative machine learning framework for platooning organization and control to reduce traffic delay and fuel consumption. The team developed the DRL control framework to handle four basic platoon manipulations: split, acceleration, deceleration, and no-op, and used deep reinforcement learning (DRL) to train a DRL platoon control agent. This framework (Figure 2) integrates deep learning, dueling architecture, and experience replay memory. The DRL agent learns to determine the optimal speed and size of each platoon to reduce the delay and fuel consumption by considering different arrival times of vehicles in a platoon. The developed framework is implemented in a microscopic traffic simulation software SUMO, and its performance was evaluated through a case study on a four-intersection corridor.

The experimental results show that the DRL agent can learn to organize and control CAV platoons under highly varying traffic conditions. By controlling the size of platoons and its traveling speeds with the knowledge of traffic signal control status, the DRL agent manages to reduce both traffic delay and fuel consumption substantially.

This research demonstrates the potential of CAV technology to improve mobility, energy use, and the environment, and developed AI based technologies to realize some of this potential.

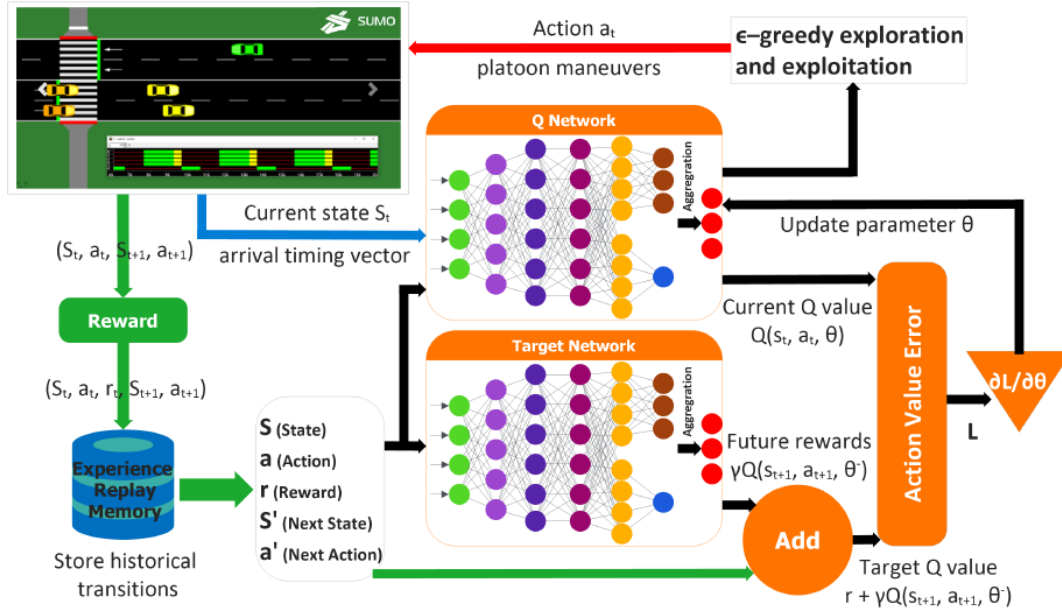


Figure 2. The proposed architecture for the DRL platoon control agent.

Additional outcomes include:

- Some of Xiaopeng Li's past CTECH research contributed to a DOE's Vehicle Technologies Office proposal that resulted in a \$3.5 million award to USF's Center for Urban Transportation Research (CUTR). The team's research will be focused on advancing the R&D necessary to decarbonize the transportation sector.
- Yiye Zhang's work with multiplate stakeholders, including clinicians, IT professionals, and hospital administrators, has increased awareness of postpartum depression and the potential to leverage IT in preventing it.
- Yiye Zhang jointly applied for an NIH R01 grant with Vanderbilt University titled "A digital and personalized support network for pregnancy loss", based on preliminary work developed under a prior CTECH project.
- Yiye Zhang submitted one, and is in the process of submitting a second, NIGH R01 grant application with the University of Washington; both are based on postpartum depression prediction and funded by the USDOT through CTECH.
- Qing Lu's Research Group's laboratory testing has been performed to evaluate the feasibility of using epoxy asphalt in reclaimed asphalt pavement (RAP) materials to improve the performance of old pavement materials. Current results showed that the moisture sensitivity of RAP materials can be improved by epoxy asphalt. Further testing is planned to evaluate other mechanical properties of RAP materials with epoxy asphalt.

- Laboratory testing has also been performed in Lu's Group to evaluate the effect of incorporating recycled concrete aggregate into porous asphalt mixtures in terms of Marshall stability, permeability, tensile strength, and surface texture. The current finding is that it is feasible to replace 10 percent virgin aggregate with recycled concrete aggregate in porous asphalt mixtures. Further evaluation on other replacement rate and other mechanical properties is planned for the next phase.

