USDOT NATIONAL CENTER FOR UNDERSTANDING FUTURE
TRAVEL BEHAVIOR AND DEMAND

Semi-Annual Progress Report for University Transportation Centers

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1. ACCOMPLISHMENTS

The mission of TBD National Center is to revolutionize the understanding and management of travel behavior and demand through pioneering research and education, fostering a sustainable, efficient, and inclusive transportation system that effectively serves and adapts to the evolving needs of everyone. Led by The University of Texas at Austin and in partnership with Arizona State University, California State Polytechnic University – Pomona, Diné College, Georgia Institute of Technology, The City College of New York, University of Michigan, and University of Washington, the TBD Consortium is committed to serving all communities and the entirety of the US economy through the safe, efficient, accessible, equitable, and sustainable movement of people and goods.

What are the major goals of the program?

The TBD's overarching goal is to undertake breakthrough research that will fundamentally re-examine and transform the scientific base for measuring, monitoring, modeling, and managing traveler behaviors to foster the design, development, and operation of a people-centric, multimodal, intelligent transportation system that meets the needs of the people, institutions, and businesses for generations to come. The TBD initiative aligns with the USDOT strategic goal of transformation and anticipates significant contributions to equity and climate and sustainability goals. Among its multitude of activities, the Center aims to undertake two flagship endeavors of national significance to bring about transformative impacts in planning and decision-making. The first is a *travel behavior data (TBD) hub* that the public, transportation planners, and policy-makers alike can leverage to understand the state of the transportation system, with built-in *quality of life/well-being, energy footprint, and mobility poverty calculators* to aid in planning for equity, sustainability, and community well-being. The second is a panel-based multi-year *Transportation Heartbeat of America Travel Behavior and Demand Survey, including a survey of individuals, businesses, and employers*, to understand how travel behavior and demand are evolving, which will provide critical insights into the future of transportation and the priorities of the nation.

What was accomplished under these goals?

Center-Wide Accomplishments

The past six months have been another productive and successful one for the TBD center, with multiple research projects continuing and three projects being completed. Many of the research projects have resulted in submissions for presentation consideration at the 2025 Transportation Research Board (TRB) Meeting, at the 2025 American Society of Civil Engineers' International Conference on Transportation and Development (ICTD), and the 2025 International Scientific Committee on Transportation Survey Conference (ISTSC). The TBD team has also made substantial progress on the two flagship endeavors. These and other center-wide highlights are discussed below:

- As part of the TBD Hub, a data dashboard based on the American Time Use Survey (ATUS) data was developed in partnership with TOMNET UTC. The dashboard, called the Time Use, Travel, and Telework Dashboard (T3D), was launched on May 27, 2024, and has attracted nearly 2,000 unique users in this short period. T3D is the first dashboard to be incorporated into the TBD Hub. Developed by the ASU team, T3D is an important open-source, web-based data dashboard that democratizes access to ATUS, putting this valuable data at the fingertips of a broad spectrum of users, including policymakers, planners, researchers, and the public. The dashboard holds immense value for a wide range of disciplines, including transportation and urban planning, economics, and public policy. T3D has garnered significant attention, with multiple agencies contacting the study team to learn more about the T3D and the TBD Hub. The project PI (Batur) has been invited to introduce the T3D at the US DOT Future of Transportation Summit and the Southeast Florida FSUTMS Users Group Meeting.
- The Transportation Heartbeat of America TBD Survey instrument was developed based on multiple rounds of discussions among TBD university researchers, and multiple rounds of pre-testing and testing. For survey administration, quotas were developed for responses from different socioeconomic groups. Several rounds of discussions with Qualtrics resulted in the development of a contract for 7,500 responses from individuals from across the United States.

- The TBD website has been populated with new content, including the T3D dashboard. The site attracted over 2,000 visitors during the current reporting period.
- The Austin Symposium on "Back to the Foundations of Travel Demand" was followed up with a proposal for a virtual special issue (VSI) in the Journal of Transport Policy and received approval. Papers, including resource papers (modified based on the discussions at the Symposium), have been received and are in the review process. The emphasis is on papers that focus on revisiting and rethinking the foundations of our travel demand models, and how those foundations may be brought together to inform future policy analyses. Planning professionals and decision-makers are increasingly interested in shaping, not just forecasting, demand. Understanding the shifting travel behaviors and demand is critical for informed transport policy-making.

Some other overall accomplishments of the TBD Center in this reporting period are listed below:

Selected TBD Awards and Honors:

- TBD Director Dr. Bhat received the 2023-2024 Joe J. King Professional Engineering Achievement Award from the Cockrell School of Engineering at UT Austin. The award recognizes "a faculty member who has made significant contributions in furthering the profession of engineering."
- TBD PhD student Kyle Bathgate won a FHWA Dwight D. Eisenhower Graduate Fellowship.
- TBD PhD student Katherine Asmussen received an honorable mention for best paper presented at the International Choice Modeling Conference (ICMC) held in Puerto Varas, Chile, in April 2024.
- TBD researcher Qing Shen received the Outstanding Educator Award from PacTrans.
- TBD Associate Director Dr. Conway was promoted to the rank of Full Professor at the City College of New York. Dr. Conway was also invited to serve as the Chair of the TRB's Data Section.
- TBD Associate Director Dr. Mokhtarian gave two keynote speeches on the insidious problem of selection biases: first, at the 12th Symposium of the European Association for Research in Transportation (hEART 2024) on June 20, 2024, at Aalto University in Espoo, Finland, and second, at the 2nd Symposium on Cities and Sustainable Transportation held on July 3, 2024, at Chang'an University, Xi'an, China.
- TBD researcher, Srinivas Peeta, provided a plenary talk entitled "Implications of Stop-and-Go Traffic on Training Learning-Based Car-Following Control," at the 25th International Symposium on Transportation and Traffic Theory, Ann Arbor, Michigan, July 2024; he also was invited as a Distinguished Speaker at the NGTS Seminar Series at University of Michigan in April 2024.
- TBD Associate Director Dr. Chen provided a keynote address at the 2024 International Conference on Resilient Systems (ICRS) in Singapore, in August 2024.
- TBD researcher Qing Shen made a Keynote address at a 2024 Symposium on *Planning Frontiers for Urban Sustainability* at Tongji University, Shanghai, July 2024.
- TBD Director Dr. Bhat served as a keynote panelist for a fireside chat in the Inaugural Mobility Summit: Mobility in a Digital World, Mobility and Intelligent Transportation (MInT) Collaborative, IIT Madras, India, April 2024. Dr. Bhat also delivered a distinguished lecture as part of the Boyer Invited Seminar Series of the Department of Civil & Environmental Engineering, University of Massachusetts Amherst, Amherst, MA, in April 2024. He also made a keynote address at the *17th International Conference on Travel Behaviour Research* in Vienna, Austria, in July 2024.

Selected TBD Media Interviews and Blogs:

- TBD researchers have provided multiple interviews during this reporting period. Andrew Maynard has been featured in interviews on 12 News and NBC News discussing the challenges and developments in autonomous vehicle (AV) technology. His discussions analyze the behavior of 'hesitant' and 'confused' AVs, address safety perceptions following multiple incidents involving Waymo vehicles, provide commentary on Waymo's investigation in Arizona, the recall of 600 self-driving cars, and a live test ride in a driverless taxi. His insights provide a critical perspective on the evolving landscape of autonomous transportation. Similarly, Srinivas Peeta has been featured in several interviews regarding the introduction of AVs in Atlanta. His commentary covers the rollout and public reception

of Waymo's vehicles on WSB TV 2, Atlanta's readiness for autonomous driving as featured on CBS News, and the broader impact and testing of these technologies, which was discussed on Fox 5 News.

- TBD Director Dr. Bhat has actively participated in media discussions about the application of Artificial Intelligence (AI) and historic equity in road building. He discussed AI's role in education and research on Spectrum News, explored the historical impact of the I-35 expansion in Austin on KXAN, and addressed ethics and bias in surveillance technology on the Generation AI Podcast.
- A new TBD study was recently published in Transportation Research Part D, focusing on understanding the impact of extreme heat on daily activity-travel and time use patterns. Led by TBD Assistant Director Dr. Batur and TBD Associate Director Dr. Pendyala, this important study is one of the first of its kind and offers valuable insights into future transportation planning as the frequency and intensity of extreme heat events increase due to climate change. The study has garnered significant media attention: Prevention Web, Earth.com, The Weather Channel, Science Daily, Phys.org, India Today, ASU News, and Mirage News, highlighting the broad interest and relevance of the study.

Workforce Development/Technology Transfer Events

- In April, the WTS-LA Transportation YOU Committee and the Cal Poly Pomona WTS-CPP Student Chapter, advised by Prof. Yongping Zhang, co-hosted the 2nd Girl's Empowerment Day at Cal Poly Pomona. This event drew nearly 90 high school girls and focused on encouraging them to pursue careers in Science, Technology, Engineering, Arts, and Math (STEAM), including transportation careers.
- In the summer, TBD Associate Director Dr. Shaw's research lab participated in the Community College Summer Fellowship Program at UMich and mentored an undergraduate engineering student from a local community college. Dr. Shaw also collaborated with UMich's Center for Socially Engaged Design to co-develop an active learning workshop on the Detroit I-375 Highway Reclamation Effort.
- The TBD team, led by Dr. Bhat, co-organized a national-level workshop for young transportation faculty members in June 2024, before the 2024 ICTD Conference in Atlanta. Sponsored by ASCE T&DI, Early Academia Career (EAC) Workshop Series, the "Getting into Research" workshop included panels on improving research writing, managing students, and funding research programs.
- The TBD team organized a Short Course on Multivariate and Multiple Discrete-Continuous Choice Modeling Methods at Georgia Tech in May 2024. This short course drew graduate students from around the country and exposed them to the latest cutting edge choice analysis techniques.
- TBD Assistant Director Dr. Irfan Batur provided a seminar/webinar entitled "T3D: A Comprehensive Data Dashboard for Time, Travel, and Telework" on July 23, 2024 (number of participations ~ 40).
- TBD hosted a seminar by Dr. Jordan Srour from the Lebanese American University on July 22, titled "Driver Behavior to Ancient Egypt: A Story of Machine Learning" (number of participants ~30).

