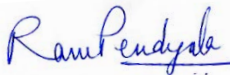


UTC Semi-Annual Progress Report (SAPR#1)



Submitted to:	Arizona State University Office of Research and Sponsored Projects Administration
Prime Federal Grant No:	69A3551747116
Center Title:	Center for Teaching Old Models New Tricks (TOMNET)
Center Associate Director:	Ram M. Pendyala, Professor, Arizona State University ram.pendyala@asu.edu, 480-727-4587
Submission Date:	April 24, 2018
DUNS Number:	943360412
Employer Identification Number:	86-01-96696
Recipient Organization:	Arizona State University Office of Research and Sponsored Projects Administration (ORSPA) PO Box 876011, Tempe, AZ 85287-6011
Grant Period:	December 1, 2016 – September 30, 2022
Reporting Period:	October 1, 2018 – March 31, 2019
Report Frequency:	Semi-Annual
Submitting Official:	 _____ Ram M. Pendyala, PhD, Director

INTRODUCTION

This document constitutes the UTC Semi-Annual Progress Report (SAPR) for the Center for Teaching Old Models New Tricks (TOMNET), a Tier 1 University Transportation Center sponsored by the US Department of Transportation. The center commenced operation on November 30, 2016 and has been active during the period of December 1, 2016 to March 31, 2019. This SAPR covers work accomplished, collaborations with academic, government, and industry partners outside TOMNET, and the center outputs, outcomes, and impacts for the period of October 1, 2018 to March 31, 2019.

1. ACCOMPLISHMENTS

The TOMNET University Transportation Center mission is to advance the state-of-the-art and state-of-the-practice in transportation demand modeling by collecting and incorporating data about human attitudes, behavioral processes, perceptions, values, and preferences in travel models.

What are the major goals of the program?

Because previous progress reports have included detailed information about center goals and mission, only abbreviated information is provided in this report to avoid excessive redundancy across progress reports. The *research* mission of TOMNET is to advance the science of activity-travel behavior modeling by developing new methods for incorporating the effects of people's attitudes, values, preferences, and perceptions in transportation demand forecasting models. The *education* and *workforce development* mission of TOMNET is to train a transportation planning and modeling workforce for the future that is capable of solving complex multi-disciplinary challenges confronting the profession. Solutions to transportation challenges require the ability to leverage concepts, methods, and tools in engineering, humanities, social sciences, behavioral sciences, management sciences, geographical sciences, urban and regional planning, health, economics, and psychology. In addition, a critical mission of TOMNET is to attract a *diverse body* of students into the transportation profession by undertaking a number of K-12 school outreach activities, particularly in under-represented communities. The *technology transfer* mission of TOMNET is to disseminate information about research findings, methods, tools, and data to a global audience of transportation professionals, students, researchers, policy-makers, and the broader public. The center's official technology transfer (T2) plan document, submitted in November 2018, contains details of the center's specific plans to transfer knowledge and develop products for potential deployment in practice. The overall goal of the T2 plan is to move advanced data fusion approaches and modeling methods into practice. TOMNET's mission is to develop tools and methods that would allow agencies to account for attitudes, values, perceptions, and lifestyle and mobility preferences in their travel demand forecasting and modeling processes. It is envisioned that this will help improve accuracy of travel forecasts and provide for more informed decision-making in the wake of disruptive forces and technologies greatly increasing uncertainty associated with long range transportation planning efforts.

What was accomplished under these goals?

Within the reporting period, TOMNET researchers worked on finalizing the outputs of 2017-2018 research projects that were initiated in Fall 2017 and explained in the previous PPRs. Most of the research projects are ongoing efforts and will be concluded at the end of 2019. Annual project reports for these projects have been received during the reporting period, and are being formatted and finalized for posting on the TOMNET center website.