T2 Plan Outcome One – Cited works - Number of reports in media – goal of 8 annually.

How to reach 50 percent zero-emission vehicles, by Christopher R. Knittel, Jim Stock, and CTECH's Shnajun Li, September 1, 2021 in *The Hill*.

<https://thehill.com/opinion/energy-environment/570384-how-to-reach-50-percent-zero-emission-vehicles/>

Orlando Business Journal interviewed Yu Zhang on Wireless Charging Technologies and Adaptation for Electric Vehicles on March 25, 2022.

Sarasota Herald-Tribune interviewed Yu Zhang on Sharing Micromobility on March 25, 2022.

T2 Plan Outcome Two – Cited works – Number of citations/requests of reports, papers, and research briefs – goal of 100 annually.

Three papers published as a result of CTECH research, co-authored by Fred Mannering are now Web-of-Science Highly Cited Papers. Citations that place them in the top 1% by citations for field and year in Web-of-Science. That indicates these articles are influencing methodological advancements in the transportation field.

Islam M., Mannering, F., A temporal analysis of driver-injury severities in crashes involving aggressive and non-aggressive driving. *Analytic Methods in Accident Research*, 2020. Volume 27, Page 100128, DOI: <https://doi.org/10.1016/j.amar.2020.100128>.

Behnood, A., Mannering, F., Time-of-day variations and temporal instability of factors affecting injury severities in large-truck crashes. *Analytic Methods in Accident Research*, 2019, Volume 23, Page 100102, DOI: [10.1016/j.amar.2019.100102](https://doi.org/10.1016/j.amar.2019.100102).

Menon, N., Barbour, N., Zhang, Y., Pinjari, A., Mannering, F., Shared autonomous vehicles and their potential impacts on household vehicle ownership: An exploratory empirical assessment. *International Journal of Sustainable Transportation*, 2019, Volume 13(2), Pages 111-122, DOI: [10.1080/15568318.2018.1443178](https://doi.org/10.1080/15568318.2018.1443178).

5. IMPACTS

One key challenge faced by transportation agencies is transit system operation and management, particularly public transit amid post-peak and post-epidemic periods. It is a double-edged sword: on one hand, it provides basic and low-cost mobility services to those not owning cars or who place environmental concerns at the center of commuting decisions; on the other hand, human mobility, especially commuting by mass transit, contributes to the spatial propagation of infectious diseases. Policy-makers face this health-and-economic trade-off when lifting the restrictions and restarting public transit systems during the unprecedented COVID-19 pandemic. While the potential risk of epidemic exposure inside subway carriages or buses has been well-recognized, there is a lack of scientific knowledge and methods for the corresponding prevention strategies. Samitha Samaranayake led a cross-institution team on a project titled “Managing public transit during a pandemic: the trade-off between

safety and mobility”. It aimed to answer a critical question frequently raised by transportation agencies and researchers: How to control traffic flows in public transit networks to improve safety and preparedness during periods of spreading infection?

The team first modeled the spread and mitigation of a particular epidemic disease through public transit networks using a metapopulation compartmental model. The risk of disease transmission associated with public transit depends on the characteristics of the disease and the intervention policies implemented across the entire environment being modeled. In particular, they focus on movements between residences and work locations and propose a mathematical-programming-based approach for designing targeted public transit policies, with the intent of minimizing the public health risk while maximizing mobility in the context of dynamically evolving epidemics. Their results show that by applying targeted interventions on high-risk transit routes and regions, most inelastic travel demand can be satisfied while the spatial propagation of the infectious disease is restrained.

The main contributions of this work were:

1. The development of an optimization-based analysis by integrating the spatial epidemic model and the commute network model.
2. Providing a forward-backward iterative method to solve the large-scale transit traffic control policies and obtain insight for effective interventions.
3. Investigating the optimal subway route operations plans in Manhattan, New York City (NYC) and evaluating the impact on COVID-19 pandemic transmission.

A case study based on the COVID-19 pandemic reveals that a well-planned subway system in New York City can sustain 88% of transit flow while reducing the risk of disease transmission by 50% relative to fully-loaded public transit systems. The method developed in this work can be applied to any infectious disease that can be potentially transmitted through public transit services, e.g., risk of aerosol and contact transmissions inside vehicles. The spatial epidemic model on the commute networks captures the influence of two most commonly implemented regulations: quarantine policies (population with severe symptoms is forced to stay at home) and social-distancing policies on public transit. This CTECH work is one of the first attempts to investigate the transit traffic control policies with monitoring feedback considering the combined effects of repetitive commuting patterns and epidemic dynamics. The model developed in this work requires access to only publicly-available data and thus can be easily adopted by local transportation agencies to make data-driven responsiveness and preparedness plans. Therefore, the model is suitable for facilitating the healthcare measures to contain infectious diseases.