Project-Specific Accomplishments

During this reporting period, TBD researchers made significant progress on various projects. Three projects initiated last year were completed, while others have progressed into subsequent phases. Final reports for the completed projects have been distributed per USDOT guidelines. A comprehensive list of all 24 TBD projects, including their active periods, is presented in Table 1. Additionally, the TBD website has been fully updated to provide information and deliverables for these research projects.

Table 1. TBD Research Projects

Project Topic/Title		Institution (PI)	Active Period	Status
1*	Travel Behavior Data (TBD) Hub	Multi-Institution (Bhat)	2023 - Present	
2*	Transportation Heartbeat of America Travel Behavior and Demand Survey	Multi-Institution (Bhat)	2023 - Present	
3	City-Wide Strategic EV Charging Network Design: Demand-Supply Integration via Market Dynamics	ASU (Zhou)	2023 - Present	
4	Future Travel Foresight Catalyst: A Unique Approach to Exploring the Intersection of Transformative Technologies and Future Travel Behavior and Demand	ASU (Maynard)	2023 - Present	

Project Topic/Title		Institution (PI)	Active Period	Status
5*	Exploring the Changing Dynamics of Household Vehicle Ownership and Use in the U.S.	ASU (Batur)	2023 - Present	⚙
6	Trends in Time, Travel, Transit, Telework, and Treasure (T5)	ASU (Polzin)	2023 - Present	⚙
7	Measuring the Impact of Transformative Transportation Technologies on Local Government Revenues Linked to Transportation Infrastructure	ASU (Swindell)	2023 - Present	⚙
8	Analysis of Changes in the Activity Prisms of Individuals to Predict a Shared Life Experience Metric Over Different Regions and Sociodemographic Groups	CCNY (Allahviranloo)	2024 - Present	⚙
9	Measuring the Last-Mile: A Comprehensive Evaluation of Synthesis Approaches to Address Data Gaps for Local Freight Decision-Making (Phase 1)	CCNY (Conway)	2023 - Present	⚙
10*	The Effects of Changing Commutes on Home Delivery Activity	CCNY (Conway)	2023 - Present	⚙
11*	Deep Learning with LiDAR Point Cloud Data for Automatic Roadway Health Monitoring	CPP (Zhang)	2023 - Present	⚙
12	A Pilot Experimental Project for Predicting Pedestrian Flows Using Computer Vision and Deep Learning	GT (Guhathakurta)	2024 - Present	⚙
13*	How Effective Are Marker Variables at Predicting Attitudinal Factor Scores? An Out-of-Sample Evaluation	GT (Mokhtarian)	2023 - 2024	✓
14	Promoting Sustainable Travel within Communities through Behavioral Interventions and Emerging Mobility Solutions	GT (Peeta)	2023 - Present	⚙
15*	Investigating Travel Survey Representativeness: Who's missing and what can we do?	UM (Shaw)	2024 - Present	⚙
16*	Telemedicine Adoption Before, During, and After COVID-19: The Role of Socioeconomic and Built Environment Variables	UT (Bhat)	2023 - 2024	✓
17	Teleworking to Play or Playing to Telework? A Latent Segmentation Approach to Exploring the Relationship Between Telework and Nonwork Travel	UT (Bhat)	2023 - 2024	✓
18	Enhanced Network Models for Multimodal Resiliency	UT (Boyles)	2023 - Present	⚙
19	Identifying Travel Needs, Barriers, and Solutions	UT (Karner)	2023 - Present	⚙
20	Identifying Targets for Electric Vehicle Industry Improvement	UT (Machemehl)	2023 - Present	⚙
21	A Dynamic Analysis of the Built Environment-Travel Behavior Relationship Using Three Activity-Travel Surveys in the Austin, Texas Region	UT (Zhang)	2023 - Present	⚙
22*	The Effect of Urban Infrastructure Change on Movement	UW (Chen)	2023 - Present	⚙
23	A Pilot Study to Integrate Mobility Data Collection APPs with Personalized Recommendation Systems	UW (Huang)	2023 - Present	⚙
24	The Differential Accessibility Effects of Work from Home: Travel Behavior Outcomes and Transportation Equity Implications	UW (Shen)	2024 - Present	⚙

ASU = Arizona State University; CCNY = The City College of New York; CPP = California State Polytechnic University – Pomona; GT = Georgia Institute of Technology; UM = University of Michigan; UT = The University of Texas at Austin; UW = University of Washington. ✓ = Completed; ⚙ = In progress; * = Narrative provided below.

A few illustrative details about the progress made for a sample of active projects or projects completed within this reporting period are provided below.

Project #1: Travel Behavior Data (TBD) Hub
PI: Chandra Bhat (UT) **Co-PIs:** Irfan Batur (ASU), Ram Pendyala (ASU)

Progress: Serving as one of the two TBD flagship endeavors, this project aims to develop a comprehensive Travel Behavior Data (TBD) Hub that brings a variety of data sets into a single unified platform for instant data-driven insights on travel behavior and demand. Examples of the datasets that the Hub will bring together include, but are not limited to, the American Community Survey (ACS), National Household Travel Survey (NHTS), American Time Use Survey (ATUS), Consumer Expenditure Survey (CES), Commodity Flow Survey (CFS), and Vehicle Inventory and Use Survey (VIUS). The team will harness the latest techniques in data aggregation, data fusion and integration, data imputation and weighting, data prediction, and data visualization to build a national TBD hub that the public, planners, and policy-makers alike can leverage to understand the state of the transportation system. The Hub is planned to be built

through a multi-year, multi-university effort that spans multiple disciplines and thrust areas. During this reporting period, a data dashboard based on ATUS data was developed in partnership with TOMNET UTC. The dashboard, called the Time Use, Travel, and Telework Dashboard (T3D), was launched on May 27, 2024, and has attracted nearly 2,000 unique users in this short period. T3D is the first dashboard to be incorporated into the TBD Hub. In the next reporting period, work will begin on developing another ATUS-based dashboard, the TBD Mobility Dashboard, which will offer a comprehensive view of travel episodes from ATUS, focusing on aspects such as travel mode, trip purpose, trip chaining, and zero trip-making.

Project #2: Transportation Heartbeat of America Travel Behavior and Demand ("THA") Survey
PI: Chandra Bhat (UT) **Co-PIs:** Irfan Batur (ASU), Ram Pendyala (ASU), Patricia Mokhtarian (GA Tech), Atiyya Shaw (UMichigan), Steven Polzin (ASU), Alison Conway (CCNY), Cynthia Chen (UW)

Progress: Serving as one of the two TBD flagship endeavors, TBD endeavors to deploy a comprehensive longitudinal travel behavior and demand survey across the nation for five years to obtain a statistically representative depiction of attitudes, values, choices, socioeconomics, demographics, well-being, mobility, and accessibility. To assess rapidly changing travel conditions and behaviors, the "THA" survey employs a combination of panel and cross-sectional methods. This combination will track, for a subset of sampled individuals/households, attitudes and behaviors across multiple waves of data collection (the "panel" component), as well as incorporate fresh individuals/households in each subsequent wave (the "cross-sectional component). Uniquely, it will also include a component that tracks the "pulse" of U.S. businesses and employers with regard to employer-provided transportation benefits, work-from-home options offered to employees, and the use of e-commerce and delivery platforms to reach customers. During the current reporting period, the survey instrument was developed for the individual-level survey component, and data collection for the first wave was initiated (to reach 7,500 respondents). In the next reporting period, work will begin on developing the business and employer portion of the survey, and subsequent waves of each component will be distributed during the fall of each subsequent year until 2027.

Project #5: Exploring the Changing Dynamics of Household Vehicle Ownership and Use in the U.S.
PI: Ram Pendyala (ASU) **Co-PI:** Irfan Batur (ASU)

Progress: This project aims to design and deploy a comprehensive nationwide survey, called the National Vehicle Survey (NVS), to collect data on vehicle ownership, use, and preferences in the context of societal and environmental changes as well as related changes in household energy use. The major contributions of the project are the following: 1) a nationwide dataset including data on travel behavior, household characteristics, vehicle ownership/transactions and use, mobility patterns as well as attitudes, perceptions, preferences, and lifestyles, made available to other researchers; 2) enhanced understanding of key barriers and drivers of electric vehicle adoption in distinct population segments; 3) a basis for new policies and programs and improvements to existing policies and programs to enable an equitable transition to sustainable mobility across heterogeneous population segments throughout the country. In this reporting period, the team finalized the survey instrument and began working on the IRB protocol to obtain IRB approval. Additionally, the team contacted three different vendors to request quotes for respondent recruitment. In the next reporting period, the team hopes to receive IRB approval, complete the vendor selection process, and deploy the survey to collect this nationwide data set.

Project #10: The Effects of Changing Commutes on Home Delivery Activity
PI: Alison Conway (CCNY) **Co-PIs:** Yana Kucheva (CCNY)

Progress: The goal of this project is to investigate the relationship between work-related travel activity and propensity for home delivery to better understand the implications of teleworking for local delivery activity in residential areas. The study aims to jointly explore personal travel behavior patterns and shopping patterns for several specific categories of goods (e.g., groceries, prepared food, and parcels). During this reporting period, an initial dataset was constructed from the 2022 NYC DOT Citywide Mobility Survey, and binary logit models were estimated to evaluate the relationship between teleworking and online

shopping and three different types of delivery activity. A paper detailing these results was submitted and accepted for presentation at the 2025 TRB Annual Meeting. An abstract was also submitted and accepted for presentation at the Metrans International Urban Freight Conference (I-NUF) in April 2025. In the next reporting period, the team will construct a new weekly dataset to evaluate the same relationship while better controlling for time-lag between shopping and delivery and incorporating some additional time-use variables. The team expects to complete this new analysis in the next reporting period.