During TOMNET annual meeting on May 9-10, 2018 at Arizona State University, a list of 2018-2019 projects was developed. The 2018-2019 list of selected projects is provided in Table 1. Most of the 2018-2019 research projects are a continuation of 2017-2018 projects which are all labeled with "Phase II" in Table 1. It should be noted that three new 2018-2019 projects are those proposed by faculty

members at Arizona State University outside of the TOMNET core group, who submitted their proposals in response to an open TOMNET Call for Proposals. These projects were selected based on a rigorous peer review process. Due to delays in obtaining 2018-2019 funding, the projects are just getting off the ground and no progress is being reported for those projects.

The following is a summary of progress made on various 2017-2018 projects, with descriptions, accomplishments, and plans for the next year if applicable. It was planned that 2018-2019 projects would commence October 1, 2018; however, the projects are now scheduled to commence officially in Summer 2019. Due to page limitations, only per unit descriptions of progress cannot be furnished here for all projects. For further information please check the center website.

Table 1. 2018-2019 TOMNET Research Projects

Project Topic/Title	Lead	Institution PI
Development of an Integrated Model of Activity-Travel Behavior and Subjective Well-Being	ASU	Ram Pendyala
Data Fusion to Model Residential and Transport Energy Footprint of Households While Considering Attitudinal Variables	ASU	Sara Khoeini
Attitudes Towards Mobility Options/Technologies – A Multi-region Survey Design and Data Collection Effort - Phase II	ASU	Sara Khoeini
Comprehensive Review of Attitudes-Travel Behavior Literature - Phase II	ASU	Deborah Salon
Assembling Integrated Data Sets for Analyzing Connections between Travel Behavior, Attitudes, and the Built Environment - Phase II	ASU	Deborah Salon
Consumer Attitudes and Behavioral Implications in the New Era of Shared Mobility	ASU	Zhongju Zhang
Emerging Approaches to Autonomous Vehicles in Transportation Policy and Planning	ASU	Thaddeus Miller
Consistency Guarantee of Transportation Modeling Calibration and Validation Using Multi-source Data in a Computational Graph Approach	ASU	Xuesong Zhou
Attitudes Towards Mobility Options/Technologies – A Multi-region Survey Design and Data Collection Effort - Phase II	GT	Giovanni Circella
An Investigation of the Contribution of Targeted Marketing Data to the Prediction of Attitudes - Phase II	GT	Patricia Mokhtarian
Attitudes Towards Mobility Options/Technologies – A Multi-region Survey Design and Data Collection Effort - Phase II	USF	Michael Maness
Investigation of the Role of Attitudinal Factors on Adoption of Emerging Automated Vehicle and Vehicle Safety Technologies - Phase II	USF	Fred Mannering
Understanding community behaviors and attitudes for resilience: developing and implementing a scalable survey methodology - Phase II	UW	Cynthia Chen

Note: ASU = Arizona State University; GT = Georgia Institute of Technology; USF = University of South Florida; UW = University of Washington.

Project Title: Attitudes towards Transformative Mobility Options/Technologies – A Multi-region Survey Design and Data Collection Effort (Phase II)

Institution and Investigators: Arizona State University – Sara Khoeini; Georgia Tech – Giovanni Circella; University of South Florida – Michael Maness

Description: To enhance transportation forecasting models such that they can consider the increasing penetration of disruptive mobility options and technologies, people’s attitudes towards and perceptions of these technologies and services need to be measured and understood. This project involved the design of a survey, two phases of respondent recruitment, and subsequent data analysis and modeling for a sample of more than 5000 individuals across Phoenix, Atlanta, Tampa, and Austin metro areas. The collected dataset will be unique in terms of sample size, content, and spatial coverage across multiple southern metro areas. The project team plans to undertake a comparison of attitudes and perceptions with respect to new transportation technologies across metro areas.

During Phase 1 (2017-2018) of this project, a comprehensive literature review of survey design and methodology was performed. A survey questionnaire was designed in accordance with the findings from the review. During the second phase of the project (2018-2019), data collection is going on in two

phases: pilot and full deployment. Pilot phase of data collection was performed during October-November 2018 with a respondent sample size of 260 respondents, which was found to be reasonably representative of the general population in terms of socio-economic and demographic characteristics, provided rich data about mobility patterns and how mobility choices might evolve in the future as emerging transportation technologies, such as autonomous vehicles, increasingly make their way into the marketplace. The email response rate was 2.6% and the mail response rate was 7.1%.