Additional impact includes:

- The modeling group at NYMTC continues to use the web-based emissions post-processing software, CU-PPS, developed by the Gao Research Group, for their transportation conformity analysis, improving service to approximately 12 million residents in the region. It has also helped transportation planning in NYC, resulting in cleaner air and healthier communities.

T2 Plan Impact One – Impact on practice –Number of research recommendations implemented – goal of 7 annually.

Amy Stuart’s Research Group at USF is currently working with the Hillsborough County Transportation Planning Organization and the Environmental Protection Commission on a project to install low-cost air quality monitors in historically marginalized neighborhoods near the I-275/I-4 corridor, in order to improve transportation decision making and air pollution exposure equity. This work resulted in part from Stuart’s CTECH projects, Impacts of Transit-Oriented Compact-Growth on Air Pollutant Concentrations and Exposures in the Tampa Region and Air pollution and equity impacts of the proposed Tampa Bay Next program from a Health in all Policies perspective.

T2 Plan Impact Two –Software applications – Number of algorithms, codes, software used by researchers – goal of 7 annually.

H.M. Zhang’s optimal platoon control algorithm for connected autonomous vehicles was used by the Dexin Huan School of Traffic and Transportation Central South University.

Yiye Zhang’s risk prediction tool for postpartum depression using electronic health records is being used at Reliable Health and by researchers at Stanford University.

6. CHANGES/PROBLEMS

COVID-19 related issues appear to be less of an issue. Virtual interactions with students, collaborators, and external partners still continue to be less effective and less than ideal in many cases. Online surveys were adopted to collect desired data when in-lab experiments were not possible. Delays, reduced productivity, impacts on students’ well-being, especially mental health, were all reported as issues in this period.

CTECH has selected a current project that addresses mobility challenges faced by the public during the pandemic. It hopes to promote mobility equity and ensures the productivity of our civil society. It calls for special attention to females, the elderly, and low-income households. For methodology, this project jointly applies advanced statistical models and machine learning algorithms to provide scientific evidence to support related claims. It captures dynamic changes over time. For theories, this project examines the validity regarding the rebound effect between telecommuting and trip frequency during the pandemic and envisions the future of public transportation under the new normal.

Specifically, researchers working on this project are addressing the following questions:

- (1) What is the relationship between telecommuting and trip frequency during the Coronavirus pandemic?
- (2) What is the long-term impact of COVID-19 on transit?
- (3) What is the relationship between mobility-related indicators and health outcomes?
- (4) What is the effect of COVID-19-related policy measures on mobility?

The coronavirus pandemic has had widespread effects on individuals, families, and communities throughout the world. The pandemic has changed the way everyone works, but the public discussion mainly revolves around the role of technology and the fascinating "work from home". Not all Americans can choose to telework. Many females, especially females of color, are critical workers and are incapable of teleworking. How the quality of life is impacted and how much the mobility has been challenged remain unclear.

7. SPECIAL REPORTING REQUIREMENTS

CTECH Specific Metric: Overarching goals of the Center include the development of a metric for community health that incorporates mobility and health indicators; mobility on-demand models including environmental sustainability indicators; large-scale models to promote environmental sustainability, community health, and environmental justice. For example, emerging urban air mobility (UAM) is anticipated to use electric vertical take-off and landing (eVTOL) vehicles to transport passengers and goods in low altitude urban airspace. A previous CTECH research study done by Yu Zhang and co-authors determined optimal placement of vertiports and estimated diverted demand from ground transportation modes by integrating network design and travel mode choice models. To answer questions concerned by local communities in embracing this emerging advanced air mobility (AAM), the same team went on to propose an integrated modeling framework to evaluate the environmental impacts of

UAM and use the same case, Tampa Bay Region. The air pollutant emissions analyzed in this study include greenhouse gases (CO₂, N₂O, CH₄) and other air pollutants (NO_x, SO₂, PM_{2.5}). The outcomes from the Tampa Bay Region case study reveal that for serving diverted trips, on-demand UAM (including vertiport access and egress) generates more air pollutant emissions compared to ground transportation modes. Sensitivity analysis shows that the emission differences heavily depend on the resource mix of electricity production. It also shows that lower UAM service price and more vertiports will attract more demand and lead to higher emissions.

The outcomes of this project advanced the knowledge of environmental impacts of emerging Urban Air Mobility. More importantly, by applying the integrated network design and travel mode choice modeling developed in the noted previous study, this project delivered a research framework for performing environmental impact analysis for this emerging transportation model, which could be applied for other case study regions. A key challenge of AAM is community integration. Although the benefits of AAM have been advocated by eVTOL manufacturers and potential UAM service operators, the outcomes of this project let stakeholders see the other side of the picture and improve their awareness of the emerging transportation mode.