Project #11: Deep Learning with LiDAR Point Cloud Data for Automatic Roadway Health Monitoring
PI: Yongping Zhang (CPP) **Co-PIs:** Wen Cheng (CPP), Hao Ji (CPP), Omar Mora (CPP)

Progress: The primary goal of this research is to explore the effectiveness of various deep learning-based approaches utilizing point cloud data for automating the monitoring and assessment of roadway health. We conducted investigations into methods for 3D object detection of traffic signs and 3D point cloud extraction of road potholes. We aim to develop an approach for detecting traffic signs and potholes to support the automatic evaluation of roadway conditions. In this reporting period, we designed a dataset annotated with 2D/3D bounding boxes of traffic signs to train deep learning models, developed a reprojection-loss network along with a geometric-aware refinement technique to improve the detection accuracy of 3D bounding boxes for traffic sign symbols, and designed a cost-effective method of extracting 3D point clouds of road potholes from monocular video captured in real-world settings. We also developed a novel method for accurate 3D detection of traffic signs using image-based depth estimation, supporting the automatic generation of 3D annotations in object detection tasks. This work is accepted for presentation at the 2025 TRB Annual Meeting. In the next reporting period, we will continue refining our pipeline for traffic sign and pothole detection, aiming to enhance their accuracy and efficiency in roadway condition assessments.

Project #13: How Effective Are Marker Variables at Predicting Attitudinal Factor Scores? An Out-of-Sample Evaluation | **PI:** Patricia Mokhtarian (GT)

Progress: This project is one in a series of studies designed to investigate the practicality of including attitudes as explanatory variables in practice-oriented travel demand forecasting models. The study respectively applied random forest (RF) and elastic net regression (ENR) to 15 marker variables (MVs), to predict factor scores on four attitudes. We incorporated those four imputed attitudes into multinomial logit vehicle ownership (VO) models and compared the results to those of models including the original four-factor scores, models containing only the four MVs most strongly associated with the same four attitudes, and models containing no attitudes. We created 1,000 random splits of a sample of 3,178 responses to a 2017 survey of Georgia adults, training the RF and ENR functions on each donor half-sample and applying those functions to the recipient half-sample. We reported results averaged over the 1,000 recipient half-samples. In the VO models, estimated coefficients for all sets of attitudes were by far most often both statistically significant and with the expected sign. More importantly, the predictive power of the models markedly improved specifically for zero-car households whenever the attitudes were included. Using only MVs themselves gave results nearly as good as those associated with the more elaborate prediction of factor scores using machine learning methods. The final report was submitted during this reporting period, and a paper based on this report is currently undergoing peer review at a major transportation journal.

Project #15: Investigating Travel Survey Representativeness: Who's Missing and What Can We Do?
PI: Atiyya Shaw (UM)

Progress: This project was conducted in collaboration with the Southeast Michigan Council of Governments, the Michigan Department of Transportation (MDOT), and the University of Michigan Graham Sustainability Institute. The goals of this effort centered on the investigation of travel survey biases and representativeness for household travel surveys. During this reporting period, significant progress was made in establishing connections with several MPOs (MTC, Met Council, PSRC, and SEMCOG), and in identifying actionable insights that MPOs and researchers can utilize for addressing data quality concerns through both the sampling and post-processing stages of the survey implementation process. The research

team has shared insights with all involved participants through information sharing sessions and received very positive feedback and useful practice-oriented insights on progress thus far.

Project #16: Telemedicine Adoption Before, During, and After COVID-19: The Role of Socioeconomic and Built Environment Variables | **PI: Chandra Bhat** (UT)

Telemedicine, also referred to as telehealth, is the practice of using information-communication technology (ICT) to receive medical care or advice remotely from clinicians, either in real-time or asynchronously. In this study, using multivariate econometric models, we identify determinants of telemedicine use in the "after-COVID" period. In addition to investigating telemedicine adoption tendencies, we investigate the underlying reasons for both adopting and not adopting telemedicine in the after-COVID period. The primary data used in this study is obtained from the COVID Future Survey administered to a stratified random sample of households across the U.S. during the period spanning from October to November of 2021. The results contribute significantly to our understanding of telemedicine adoption and its implications and provide important insights. This project has been completed with a final report.

Project #22: The Effect of Urban Infrastructure Change on Movement
PI: Cynthia Chen (UW) **Co-PIs:** Steve Mooney (UW), Jon Froehlich (UW)

Progress: This project aims to investigate the impacts of urban infrastructure innovations during COVID-19 on visitor patterns, business activity, and regional traffic flow at the block level. Upon reviewing the existing literature, we found that most studies focus on larger geographic scales and lack insights at the more granular level where local policies take effect. Then, we have developed methods, Mobility Analysis Workflow (MAW), to clean app-based GPS data and analyze where people stay and for how long. Primary data was collected by downloading apps to record GPS traces for three weeks and keeping a travel diary as the ground truth. We found that MAW can process the GPS traces and generate results similar to the ground truth. MAW can serve as the tool to analyze human mobility pattern changes before and after urban infrastructure innovations. The team also looked into the representativeness of GPS traces provided by a third-party vendor, Spectus, and documented the findings for future reference. The MAW is now hosted on a public GitHub repository and documented in detail on how to use it and what outputs to expect. By making MAW publicly accessible on a widely-used platform, other researchers can easily leverage and adapt the tool for their own purposes. In the next reporting period, the goal is to use this tool to process millions of users' GPS trace data to understand the effect of urban infrastructure innovations. We will also identify blocks and neighborhoods with urban infrastructure innovations across the nation to draw comparisons.

What opportunities for training and professional development has the program provided?

The center-wide workforce development/technology transfer events are discussed earlier in this SAPR. In terms of education, the courses offered by TBD core faculty members are presented below in Table 2.

Table 2. Courses Offered by Core Faculty Members of TBD (Spring & Summer 2024)

Semester	Level	Course No	Course Title	No*	Instructor	Unit
Arizona State University						
Spring 24	Grad	CEE 579	Transportation Data Collection and Analysis Methods	11	Pendyala	SSEBE
Spring 24	Grad	CEE 598	Traffic Flow Theory	9	Zhou	SSEBE
Spring 24	Undergrad	CEE 372	Transportation Engineering	77	Zhou	SSEBE
Cal Poly Pomona						
Spring 24	Grad	CE5640	Transportation Planning and Management	25	Zhang	CE
Spring 24	Undergrad	CE3601	Transportation Engineering	41	Zhang	CE
Spring 24	Undergrad	CE3601	Transportation Engineering	32	Cheng	CE
Summer 24	Undergrad	CE3601	Transportation Engineering	26	Cheng&Zhang	CE
Summer 24	Undergrad	CE3601L	Transportation Engineering Laboratory	26	Cheng&Zhang	CE
Summer 24	Undergrad	CE4811	Design of Transportation Facilities	10	Zhang	CE
Summer 24	Undergrad	CE4811L	Design of Transportation Facilities Laboratory	9	Zhang	CE
City College of New York						
Spring 24	Grad	CE H2000	Transportation Economics	5	Allahviranloo	GSOE

Spring 24	Cross-Listed	CE 54500/ H4500	Urban Transportation	5	Conway	GSOE
Spring 24	Grad	CSC I1910	Neural Networks with Tensorflow	19	Grossberg	GSOE
Spring 24	Grad	DSE I2100	Applied Machine Learning and Data Mining	20	Grossberg	GSOE
Georgia Institute of Technology						
Spring 24	Undergrad	CEE 3770	Statistics and Applications	39	Mokhtarian	CEE
Spring 24	Grad	CEE 8813-F	Transportation Systems Analysis	17	Peeta	CEE
Spring 24	Undergrad	VIP 2601, 3601, 02, 4601, 02, 03	Vertically Integrated Projects	52	Peeta	VIP
Spring 24	Grad	VIP 6601-6603	Vertically Integrated Projects	9	Peeta	VIP
University of Michigan						
Winter 24	Undergrad	CEE 450	Introduction to Transportation Engineering	29	Shaw	CEE
University of Texas at Austin						
Spring 24	Undergrad	CE 301	Civil Engineering Systems	69	Boyles	CE
Spring 24	Undergrad	CE 321	Transportation Systems	48	Boyles	CE
Spring 24	Undergrad	CE 321	Transportation Systems	18	Machemehl	CE
Spring 24	Undergrad	CE 367T	Traffic Engineering	18	Machemehl	CE
Spring 24	Grad	CRP 384	Metro Trans Studies with GIS	12	Zhang	CRP
Spring 24	Grad	CRP 384	Transit-Oriented Development	20	Zhang	CRP
Summ 24	Grad	CRP 384	Megaregional Planning (First term)	10	Zhang	CRP
University of Washington						
Spring 24	Grad	URBDP 561 PUBPOL 561	Urban Economics and Public Policy	27	Shen	URBDP
Spring 24	Undergrad	CEE415	Machine Learning for Civil Engineers	20	Jia	CEE
Spring 24	Undergrad	ISE	Statistical quality control	48	Huang	ISE

Notes: SSEBE = School of Sustainable Engineering and the Built Environment; GSOE = Grove School of Engineering; CE = Civil Engineering; CRP = Community and Regional Planning; URBDP = Urban Planning; CEE = Civil and Environmental Engineering; VIP: Vertically-Integrated Project; ISE = Industrial and Systems Engineering. *Enrollment number.

Many students across all levels and post-doctoral scholars at TBD institutions have participated in TBD-related activities. Table 3 provides a comprehensive listing of these individuals. During this reporting period, Dr. Jason Soria has joined Cintra, a global infrastructure company, and Dr. Katie Asmussen, who graduated in August 2024, is continuing her research as a post-doctoral researcher at UT Austin.