During the reporting period, the research team has compiled and cleaned the pilot data, performed descriptive statistical analysis, and produce the project reports, data documentation and abstracts for upcoming conference presentations. In analyzing attitudes towards emerging mobility options, the research team is uncovering many insights about people's familiarity with and usage of ride-hailing services (such as Uber and Lyft), and level of interest in and willingness to own, share, and use autonomous vehicles. Among the many key findings is that there is a great generational divide in the extent to which people embrace emerging transportation technologies. Among those 21-30 years of age, only four percent indicate that they are not familiar with ride-hailing services. But among those over 70 years of age, 26 percent indicate that they have never heard of such services. Even among those 61-70 years of age, 14 percent indicate not being familiar with the service. For all age groups above 40 years old, more than one-half of the individuals indicate that they are familiar with the service but do not use it. The research team also found that 36 percent of those 21-30 years of age indicated using ride-hailing services at least once a month. The corresponding percentage for those 61-70 years of age is under 11 percent, while that for those over 70 years of age is a mere 6.5 percent (with nobody indicating use on a weekly basis). The project is now proceeding into full deployment across four cities.

Project Title: Development of an Integrated Model of Daily Activity-Travel Behavior and subjective Well-Being

Institution and Investigators: Arizona State University – Ram Pendyala

Description: This project is an effort to develop a model of well-being that explicitly accounts for in-home time allocation to different activities. The preliminary model is estimated using the 2010, 2012, and 2013 well-being modules of the American Time Use Survey (ATUS). The data set includes activity-time use information for an entire day together with feelings on six different emotions using a seven-point scale for three random activity-travel episodes pursued in the day. The final complete model that will be eventually developed in this study includes two major components. First part is a multiple discrete-continuous extreme value (MDCEV) model to allocate total in-home time to various activities. Second part is a factor analysis to derive composite positive and negative measures of well-being; the emotion measures are then modeled as a function of a detailed set of activity-travel episode attributes and socio-economic characteristics. NHTS 2017 activity-travel database is being used to demonstrate the efficacy of the final model. The final product of this well-being model system is called WBEAT (Well-Being Estimator for Activities and Travel) which provides a robust behavioral approach to assess the quality of life implications of transportation investments and policies for all segments of society. The goal for the next period is to enhance the estimated models, evaluate their accuracy and implement them as an open source software tool (WBEAT) to be publicly used.

Project Title: Data Fusion to Model Residential and Transport Energy Footprint of Households While Considering Attitudinal Variables

Institution and Investigators: Arizona State University – Sara Khoeini

Description: The energy footprint of households is inextricably tied to the amount of travel undertaken by households. An integrated model system that tightly connects activity-travel demand, travel energy consumption (sensitive to vehicle fleet/fuel type), and residential energy consumption (sensitive to activity-travel choices) is needed to obtain a holistic picture of household energy footprint. In other words,

household energy footprint is assumed to comprise of two main components. The first component is the transport energy consumption and the second component is the residential energy consumption that stems from electricity, natural gas, and other utility expenditures. The travel energy footprint of a household is dependent on the mix of vehicles owned and used by members of the household, and the extent to which different vehicles in a household are driven. The estimation of the total energy footprint of a household should take into account the potential relationship that may exist between transport and residential energy footprint. The final product of this project is called “integrated transport and residential energy analysis tool (iTREAT)” which will provide a methodology to estimate total household energy expenditure that can be used for planning and policy making in the context of reducing household energy consumption.