Table 3. Students and Research Staff Engaged in TBD-Related Research and Education Activities

Name of Scholar	Level	Major/ Unit	Supervisor/ Advisor
Arizona State University			
Eleanor Hennessy	Postdoc	SSEBE	Ram Pendyala
Roberto Dimas Valle	PhD Student	SSEBE	Ram Pendyala
Fan Yu	PhD Student	SSEBE	Ram Pendyala
Victor O. Alhassan	PhD Student	SSEBE	Ram Pendyala
Jinghai Huo	PhD Student	SSEBE	Ram Pendyala
Miguel Rodriguez Ocana	MS Student	SSEBE	Ram Pendyala
Roshan Varghese	MS Student	Computer Science	Ram Pendyala
Xiangyong Luo	PhD Student	SSEBE	Xuesong Zhou
Cal Poly Pomona			
Ardavan Sherafat	MS Student	Comp Science	Hao Ji
Rafael Trinidad	MS Student	Comp Science	Hao Ji
Alberto Laureano-Rumbo	Undergraduate Student	Civil Engineering	Yongping Zhang
Eric Diaz	Undergraduate Student	Civil Engineering	Yongping Zhang
Danyan Guan	Undergraduate Student	Civil Engineering	Yongping Zhang
Danelia Teran	Undergraduate Student	Civil Engineering	Yongping Zhang
City College of New York			
Fateme Rezapour Fardin	PhD Student	Civil Engineering	Alison Conway
Shradha Ghodse	MS Student	Data Science	Alison Conway/Michael Grossberg
Abigael Legrand	MS Student (Visiting)	Civil Engineering	Alison Conway
Mila Le Morvan-Chevestre	MS Student (Visiting)	Civil Engineering	Alison Conway
Nikhita Kannam	MS Student	Data Science	Mahdieh Allahviranloo

Xiaoyang Lee	PhD Student	Civil Engineering	Mahdieh Allahviranloo
Laure Vatin	MS Student (Visiting)	Civil Engineering	Mahdieh Allahviranloo
Georgia Institute of Technology			
Chaeyeon Han	PhD Student	City & Reg. Plan.	Subhrajit Guhathakurta
Sujin Lee	MS Student	Urban Analytics	Subhrajit Guhathakurta
Animesh Agrawal	MS Student	Comp. Science	Subhrajit Guhathakurta
Jason Soria*	Postdoc	CEE	Patricia Mokhtarian
Ilsu Kim	PhD Student	CEE	Patricia Mokhtarian
Viswa Sri Rupa Anne	PhD Student	CEE	Srinivas Peeta
Md Gulam Kibria	PhD Student	OR/ISyE	Srinivas Peeta
Yuming Chang	PhD Student	CEE	Srinivas Peeta
Zheng Wang	MS Student	CSE	Srinivas Peeta
Kim YoonSuh	Undergraduate Student	IE	Srinivas Peeta
Isaiah Campusano	Undergraduate Student	Finance	Srinivas Peeta
Suhana Shirol	Undergraduate Student	IE	Srinivas Peeta
Karan Patel	Undergraduate Student	CS	Srinivas Peeta
Tejas Vermani	Undergraduate Student	CS	Srinivas Peeta
Steven Baker	Undergraduate Student	CS	Srinivas Peeta
University of Michigan			
Amy Fong	PhD student	CEE	Atiyya Shaw
Ivan Shih	PhD student	CEE	Atiyya Shaw
Sungho Lim	PhD student	CEE	Atiyya Shaw
Brynn Woolley	PhD student	CEE	Atiyya Shaw
Zeyu Lou	MSc student	Survey methods	Atiyya Shaw
University of Texas at Austin			
Katie Asmussen**	PhD Student/post-doc	CE	Chandra Bhat
Angela Haddad	PhD Student	CE	Chandra Bhat
Hyunjun Hwang	PhD Student	CE	Chandra Bhat
Ali Kothawala	PhD Student	CE	Chandra Bhat
Dale Robbennolt	PhD Student	CE	Chandra Bhat
Bonny Smith	MS Student	CE	Chandra Bhat
Anna Beliveau	UG Student	CE	Chandra Bhat
Caroline Muhith	UG Student	CE	Chandra Bhat
Mauricio Villarreal	UG Student	CE	Chandra Bhat
Kyle Bathgate	PhD student	CE	Stephen Boyles
Debojjal Bagchi	MS student	CE	Stephen Boyles
Lu Xu	Postdoc	CE	Stephen Boyles
Md Hamidur Rahman	PhD Student	CRP	Alex Karner
Maitreyee P. Gorase	MS Student	Information Science	Randy Machemehl
Niaz a Zafri	PhD Student	CRP	Ming Zhang
Seunggwan Park	PhD Student	CRP	Ming Zhang
University of Washington			
Hoseok Sa	PhD Student	URBDP	Qing Shen
Congjing Zhang	PhD student	ISE	Shuai Huang
Feng Lin	PhD student	ISE	Shuai Huang
Ekin Ugurel	PhD student	CEE	Cynthia Chen
Grace Jia	PhD student	CEE	Cynthia Chen
Jeremy Chan	MS student	CEE	Cynthia Chen
Aaron Wang	MS student	CEE	Cynthia Chen
Arsalan Esmaeili	PhD student	CEE	Cynthia Chen
Kaitlyn Ng	MS student	CEE	Cynthia Chen

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

In the next reporting period, active first-year projects and new second-year projects will be pursued as per the schedules in the proposals, and the two TBD flagship endeavors (Projects #1 and #2) will proceed. While detailed project-specific plans are provided in earlier sections of this SAPR, one noteworthy project to highlight is Project #22. The team will finalize the MAW tool and use it to process millions of users' GPS trace data to analyze the effects of urban infrastructure innovations on visitor patterns and traffic flow.

The analysis aims to capture changes in travel patterns, such as where visitors come from, their next destinations, associated transportation modes, and activity durations. This effort be validated against the Seattle Department of Transportation's Public Life observations. The team will also fuse other datasets to identify and compare similar neighborhoods with infrastructure changes to assess the broader impacts.

Furthermore, at least two webinars are planned for the next reporting period. The first will feature Dr. David Bunch from the Institute of Transportation Studies at the University of California, Davis. He will deliver a talk titled "Modeling Mobility Behavior of Californians in a Shifting Policy Landscape." The second seminar will be presented by Dr. Alex Anas, a visiting professor at the Massachusetts Institute of Technology and a professor in the Department of Economics at the University at Buffalo, State University of New York. He will discuss induced demand and its impacts on traffic movement.

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

- Arizona Department of Transportation (ADOT), Phoenix, Arizona: Collaborative research
- Army Corps of Engineers Coastal Hydraulics Laboratory, Vicksburg, MS: datasets, collaboration, in-kind support
- City of Peachtree Corners, Georgia: Transit ridership data, AV shuttle data, community engagement
- Commute Seattle and the Seattle Department of Transportation: Collaborative research
- Foothill Transit: In-kind support, panel discussion and hands-on activities for the Summer Transportation Institute
- Institute for Social Research Survey Methodology Program, Ann Arbor, MI: Collaboration and personnel exchanges
- Maricopa Associations of Government (MAG): Collaborative research
- Michigan Department of Transportation, Lansing, Michigan: Collaborative research and data sharing
- National Renewable Energy Laboratory (NREL), CO: In-kind support. access to their mobile application
- New York City Department of Transportation, NY: In-kind support, datasets, participation in a workshop
- Puget Sound Regional Council (PSRC): Collaborative research
- Southeast Michigan Council of Governments, MI: Collaborative research and data sharing
- Town of Queen Creek, AZ: Collaborative research
- Urban and Regional Planning Department at University of Michigan, MI: Collaboration and personnel exchanges
- Women's Transportation Seminar-Los Angeles Chapter (WTS-LA): Cohosted Girls' Empowerment Day

Have other collaborators or contacts been involved?

- Dr. Abolfazl Mohammadian, Univ of Illinois-Chicago, IL
- Dr. Sybil Derrible Univ of Illinois-Chicago, IL
- Dr. Deborah Salon, ASU, Tempe, AZ
- Dr. Peter Stopher, ASU, Tempe, AZ
- Dr. Mikhail Chester, ASU, Tempe, AZ
- Dr. Joe Grengs, University of Michigan, Ann Arbor, MI
- Dr. Sunghee Lee (Institute for Social Research), University of Michigan, Ann Arbor, MI
- Dr. Vivien Lim, National Univ of Singapore
- Dr. Sung Hoo Kim, Hanyang Univ, S. Korea
- Dr. Yongsung Lee, U. of California, Davis
- Dr. Basar Ozbilen, U. of California, Davis
- Dr. Xinyi Wang, MIT, Cambridge, MA
- Dr. Tassio Magassy, WSP USA
- Dr. Taehooie Kim, Maricopa, MAG, Phoenix, AZ
- Dr. Baloka Belezamo, ADOT, Phoenix, AZ
- Dr. Steve Mooney, University of Washington
- Dr. Jon Froehlich, University of Washington
- Kurt Winner, Commute Seattle, WA
- Brice Nichols, PSRC, WA
- Dr. Laurie Garrow, Georgia Tech, Atlanta, GA
- Dr. Brian German, Georgia Tech, Atlanta, GA
- Dr. Giovanni Circella, Ghent Univ, Belgium
- Dr. Brian Lee, PSRC, Seattle, WA

3. OUTPUTS

Publications, conference papers, and presentations:

Journal Publications: Papers Published Within Reporting Period

1. Batur, I., Alhassan, V. O., Chester, M. V., Polzin, S. E., Chen, C., Bhat, C. R., & Pendyala, R. M. (2024). Understanding how extreme heat impacts human activity-mobility and time use patterns. *Transportation Research Part D*, 136, 104431.
2. Kim, T., Lu, J., Pendyala, R. M., & Zhou, X. S. (2024). Computational graph-based mathematical programming reformulation for integrated demand and supply models. *Transportation Research Part C: Emerging Technologies*, 164, 104671.
3. Mohammadi, M., Davatgari, A., Asgharpour, S., Shabanpour, R., Mohammadian, A., Derrible, S., Pendyala, R.M. and Salon, D., 2024. The interaction between the recent evolution of working from home and online shopping. *Transportation*, pp.1-36.
4. Luo, X., Kuby, M. J., Honma, Y., Kchaou-Boujelben, M., & Zhou, X. S. (2024). Innovation diffusion in EV charging location decisions: Integrating demand & supply through market dynamics. *Transportation Research Part C*, 165, 104733.
5. Doll, A., Abbasi, M., Zhao, M., & Zhou, X. S. (2024). Oversaturated intersections: A real-world assessment of polynomial fluid queue models. *Physica A: Statistical Mechanics and its Applications*, 651, 129864.

6. Cheng, Q., Liu, Z., Lu, J., List, G., Liu, P., & Zhou, X. S. (2024). Using frequency domain analysis to elucidate travel time reliability along congested freeway corridors. *Transportation Research Part B: Methodological*, 184, 102961.
7. Da, L., Liou, K., Chen, T., Zhou, X., Luo, X., Yang, Y., & Wei, H. (2024). Open-ti: Open traffic intelligence with augmented language model. *International Journal of Machine Learning and Cybernetics*, 1-26.
8. Stritch, J. M., Jensen, U. T., Swindell, D., Allgood, M., & Fullerton, A. H. (2024). Veteran Status and Job Candidate Assessments in US Local Governments. *Review of Public Personnel Administration*, 44(3), 493-515.
9. Tejada, C., & Conway, A. (2024). Measuring the social effects of urban logistics facilities development, the case of New York city. *Transportation Planning and Technology,* 1–28.
10. Chaeyeon Han, Pavan Seshadri, Yiwei Ding, Noah Posner, Bon Woo Koo, Animesh Agrawal, Alexander Lerch, Subhrajit Guhathakurta. Understanding pedestrian movement using urban sensing technologies: the promise of audio-based sensors. *Urban Informatics* **3**, 22 (2024).
11. "A Conservation of Resources theory-based framework for studying the commute experience", by Vivien K. G. Lim, Patricia L. Mokhtarian, and Thompson S. H. Teo. *Transportation*, in press (accepted September 2024).
12. "Latent class models with an error structure: Investigating potential unobserved associations between latent segmentation and behavior generation", by Sung Hoo Kim and Patricia L. Mokhtarian. *Journal of Choice Modelling*, in press, 2024.
13. Garrow L., Mokhtarian P., German B., Glodek J., & Leonard C. (2024, in press). Market Segmentation of an Electric Vertical Take-Off and Landing (eVTOL) Air Taxi Commuting Service in Five Large U.S. Cities. *Transportation Research Part A*.
14. Mokhtarian, P. L. (2024). Pursuing the impossible (?) dream: Incorporating attitudes into practice-ready travel demand forecasting models. *Transportation Research Part A*, 190, 104254.
15. Wang, X., & Mokhtarian, P. L. (2024). Examining the treatment effect of teleworking on vehicle-miles driven: Applying an ordered probit selection model and incorporating the role of travel stress. Transportation Research Part A: Policy and Practice, 186, 104072.
16. Wang, X., Kim, S. H., & Mokhtarian, P. L. (2024). Identifying teleworking-related motives and comparing telework frequency expectations in the post-pandemic world: A latent class choice modeling approach. *Transportation Research Part A*, 186, 104070.
17. Panik, R. T., Nazemi, H., Saleh, J. H., Fitzpatrick, B., & Mokhtarian, P. L. (2024). Precursory elements of safety culture: Exploratory analyses of engineering students' safety attitudes. *Journal of safety research*, 88, 179-189.
18. Fong, A. Z., and Shaw, F. A. (2024). Well-being implications of mobility of care: gender differences among US adults. *Transportation Research Part D*, *129*, 104109.
19. Biswas, M., C.R. Bhat, S. Ghosh, and A.R. Pinjari, "Choice Models with Stochastic Variables and Random Coefficients," *Journal of Choice Modelling*, 51, 100488, 2024.
20. Biswas, M., C.R. Bhat, and A.R. Pinjari, "The Use of Pooled RP-SP Choice Data to Simultaneously Identify Alternative Attributes and Random Coefficients on Those Attributes," *Transportation Research Part B*, 186, 102988, 2024.
21. Asmussen, K.E., A. Mondal, and C.R. Bhat, "The Interplay between Teleworking Choice and Commute Distance," *Transportation Research Part C*, 165, 104690, 2024.
22. Saxena, S., A.R. Pinjari, C.R. Bhat, and A. Mondal, "A Flexible Multiple Discrete-Continuous Probit (MDCP) Model: Application to Analysis of Expenditure Patterns of Domestic Tourists in India," *Transportation*, 51(4), 1299-1326, 2024.
23. Anderson, S.M., K.E. Asmussen, S. Saxena, I. Batur, R.M. Pendyala, and C.R. Bhat, "An Investigation of Dissonance in Telework Frequency," *Transportation Research Part C*, 166, 104712, 2024.
24. Ashour, L. A., Shen, Q., Moudon, A., Cai, M., Wang, Y., & Brown, M. (2024). Post-pandemic transit commute: Lessons from focus group discussions on the experience of essential workers during COVID-19. *Journal of Transport Geography*, *116*.
25. Uğurel, E., Guan, X., Wang, Y., Huang, S., Wang, Q., & Chen, C. (2024). Correcting missingness in passively-generated mobile data with Multi-Task Gaussian Processes. *Transportation Research Part C: Emerging Technologies*, 161, 104523.
26. LI, M., LIN, F., ZHANG, C., VEHIK, K., PARIKH, H. M., ORAM, R. A., ... & HUANG, S. (2024). 1462-P: Genetic Risk Score for Type 1 Diabetes across Ethnic Populations via Multitask Learning. *Diabetes*, 73(Supplement_1).
27. Uğurel, E., Huang, S., & Chen, C. (2024). Learning to generate synthetic human mobility data: A physics-regularized Gaussian process approach based on multiple kernel learning. *Transportation Research Part B*, 103064.
28. Lin, F., Qian, X., Mortazavi, B., Wang, Z., Huang, S., & Chen, C. (2024). Modeling user choice behavior under data corruption: Robust learning of the latent decision threshold model. *IISE Transactions*, 56(12), 1307-1320.
29. Cano-Calhoun, C., Abramson, D., & Chen, C. (2024) On Your Own, Together: Regional Perspectives on Community Resource-sharing for Disaster Preparedness in Washington State. *Journal of Urban Affairs*, 1–25.
30. Esmaili, A., Oshanreh, M. M., Naderian, S., MacKenzie, D., & Chen, C. (2024). Assessing the spatial distributions of public electric vehicle charging stations with emphasis on equity considerations in King County, Washington. Sustainable Cities and Society, 107, 105409.
31. Cheng, W., Rogovoy, K., Sharifiilierdy, S., Mora, O., Lu, R., & Cheng, Y. (2024). Enhancing Daily Crash Count Prediction using Deep Learning with Window Size Selection and Seasonality Predictor Integration. Transportation Research Record.

Presentations Within Reporting Period

1. Batur I. *A Data Dashboard for Behavioral Insights: A Focus on Time, Travel, and Telework*. Southeast Florida FSUTMS Users Group Meeting. September 20, 2024 (link).
2. Batur I. *Data Dashboards for Behavioral and Wellbeing Insights: A Focus on Time, Travel, and Telework*. The Inaugural US DOT Future of Transportation Summit. Washington, DC. August 13-15 (link).
3. Polzin S. *Trends in Travel Demand: Insights and Implications*. The Inaugural US DOT Future of Transportation Summit. Washington, DC. August 13-15 (link).