Project Title: Assembling Integrated Data Sets for Analyzing Connections between Travel Behavior, Attitudes, and the Built Environment (Phase II)

Institution and Investigators: Arizona State University – Deborah Salon

Description: Transport-related preferences and attitudes have been found to be important determinants of travel choices, given an already-chosen residential location. The hypothesis we are working to test this year is that attitudes, preferences, and personality characteristics *that are unrelated to transport* substantially influence travel choices through their impact on residential location choices. This work builds upon our 2017-2018 TOMNET project Assembling Integrated Data Sets for Analyzing Connections between Travel Behavior, Attitudes, and the Built Environment – Phase I. We have merged three survey data sets that focused on travel choices and attitudes with detailed information from the Zillow corporation about the neighborhoods and specific residences that survey respondents chose to live in. The survey data sets included the 2012 ASU Travel Survey, the 2011 Northern California Commuter Multitasking Survey, and the 2015 California Millennials Survey. Our approach is to estimate statistical models using these three merged datasets, and identify common threads in our findings that indicate generalizability of results. Our primary model specification is a hybrid-choice latent-class model of the choice of residential location that incorporates attitudinal variables. Thus far, we have estimated preliminary versions of these models for the 2012 ASU Travel Survey and for the 2015 California Millennials Survey, and are working to refine them over the next few months. The 2012 Arizona data does not include exact home addresses, so the home characteristics included in our models are medians or averages for homes in the relevant Transportation Analysis Zone (TAZ). In addition, the attitudinal questions included in the 2012 ASU Travel Survey mostly focused on attitudes toward transit, rather than attitudes toward homes or neighborhoods. Our preliminary results are intuitive, but not ground-breaking. For the 2015 California data, we attempted to use only those household responses that included exact home addresses and lived in single family homes. This proved to be quite limiting; the results were largely not statistically significant. We are planning to expand the included data to include all surveyed households, but this means compromising on the home characteristics that can be included in the models.

Project Title: An Investigation of the Contribution of Targeted Marketing Data to the Prediction of Attitudes (Phase II)

Institution and Investigators: Georgia Tech - Patricia Mokhtarian, Giovanni Circella, Kari Watkins

Description: This project involves the “fusion” of two datasets collected in 2016-2017 in Georgia: the behaviorally-rich Georgia add-on to the National Household Travel Survey (“NHTS”, $N \sim 8,000$), and the attitudinally-rich survey designed by the project team and funded by the Georgia Department of Transportation (the “GDOT survey” or dataset, $N \sim 3,500$, before cleaning). The goal of the current project is to use machine learning methods to develop attitude-prediction training functions on the GDOT (donor, or source) sample, which will then be applied to the NHTS (recipient) sample to impute (or “transfer”) attitudes into the latter. The inputs to the training function must be variables that are common, or

available, to both datasets. A previous study used socioeconomic/demographic (SED) and land use (LU) characteristics as the common variables (CVs); a distinctive feature of the current study is the addition of targeted marketing (TM) variables to the CV set. TM variables can be purchased economically from third-party providers (such as the consumer credit reporting agency Experian), and include a host of indicators of lifestyle and various behaviors. During this reporting period, we acquired the TM variables (after a protracted process), and then needed to spend several months cleaning them, discarding unusable cases and variables, selectively imputing missing data (where not too much was missing), and performing dimension reduction activities (principal components analysis, to reduce thousands of individual variables to a smaller number of “components”, or linear combinations of strongly related groups of those variables).

Project Title: Emerging Econometric and Data Collection Methods for Capturing Attitudinal and Social Factors in Activity and Travel Behavior Modeling

Institution and Investigators: University of South Florida - Fred Mannering, Michael Maness