4. Polzin S, Batur I., and Pendyala R.M. *Trends in Travel Demand: Insights from Past to Future*. The 17th International Conference on Travel Behavior Research, (IATBR 2024). Vienna, Austria. July 14-18, 2024.
5. Conway, A. Infrastructure Planning for Innovative E-Commerce Distribution. NJTPA Freight Initiatives Committee, Newark, NJ (Virtual), July 24, 2024.
6. Conway, A. and Conway, M. Transportation Impacts of Warehousing Growth in Berks County, PA. Presented at the American Association of Geographer's Annual Meeting, Honolulu, Hawaii, April 16, 2024.
7. Seshadri P., Han C., Koo B., Posner N., Guhathakurta S., & Lerch A.. ASPED: An Audio Dataset for Detecting Pedestrians. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). April 14-19, 2024.
8. Mokhtarian, P.. The Insidious Problem of Selection Biases: How to Recognize Them, and What to Do about Them. MIT Mobility Forum (online webinar series), April 12, 2024. (link)
9. Mokhtarian, P.. The Insidious Problem of Selection Biases: How to Recognize Them, and What to Do about Them. The Second Symposium on Cities and Sustainable Transportation. Chang'an University, Xi'an, China, July 3, 2024.
10. Mokhtarian, P. The Insidious Problem of Selection Biases: How to Recognize Them, and What to Do about Them. The 12th Symposium of the European Association for Research in Transportation. Aalto University, Espoo, Finland, June 20, 2024.
11. Mokhtarian, P. The Insidious Problem of Selection Biases: How to Recognize Them, and What to Do about Them. Purdue University, September 9, 2024.
12. Peeta, S. Plenary Speaker, "Implications of Stop-and-Go Traffic on Training Learning-Based Car-Following Control," *25th International Symposium on Transportation and Traffic Theory*, Ann Arbor, Michigan, July 2024.
13. Peeta, S. Invited Expert Tutorial, "Mixed-Flow Traffic of CAVs and HDVs," *AutoSens USA 2024*, 3-hour Invited Tutorial Provided to Participants from the Autonomous Vehicle and ADAS Industry, Detroit, MI, May 2024.
14. Peeta, S. Distinguished NGTS Seminar Speaker, "Framework for Sustainable Travel Through Smart and Engaged Communities," *Next Generation Transportation Systems Seminar Series*, University of Michigan, MI, April 2024.
15. Anne, V. S. R. & Peeta, S. Incentive-based Travel Behavior Change Mechanisms to Mitigate System-Level Greenhouse Gas Emissions. *ASCE International Conference on Transportation and Development 2024*, Atlanta, Georgia, June 2024
16. Campusano, I., Kibria, G., & Peeta, S. Exploration of Transit-TNC Partnerships to Enhance Mobility and Access for Transportation Disadvantaged Groups. *ISyE Summer Undergraduate Research Scholars Program Poster Presentation 2024*, Atlanta, Georgia, August 2024.
17. Shirol, S., Kim, Y., Patel, K., Wang, Z., Kibria, G., Anne, V. S. R., & Peeta, S. Fostering Sustainable Travel Through Engaged Communities. *PIN Summer Internship Closing Ceremony 2024*, Morrow, Georgia; August 2024.
18. Fong, A. Z., and Shaw, F. A. *Examining the Well-Being Implications of Mobility of Care: Gender Differences among U.S. Adults*. The 17th International Conference on Travel Behavior Research, Vienna, Austria, July, 2024.
19. Lim, S., Li, M. Z., and Shaw, F. A *Who experiences flight delay? Ground to air data integration for human-centered performance measures*. The 17th International Conference on Travel Behavior Research, Vienna, Austria, July, 2024.
20. Bathgate, K., D. Bagchi, and S. D. Boyles. (2024) Identifying capacities in a multimodal maritime freight network. Presented at the Annual Meeting of the Institute for Operations Research and the Management Sciences, Seattle, WA.
21. Rahman, M.H., & Karner, A. (2024). *Understanding Accessibility Sufficiency, Activity Participation, and Quality of Life: Evidence from Austin, Texas*. Presented at the TRB's 2nd Conference on Advancing Transportation Equity (CATE), Baltimore, MD, July 15-18, 2024.
22. Anderson, S.M., K.E. Asmussen, S. Saxena, I. Batur, R.M. Pendyala, and C.R. Bhat, "An Investigation of Dissonance in Telework Frequency," *International Choice Modelling Conference (ICMC 2024)*, Puerto Varas, Chile, April 2024.
23. Asmussen, K.E., A. Mondal, and C.R. Bhat, "The Interplay between Teleworking Choice and Commute Distance," *International Choice Modelling Conference (ICMC 2024)*, Puerto Varas, Chile, April 2024.
24. Hwang, H., A.J. Haddad, I. Batur, S. Saxena, R.M. Pendyala, and C.R. Bhat, "Walking Frequency Before and After the Pandemic," *International Choice Modelling Conference (ICMC 2024)*, Puerto Varas, Chile, April 2024.
25. Robbennolt, D., A. Haddad, A. Mondal, and C.R. Bhat, "Housing Choice in an Evolving Remote Work Landscape," *International Choice Modelling Conference (ICMC 2024)*, Puerto Varas, Chile, April 2024.
26. Haddad, A., A. Mondal, N. Eluru, and C.R. Bhat, "A Novel Integrated Approach to Modeling and Predicting Crash Frequency by Crash Event State," *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2024.
27. Hwang, H., A. Haddad, I. Batur, S. Saxena, R.M. Pendyala, and C.R. Bhat, "An Analysis of Walking Frequency Before and After the Pandemic," *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2024.
28. Bhat, C.R., "A Study on Telemedicine Adoption, with Implications for Healthcare, Telecommunications and Land use-Transportation Planning," *Invited Seminar*, Boyer Lecture Series, Department of Civil & Environmental Engineering, University of Massachusetts Amherst, Amherst, MA, April 2024.
29. Bhat, C.R., "MVNCD Evaluation and Potential Applications, Including Multinomial Probit (MNP) and Multivariate Ordinal Probit (MORP)," Georgia Institute of Technology Choice Modeling Methods Workshop, Atlanta, GA, May 2024
30. Bhat, C.R., "The Evolving Nature of the Transportation Profession: Sensing, Technological, and Computational Processing Developments in the Field," *Opening Super-Plenary Keynote Speaker,* ASCE International Conference on Transportation & Development (ICTD 2024), Atlanta, GA, June 2024.
31. Asmussen, K.E., A.J. Haddad, and C.R. Bhat, "Teleworking to Play or Playing to Telework?," *ASCE International Conference on Transportation & Development (ICTD 2024)*, Atlanta, GA, June 2024.
32. Haddad, A.J., & C.R. Bhat, "Telemedicine Adoption Before, During, and After COVID-19: The Role of Socioeconomic and Built Environment Variables," *ASCE International Conference on Transportation & Development*, Atlanta, GA, June 2024.

33. Hennessy, E., I. Batur, C.R. Bhat, and R.M. Pendyala, "Understanding Factors Contributing to Electric Vehicle Ownership in California," *ASCE International Conference on Transportation & Development (ICTD 2024)*, Atlanta, GA, June 2024.
34. Bhat, C.R., "Intro to Civil Engineering," My Introduction to Engineering (MITE) Summer Enrichment Camp, Equal Opportunity in Engineering Program, UT Austin, June 2024.
35. Smith, B.V., D. Robbennolt, and C.R. Bhat, "An Evaluation of the Long-Term Effects of the COVID-19 Pandemic on Public Transit Use," *Invited Seminar*, Ghent University, Ghent, Belgium, July 2024.
36. Haddad, A. & Bhat C. Telemedicine Adoption Before, During, and After COVID-19: The Role of Socioeconomic and Built Environment Variables. *Invited Seminar*, Mobilise Research Group, Vrije Universiteit Brussel, Brussels, Belgium, July 2024.
37. Bhat, C.R., "Introduction to MDCEV Model Endogeneity in Choice Modeling," *Invited Seminar*, Technical University of Munich (TUM), Munich, Germany, July 2024.
38. Robbennolt, D., A., Beliveau, and C.R. Bhat, "An Investigation of Physical Participation Dissonance and Virtual Activity Participation," *Invited Seminar*, Paris Lodron University Salzburg, Salzburg, Austria, July 2024.
39. Asmussen, K.E., C.R. Bhat, and A.J. Haddad, "Teleworking to Play or Playing to Telework? A Latent Segmentation Approach to Exploring the Relationship Between Telework and Nonwork Travel," *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
40. Bhat, C.R., "A Unified Approach to Teasing Out Causal Relationships in Travel Behavior Analysis," *Plenary Session Keynote Presentation*, *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
41. Bhat, C.R., M. Biswas, N.F. Malik, and A.R. Pinjari, "The Use of Pooled SP-RP Choice Data to Simultaneously Identify Alternative Attributes and Random Coefficients on those Attributes," *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
42. Giubergia, D., C.R. Bhat, A.J. Haddad, F. Piras, and I. Meloni, "Modeling Spatial and Social Interdependency Effects on Commuting Mode Choice," *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
43. Haddad, A.J., and C.R. Bhat, "Telemedicine Adoption Before, During, and After COVID-19: The Role of Socioeconomic and Built Environment Variables," *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
44. Hwang, H., A.J. Haddad, I. Batur, S. Saxena, R.M. Pendyala, and C.R. Bhat, "An Analysis of Walking Frequency Before and After the Pandemic," *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
45. Robbennolt, D., A. Haddad, A. Mondal, and C.R. Bhat, "Housing Choice in an Evolving Remote Work Landscape," *17th International Conference on Travel Behaviour Research*, Vienna, Austria, July 2024.
46. Robbennolt, D., A. Haddad, and C.R. Bhat, "A Rank-Based Model of Residential Location Preferences Before and After the COVID-19 Pandemic," *Invited Seminar*, Jagiellonian University, Krakow, Poland, July 2024.
47. Bhat, C.R., "Telemedicine Adoption and Implications for Healthcare and Land Use-Transportation Planning," *Invited Keynote*, 24th COTA International Conference of Transportation Professionals (CICTP 2024), Shenzhen, China, July 2024.
48. Bhat, C.R., "Discrete Choice: Basic Theory," *Advanced Choice Modelling Methods Course*, Indian Institute of Science (IISc), Bangalore, India, August 2024.
49. Bhat, C.R., "Discrete Choice: Stochastic Specification, Estimation, Goodness of Fit, Elasticities," *Advanced Choice Modelling Methods Course*, Indian Institute of Science (IISc), Bangalore, India, August 2024.
50. Bhat, C.R., "Multinomial Probit: Theory," *Advanced Choice Modelling Methods Course*, Indian Institute of Science (IISc), Bangalore, India, August 2024.
51. Bhat, C.R., "Advanced Estimation Methods and Emerging New Directions," *Advanced Choice Modelling Methods Course*, Indian Institute of Science (IISc), Bangalore, India, August 2024.
52. Bhat, C.R., "Mixed Multinomial Logit: Application and Interpretations," *Advanced Choice Modelling Methods Course*, Indian Institute of Science (IISc), Bangalore, India, August 2024.
53. Bhat, C.R., "The Exciting Challenges in the Fast-Evolving U.S. Mobility Landscape," *Invited Speaker*, Future of Transportation (FoT) Summit, US DOT University Transportation Centers program, Washington DC, August 2024.
54. Haddad, A.J., and C.R. Bhat, "Telemedicine Adoption Before, During, and After COVID-19: The Role of Socioeconomic and Built Environment Variables," *Future of Transportation (FoT) Summit*, US DOT University Transportation Centers program, Washington DC, August 2024.
55. Haddad, A.J., A. Mondal, C.R. Bhat, A. Zhang, M.C. Liao, L.J. Macias, M.K. Lee, and S.C. Watkins, "Pedestrian Crash Frequency: Unpacking the Effects of Contributing Factors and Racial Disparities," *Future of Transportation (FoT) Summit*, US DOT University Transportation Centers program, Washington DC, August 2024.
56. Shen, Q. Residential Choices in the "New Normal" and Their Connection with Telework. *Keynote* speech at *Planning Frontiers for Urban Sustainability*. Tongji University, Shanghai, China, July 3, 2024
57. Ann Arbor, Michigan, Using multiple biased datasets to recover missing trips with a behaviorally-informed likelihood-based approach, September 26 2024, University of Michigan Next-Generation Transportation Seminar Series.
58. Singapore, Untapped capacity in place-based resource sharing for enhanced community resilience. August 28 2024. *Keynote* at the 2024 International Conference on Resilient Systems (ICRS), https://www.conftool.org/resilience2024/sessions.php.
59. Davis, CA, Promises and limitations of big data for human mobility analysis, University of California, Davis, April 5th, 2024.
60. Ashour, L. and Shen Q. Unveiling Commute Mode Choice Amidst the Rise of Telework in the New Normal. Paper presented at *5th Triennial of World Symposium on Transport and Land Use Research*. Bogota, Colombia, June 17, 2024.
61. Ng, K.; Mishra, G.; and Chen, C. (2024) Restaurant Preference Personas: Travel-based Motivations of Eating Out. 17th International Conference on Travel Behavior Research, July 14-18, 2024, Vienna, Austria.

62. Jia, G.; Ng, K.; Ugurel, E.; Lee, B.; Pendyala, R.; and Chen, C. (2024) COVID & Telecommuting-induced Changes in Individual Activity and Travel Patterns: Evidence from the Puget Sound Region. 17th International Conference on Travel Behavior Research, July 14-18, 2024, Vienna, Austria.

Books or other non-periodical, one-time publications: Book Chapters

1. Goulias, K. G., & Pendyala, R. M. (2024). Choice context. In *Handbook of Choice Modelling* (pp. 117-146). Edward Elgar Publishing.
2. Mondal, A., K.E. Asmussen, C.R. Bhat, A.R. Pinjari, and R.M. Pendyala, "Time Use and Activity-Travel Behavior Analysis: Recent Developments and Emerging Trends. In *Handbook of Choice Modelling* (pp. 161-179). Edward Elgar Publishing.
3. Pinjari, A.R., C.R. Bhat, S. Saxena, and A. Mondal, "Multiple Discrete-Continuous Choice Models: A Reflective Analysis and a Prospective View. In *Handbook of Choice Modelling* (pp. 452-488). Edward Elgar Publishing.

Other Publications Within Reporting Period

1. Bhat, C.R., "What is Causality in Modeling? And What Data Do We Need to Extricate Causal Insights?" *World Conference on Transport Research Society (WCTRS), Research Newsletter*, Vol. 4, Issue 4, August 2024. (link)
2. Shen, Q., Chen, C., Cai, M., and Ashour, L. (2024). Incorporating Mobility on Demand into Public Transit in Suburban Areas: A Comparative Evaluation of Cost-Effectiveness. TOMNET UTC.
3. Ashour, L. and Shen, Q. (2024). Subarea planning based on Seattle 2022 Commute Survey. Project report submitted to the Office of Planning & Community Development (OPCD), City of Seattle.

Website(s) or other Internet site(s)

One of the center's significant products is the TBD website, which serves as a central hub for all information related to the Center's objectives and activities. The website includes dedicated sections for research projects, along with detailed descriptions, updates, and reports. It also houses data products and software and tools developed by TBD researchers. Additionally, the site provides a platform for sharing policy briefs, as well as disseminating TBD events and news to a global audience. Similar to previous reporting periods, the TBD website has been consistently maintained to reflect developments in TBD's research, technology transfer, education, workforce development, and outreach activities. During this reporting period, the Project #23 team also developed a website to introduce the study to integrate mobility data collection apps with personalized recommendation systems.

Technologies or Techniques (software codes and products)

As noted in prior progress reports and earlier in this report, the TBD team, led by ASU researchers, has been heavily involved in the development and application of open-source tools that reflect model outputs of the TBD projects. In this reporting period, the ASU team has released the Time Use, Travel, and Telework Dashboard (T3D), which is an open-source platform designed to offer insights into time use, travel, and telework trends and patterns within the United States. In addition, the beta versions of the synthetic population generator called PopGen and the TOMNET Wellbeing Platform have been created and made available for public use by the ASU team. These tools are not explained in detail (interested readers can refer to the hyperlinked websites for further information). Updated versions of these tools developed in open-source format are being posted on the TBD website. Additionally, R and Python codes related to TBD's transportation model estimation, implementation efforts, and data fusion procedures are being documented in various publications. Whenever possible, these codes and procedures are made publicly accessible through repositories such as GitHub (for example, see the ASU team's GitHub page). The ASU team has also made available the code used to process ATUS datasets and weather data to analyze the impacts of extreme heat on time use patterns. This code is developed as part of their latest publication and is now available in a publicly available GitHub repository along with the associated datasets. On another TBD project at ASU led by PI Maynard, a new podcast called Modem Futura has been launched and will be featuring TBD-relevant content over the coming months.

Furthermore, the TBD team at UW has prepared a tool called the Mobility Analysis Workflow (MAW), designed to clean and process app-based GPS data. The tool is now used to analyze changes in human mobility patterns before and after the implementation of urban infrastructure innovations. MAW will be made publicly available through a GitHub repository, where the methods and code will be accessible to other researchers. The TBD team at UW also developed a public dashboard showing the data collected

via NREL OpenPATH, as part of Project #23. It includes different metrics such as number of trips, trip length, trip frequency, and number of trips by purpose. The data metrics can be changed by the time range.

Databases and Research Materials

In a number of TBD projects, integrated datasets have been developed (or are under development), using data fusion techniques to study the impact of attitudes on different transportation-related choices such as residential location choice, mode choice, vehicle ownership, and adoption of emerging mobility services and technologies. While some of the datasets are based on native survey data collection efforts undertaken by the TBD team, others have been assembled by integrating and fusing data that is already available in the public domain. All datasets assembled by TBD are being made publicly available (without personally identifiable information) via the TBD website. In the meantime, findings from the surveys have been disseminated to the community through webinars and research papers. It is also important to note that many TBD publications include applicable model specifications that can be used by practitioners to better model the recent changes in traveler behavior and values. These model specifications also showcase robust and statistically viable solutions to integrate attitudes in travel behavior analysis. A few specific instances of database and research materials development are as follows. The TBD team at Georgia Tech has published several datasets called ASPED (Audio Sensing for PEdestrian Detection). It is a compilation of large-scale audio and video data prepared for pedestrian detection using sound and video. ASPED consists of almost 2,600 hours of audio, more than 3.4 million continuous frames in video, and corresponding annotation of pedestrian count for each audio and video. The team is currently processing the second round of collected data to make it publicly available. More information is available here, here, and here.

A summary of the TBD metrics on software/data/models and number of journal publications is provided in Table 5.

Table 5. TBD Metrics on Products

Metric	Previous Period	This Period	Annual Total	Assessment
Number of software/ data/models	2	8	10	We consider our improved accessibility measure a model for this reporting purpose.
Number of journal publications	17	31	48	

4. OUTCOMES

One major outcome from this reporting period is the new TBD study on the impacts of extreme heat (as mentioned earlier in this report). The study provides detailed insights into how extreme heat affects daily activity-travel behavior and time use patterns for different socio-demographic groups. It draws on data from the American Time Use Survey (ATUS) and weather data from the National Oceanic and Atmospheric Administration (NOAA), focusing on 11 major U.S. metropolitan areas. The study underscores the importance of getting out of the house, especially for social activities, for human well-being. At the same time, in many parts of the country and the world, extended heat waves caused by climate change are forcing individuals to stay inside, disrupting daily activity routines and our very way of life. According to the study, extreme heat significantly reduces the amount of time people spend outside their homes. On extremely hot days, people are more likely to stay indoors, cut back on outdoor activities, and avoid non-essential travel. Additionally, people shift their travel to cooler times of the day, opting for early morning or late evening trips to avoid the midday heat. The research also shows a clear shift (for those who decide to venture out despite extreme heat conditions) in transportation choices. Car use increases, while trips made by walking, biking, and public transit drop significantly. The authors note that this shift presents significant challenges for cities aiming to promote sustainable transportation options, especially as communities experience climate extremes with greater frequency. The study also found that some groups are particularly vulnerable. Low-income individuals and those without access to cars are more likely to rely on walking or public transportation, modes that leave them exposed to dangerous temperatures. These individuals also have the

least flexibility regarding when and where they work, thus necessitating travel even when temperatures are oppressive. The study concludes extreme heat exacerbates inequities in mobility and activity participation and proposes a range of policy recommendations to help mitigate the impacts on communities.

Some other outcomes from selected TBD research projects are as follows. **Project #13** entitled "How Effective Are Marker Variables at Predicting Attitudinal Factor Scores? An Out-of-Sample Evaluation" has increased our knowledge about the circumstances under which attitudes add explanatory power to disaggregate models of household vehicle ownership, which is a key precursor to many other travel behavior metrics. In particular, models including attitudes did markedly better than those without attitudes in predicting the choice to own zero vehicles, which is an important improvement. The study also demonstrated that using as few as four attitudinal items provides very good results compared to using typical attitudinal factor scores, which are based on many more items. This increases the feasibility of eventually improving regional travel demand forecasting models through the inclusion of attitudes, by showing that doing so need not impose an undue burden on household travel survey respondents.

Project #14 entitled "Promoting Sustainable Travel within Communities through Behavioral Interventions and Emerging Mobility Solutions" has led to the following outcomes. *(1)* Online surveys conducted through randomized control trials revealed insights into how various behavioral interventions, including gamification and informational messages, influence sustainable travel behaviors among private vehicle users. This deepened the understanding of the factors that can shift trips toward more sustainable modes. *(2)* The acceptance of a paper at the 2025 TRB Annual Meeting, alongside multiple presentations at conferences such as ASCE ICTD and INFORMS, contributed to the academic discourse on promoting sustainable travel. These outputs disseminated findings on incentive-based travel behavior changes and public-private partnerships in transportation. *(3)* The project engages four graduate students (three PhD and one MS students) and 19 undergraduate students (six interns and 13 VIP students), in data collection, modeling, and analysis. This involvement provides hands-on training in advanced techniques like optimization modeling and survey design, equipping them to tackle emerging transportation challenges. *(4)* The project explores emerging mobility technologies to enhance accessibility, and it adapts behavioral intervention techniques, traditionally used in public health, to promote sustainable travel behaviors.

Project #18 entitled "Enhanced Network Models for Multimodal Resiliency" has used vessel-tracking data and discrete event simulation to propose a preliminary definition of waterway capacity. Compared to roadway capacity, waterway capacity is much less well understood. **Project #20** entitled "Identifying Targets for Electric Vehicle (EV) Industry Improvement" has investigated alternative EV vehicle battery technologies based on battery technologies. Each has advantages and disadvantages for costs, charging efficiency, operational effectiveness, and charging infrastructure availability. Changing consumer sentiments are and will continue to be the "demand" factor creating the direction, urgency, and innovation in EV battery technologies. This research continues to identify the "supply" side of this emerging industry's innovations and implementations to identify those targets that will result in industry improvements judged by consumers to meet their demands to make EV use economically attractive.

Project #22 entitled "The Effect of Urban Infrastructure Change on Movement" focuses on the development of the MAW tool, which has introduced new (and more) efficient methods for processing GPS trace data for identifying human mobility patterns and understanding infrastructure impacts. This tool has streamlined the process of analyzing large-scale mobility data, offering a more effective way to track behavioral changes over time. Graduate students involved in the project have gained valuable experience in data collection, analysis, and tool development. They have also examined the representativeness of third-party data, documented findings for future research, and contributed to ongoing studies, enhancing their expertise in transportation analysis and urban infrastructure planning.