Description: The project team completed work in a number of topics related to this over-arching project. Several topics focused on the goal of assessing emerging transportation options including bikesharing, ridesourcing, and person-to-person renting of personal vehicles. Bikesharing has become increasingly popular in urban areas as an alternative transportation mode that can help relieve congestion, protect the environment, and improve public health through increased physical activity. To study this phenomenon, a statistical analysis of bikesharing use and its potential as an auto-trip substitute was conducted. It was found that health measures, gender, age, income, household size, commute type and length, and vehicle ownership all played significant roles in bikesharing usage and modal substitution decisions. The findings provide insights into the bikesharing decision-making process that can help guide the development of policies to improve the performance of bikesharing systems and making them a more viable transportation option. In other work, the recent growth in the popularity of mobility-on-demand (ridesourcing) has substantially disrupted the transportation market by providing a variety of new transportation options. To study the factors that determine usage rates of new ridesourcing options, a sample of recently collected data was used to estimate statistical models for ridesourcing-usage. Results suggest that ridesourcing usage tends to be driven by a wide variety of individual characteristics and lifestyle choices that can help guide future transportation policies. In the next reporting period we plan to continue disseminating the findings of the above research efforts, and also begin exploring factors that affect transportation safety, and to determine how new modeling methodologies can be used improve current safety-modeling practice.

Project Title: Understanding Community Behaviors and Attitudes for Resilience: Developing and Implementing a Scalable Survey Methodology (Phase II)

Institution and Investigators: University of Washington - Cynthia Chen, Daniel B. Abramson

Description: The overarching goal of the project is to understand, model and develop ways in which communities can leverage unique – and interconnected – physical and social resources of place to enhance their own adaptive capacity. This current phase builds upon findings from previous project phases to implement a pilot survey focused on issues of social trust, place attachment, and disaster preparedness and response as relevant to different modes of transportation and communication services. Understanding the interactions among these three aspects of community will provide us with data to inform strategies for enhancing adaptive capacity via collaborative infrastructure in future phases. Building upon information gathered from the pilot survey and community workshops, this project will further define the concept of collaborative infrastructure. The survey and community workshop methodologies are designed to highlight community strengths in an appreciative inquiry approach,

engaging community partners in a creative, constructive dialogue about the potential benefits and limitations of collaborative infrastructure in both everyday life and during disaster or other disruption.

One of the main accomplishments during the reporting period is conducting workshops. On November 7, 2018, Laurelhurst Earthquake Action Preparedness (LEAP) and a multidisciplinary research team from the University of Washington (UW) co-hosted a public workshop at the Laurelhurst Community Center, creating a forum for neighborhood stakeholders to discuss, via participatory group activities, the qualities that contribute to a resilient community (Figure 2). The workshop helped LEAP to recruit new members by spreading the word about their community emergency preparedness work. Workshop activities, which included community asset mapping and resource matching scenarios, served to build a better understanding of the unique community values and assets that might contribute to strengthening community resilience in Laurelhurst. Approximately 15 community members, five LEAP team members and the UW team participated in the workshop. Moreover, a two-day sequence of workshops on November 16-17 adopted an appreciative inquiry-based protocol to organize multi-scenario tabletop exercises for expert stakeholders using WeTable, and for members of the general public using printed maps. The workshops communicated uncertainties in the science of earthquake, subsidence and tsunami hazards as well as different time horizons of sea level rise; educated the participants in best practices of emergency preparedness and response; and elicited local knowledge of community values, assets, needs and aspirations, and strategies for multi-hazard mitigation that also achieve everyday co-benefits. The community workshops provided valuable information about community assets and values that helped to inform the design of the community resilience survey instrument.

The research team also started administration of Laurelhurst pilot survey. In March 2019, initial mailings for the community resilience pilot survey were sent to randomly sampled members of the Laurelhurst neighborhood. The information is still being collected and analyzed. We expect to be able to report preliminary survey results during the next reporting period. The University of Washington plans to complete the analysis of the data collected during the pilot survey in Laurelhurst (Seattle). Additionally, a full community survey in Laurelhurst will be implemented during the summer and fall quarters of 2019.