Project #23 entitled "A Pilot Study to Integrate Mobility Data Collection APPs with Personalized Recommendation Systems" has achieved several outcomes that contribute to a deeper understanding of traveler behavior and improvements in data collection and recommendation systems, as follows. (1) Through the benchmarking of existing personalized Point-of-Interest (POI) recommender systems, we identified gaps in accuracy when using location-based data. This finding has highlighted the challenges of applying current recommendation models to real-world scenarios on providing personalized location

recommendations and has brought attention to the need for further development in this area. (2) The evaluation of mobility data collected from users of NREL OpenPATH provided new insights into the limitations of existing data collection tools. Specifically, we identified common faults such as inaccuracies in trip start and end times, difficulties in detecting transportation modes, and errors in route tracking. This analysis has contributed to the knowledge base surrounding data quality issues in mobility data collection. (3) The design of a new framework for incentivizing personalized recommendations using NREL OpenPATH represents an advancement in promoting behavior change through technology. By incorporating a feedback loop based on user responses, the system will offer a more precise and user-centric approach to delivering recommendations with reward points, which can potentially enhance user engagement and the adoption of sustainable travel behaviors.

Project #24 entitled "The Differential Accessibility Effects of Work from Home: Travel Behavior Outcomes and Transportation Equity Implications" has led to (a) a better understanding of work-from-home impacts on accessibility, travel behavior, and social equity, (b) increased awareness of the challenges and opportunities of work-from-home for different groups of people., (c) improved methodologies in measuring accessibility considering the fundamental changes in work models, travel options, and data sources, and (d) new insights informing transportation planning processes that explicitly take into consideration the accessibility and equity impacts of work-from-home.

5. IMPACTS

What is the impact on the effectiveness of the transportation system?

The new TBD study focusing on the impacts of extreme heat has provided new insights into how transportation choices are affected during such events and identifies vulnerable groups, highlighting the urgent need for policy action as cities worldwide grapple with rising temperatures. Based on its findings, the study proposes a range of policy recommendations for transportation planning to help mitigate the impacts of extreme heat on communities. While broad center-wide impacts have been identified in the section on "center-wide accomplishments" earlier, some select project-level impacts are as follows.

Project #22 entitled "The Effect of Urban Infrastructure Change on Movement" is still in the early stages of analyzing the impacts of urban infrastructure innovations, such as street furniture and repurposing street space, on the effectiveness of the transportation system. While we have not yet concluded the full extent of these impacts, we are developing methods to assess how such changes influence mobility patterns, traffic flow, and accessibility. By leveraging tools such as the Mobility Analysis Workflow (MAW), we aim to analyze shifts in visitor behavior and traffic management following these innovations, which will inform future decisions on how urban infrastructure affects transportation efficiency. As the research progresses, we expect to provide detailed insights into how infrastructure changes, such as outdoor dining areas and pedestrianized streets, affect transportation operations. These findings will help shape data-driven strategies to optimize urban spaces for both transportation and local economic vitality.

Project #24 entitled "The Differential Accessibility Effects of Work from Home: Travel Behavior Outcomes and Transportation Equity Implications" supports the development of new travel demand management strategies, such as telecommuting incentives or staggered work hours, which can help reduce traffic congestion and GHG emissions. It also informs the development and implementation of transportation policies and programs that promote equitable and inclusive communities, such as investments in innovative mobility programs for underserved communities.

What is the impact of technology transfer on industry and government entities, on the adoption of new practices, or on research outcomes which have led to initiating a start-up company?

TBD projects related to surveys, built environment effects, and tele-activity effects have the potential to inform government/industry, drive innovative new ways of survey data collection, and inform new land use-transportation policies. These efforts will also result in open-source codes and tools that cities and government entities can use to evaluate the effects of the changes in urban infrastructure. As another evidence of the impact of TBD research on the adoption of new practices, Georgia DOT & the Atlanta

Regional Commission adopted attitudinal statement recommendations by TBD Associate Director, Dr. Mokhtarian for inclusion in the Georgia add-on sample of the 2024 National Household Travel Survey.

What is the impact on the body of scientific knowledge?

TBD research is contributing to the body of scientific knowledge on the relationship between transportation and ICTs in (a) shaping the land-use and spatial economy in cities and regions, (b) improving smartphone-based mobility data collection to support personalized recommendations, (c) identifying challenges and gaps in the design of personalized recommendation systems in the context of travel behaviors, and (d) exploring nuanced questions related to travel behavior, infrastructure planning, and environmental sustainability within the context of an increasingly hybridized workforce. For instance, the MAW tool, which processes large-scale GPS data to analyze human mobility patterns before and after urban infrastructure changes, provides a valuable resource for cities and transportation agencies to assess the effectiveness of newly implemented infrastructure, such as outdoor dining areas or pedestrian zones. As cities reimagine their urban cores post-COVID, the data and insights generated by MAW can inform decisions on how to reallocate street space and improve transportation efficiency. The integration of multiple datasets, including GPS traces, Google Street View, and business activity, enables a more dynamic understanding of infrastructure impacts. These practices have the potential to be widely adopted by municipalities and planners looking to optimize urban environments, particularly in response to shifting travel behaviors and economic patterns brought on by the pandemic. More broadly, by providing open-source tools and data visualizations, TBD research is positioned to influence public use and encourage government and industry entities to adopt data-driven approaches for enhancing urban mobility and infrastructure planning.

TBD research is also exploring how information-based behavioral interventions and emerging mobility modes, such as micromobility and ridesharing, can enhance travel sustainability at the community level. By integrating behavioral interventions, policy interventions, and emerging mobility solutions, TBD research has the potential to make significant contributions to the field of transportation by adapting behavioral science techniques, such as gamification and targeted informational messaging, to promote sustainable travel behaviors. These methods, traditionally used to encourage healthier lifestyles in public health, were applied to motivate shifts from private vehicle use to more sustainable modes. This approach introduces a new dimension to travel behavior research, providing insights into how monetary and non-monetary incentives can drive behavior change, which is particularly valuable for urban areas aiming to reduce congestion and emissions. Additionally, the models being developed that integrate emerging mobility options, such as micromobility and ridesharing, with existing public transit systems aim to improve equity and access for disadvantaged communities by addressing first/last-mile challenges and providing better connectivity to essential services. It can aid the design of partnerships between public and private mobility services, offering a new framework for improving multimodal connectivity and access. Such findings provide actionable insights to aid policymakers, urban planners, mobility service providers, and city managers/engineers in designing practical solutions that promote sustainable travel. The project advances the understanding of how to integrate behavioral interventions, policy actions, and emerging mobility solutions into a cohesive approach that addresses diverse community needs.

From a data collection perspective, TBD research has the potential to improve the quality of household survey data by explicitly developing recommendations for reducing behavioral biases (moving beyond the surface level socioeconomic and demographic representativeness), thereby improving forecasts and resultant policy implications.

Table 6 provides TBD metrics on the impact of TBD core PIs on the scientific body of knowledge, as captured in the Google Scholar statistics. The table provides citation numbers for all publications of the core researchers in 2023 and 2024 (to date).

Table 6. TBD Metrics on Impacts

Metric	2023	2024 (+)	Total
Number of new agencies adopting TBD data/tools	0	1	1
Citations of core TBD researchers (Google Scholar)	13,451	11,635	25,086

What is the impact on transportation workforce development?

All TBD core faculty teach courses at their respective universities. The typical teaching schedule involves anywhere from two to four courses per year, directed toward both undergraduate and graduate teaching. TBD faculty also supervise the MS and PhD theses of graduate students supported by the TBD grant, numbering over 40 graduate students across all participating institutions. In addition, TBD projects fund undergraduate research assistantships, and train students from multiple disciplines (including civil and environmental engineering, epidemiology, and computer science). The students working together tackle interdisciplinary problems that matter to transportation, safety, health, societal and community wellness, and the economy of a local area. Importantly, the students supported by TBD are drawn from diverse backgrounds, and include undergraduate students (see Table 3). As but just one example of this diversity, research projects at the City College of New York engaged seven female graduate students, including two CCNY Civil Engineering PhD students, two CCNY Data Science Masters students, and three visiting Civil Engineering Masters students from Ecole Nationale Travaux Publics Etat (ENTPE) in Lyon, France. The projects allowed relevant students to meet with local transportation stakeholders and to build applied data analysis and data science skills for transportation applications.

6. CHANGES/PROBLEMS

During the reporting period, Project #14 entitled "Promoting Sustainable Travel within Communities through Behavioral Interventions and Emerging Mobility Solutions" expanded its scope of behavioral interventions to include new categories such as descriptive and injunctive social norm messages. This change was guided by a review and synthesis of literature from the transportation, public health, and energy sectors, where such interventions have proven effective. Additionally, the project explored the concept of seamless connectivity to assess whether providing information about seamless multimodal services could encourage private vehicle users to adopt sustainable modes. This change in approach aims to provide a more comprehensive understanding of behavioral interventions, potentially enhancing the project's effectiveness in promoting shifts toward sustainable travel behaviors.

Changes in approach and reasons for change

Nothing specific to report other than for project #14 as discussed above.

Actual or anticipated problems or delays and actions or plans to resolve them

For project # 9 entitled "Measuring the Last-Mile: A Comprehensive Evaluation of Synthesis Approaches to Address Data Gaps for Local Freight Decision-Making (Phase 1)", we have been slowly gaining access to additional datasets from the NYC DOT to evaluate their potential to estimate specific performance metrics and for local freight data decision-making since these data require separate approval processes to access. To date, we have received access to ATRI, NYC Clean Truck Program AVL data, the NYC DOT TIMS database, and Streetlight data (just in October 2024). We are actively working with NYC DOT to gain access to two additional commercial data sources, Inrix and GeoTab data. We expect to be able to access these data in the next few weeks.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

Nothing to report.

Change of primary performance site location from that originally proposed

Nothing to report.