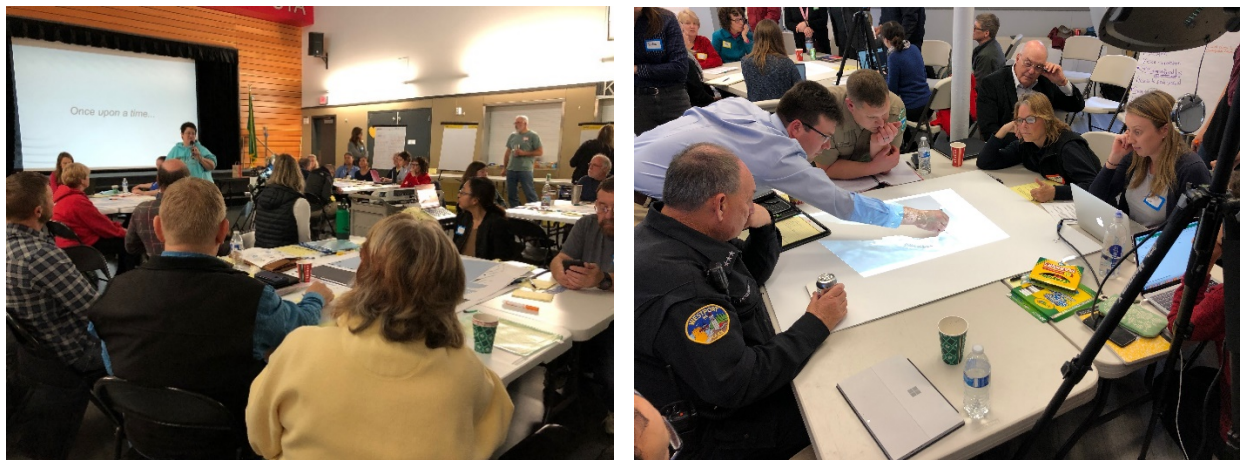


Figure 2 Images from the community resilience workshops on November 16-17 2018

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

In the *education and workforce development* domain, all of the TOMNET partners offered a number of undergraduate and graduate courses at their respective institutions during spring semester of 2019 (that spans the reporting period covered by this SAPR). Table 2 offers a detailed summary of the courses offered by faculty members closely affiliated with the TOMNET center.

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

In the *education and workforce development* domain, all of the TOMNET partners offered a number of undergraduate and graduate courses at their respective institutions during spring semester of 2019 (that spans the reporting period covered by this SAPR). Table 2 offers a detailed summary of the courses offered by faculty members closely affiliated with the TOMNET center.

Table 2. Courses Offered by Mission-Critical Faculty Members of TOMNET (Spring 2019)

Semester	Course Level	Course No.	Course Title	No.	Instructor	Unit
Arizona State University						
Spring19	Undergrad	CEE372	Transportation Engineering	100	Zhou	SSEBE
Spring19	Undergrad	CEE591	Interdisciplinary Transportation Seminar	30	Pendyala	SSEBE
Spring19	Undergrad	CEE598	Transportation Data Collection and Analysis	30	Pendyala	SSEBE
Spring19	Undergrad	PUP424	Planning Methods	27	Salon	SGSUP
Spring19	Graduate	PUP550	Transportation and the Environment	4	Salon	SGSUP
Georgia Institute of Technology						
Spring19	Graduate	CEE 6601	Statistics in Transportation	29	Mokhtarian	CEE
Spring19	Undergrad	CEE 4660	Sustainable Transport Abroad	16	Watkins	CEE
University of South Florida						
Spring19	Graduate	TTE6930	Graduate Transportation Seminar	10	Lu	CEE
Spring19	Graduate	TTE5620	Air Transportation	9	Zhang	CEE
Spring19	Graduate	TTE6657	Sustainable Transportation	28	Bertini/ Jackman	CEE
Spring19	Graduate	TTE6933	Automated Transportation Seminar	12	Li	CEE
Spring19	Graduate	TTE6651	Public Transportation	13	Polzin	CEE
Spring19	Undergrad	TTE4005	Transportation Engineering II	97	Zhang/Chen	CEE
Spring19	Graduate	TTE6315	Transportation Safety	33	Wang	CUTR
Spring19	Undergrad	TTE4004	Transportation Engineering I	27	Maness	CEE
Spring19	Undergrad	CEG4850	Capstone Transportation Design	27	Lu	CEE
Spring19	Graduate	CGN6933	Transportation/Infrastructure Networks	9	Li	CEE
Spring19	Graduate	TTE6501	Statistical and Econometric Methods II	12	Mannering	CEE
University of Washington						
Winter19	Undergrad	URBDP 424/524	Site Planning	13	Abramson	UrbPln
Spring19	Grad/UG	URBDP 423/523	Introduction to Urban Design	27	Abramson	UrbPln
Spring19	Undergrad	CEP 303	Social Structures and Processes	34	Abramson	UrbPln

Notes: Arizona State University; SSEBE = School of Sustainable Engineering and the Built Environment; SGSUP = School of Geographical Sciences and Urban Planning; Georgia Institute of Technology; CEE = School of Civil and Environmental Engineering; University of Washington; CEE = Department of Civil and Environmental Engineering; University of South Florida; CEE = Department of Civil and Environmental Engineering

It should be noted that there are many additional transportation-related courses taught at each institution at both undergraduate and graduate levels; however, the scope of activities reported in this SAPR is limited to the activities of faculty members who comprise the core group of TOMNET and are deeply engaged in advancing the activities and mission of the center. In addition, TOMNET faculty supervised a number of students and post-doctoral scholars, providing them guidance and mentorship necessary to pursue independent research and discovery. Students engaged in TOMNET related research and education activities are listed in Table 3. Besides graduate students pursuing Masters and PhD degrees, the TOMNET consortium is involving five undergraduate students in various research endeavors in an effort to provide research experiences for undergraduate students and inspire them to pursue advanced studies and a career in transportation systems engineering and planning.

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

Name of Scholar	Level	Major/ Unit	Supervisor/ Advisor	Gender
Arizona State University				
Irfan Batur	PhD Student	SSEBE	Pendyala	M
Allison Charles	Undergrad	SSEBE	Pendyala	F
Matthew Conway	PhD Student	SGSUP	Salon	M
Eileen Imbus	Undergrad	SSEBE	Pendyala	F
Elyse Kats	Undergrad	SOS	Salon	F
Tae Hooie Kim	PhD Student	SSEBE	Pendyala	M
Tassio Bezerra Magassy	PhD Student	SSEBE	Pendyala	M
Sarah Moran	Undergrad	CIDSE	Pendyala	F
Amy Santilli	Undergrad	SSEBE	Pendyala	F
Shivam Sharda	PhD Student	SSEBE	Pendyala	M
Denise Capasso da Silva	PhD Student	SSEBE	Pendyala/Khoeini	F
Georgia Tech				
Gwen Kash	Postdoc	CEE	Mokhtarian	F
Yongsung Lee	Postdoc	CEE	Circella	M
Ali Etezady	PhD Student	CEE	Circella/Mokhtarian	M
Alyas Widita	PhD Student	SCaRP	Circella	M
Xinyi Wang	PhD Student	CEE	Mokhtarian	F
Faaïqa (Atiyya) Shaw	PhD Student	CEE	Mokhtarian	F
Aliaksandr Malokin	PhD Student	CEE	Mokhtarian	M
Sung Hoo Kim	PhD Student	CEE	Mokhtarian	M
University of South Florida				
Suryaprasanna Balusu	Graduate	CEE	Mannering/Pinjari	M
Natalia Barbour	Graduate	CEE	Zhang/Mannering	F
Nawaf Alnawmasi	Graduate	CEE	Mannering	M
Asim Alogaili	Graduate	CEE	Mannering	M
Dr. Nikhil Menon	Post-doc	CEE	Bertini	M
Trang Luong	Graduate	CEE	Maness	F
Divyamitra Misha	Graduate	CEE	Maness	F
University of Washington				
Katie Idziorek	PhD Student	Urban Planning	Chen/Abramson	F
Xi Zhu	PhD Student	Urban Planning	Abramson	F
Feilong Wang	Post-doc	CEE	Chen	M
Jenny Phan	PhD Student	CEE	Chen	F

Notes: Please use the information below table 2.

In the *technology transfer* domain, Arizona State University continued the **weekly TOMNET webinar/seminar series** that is presented to a worldwide audience through the webinar arrangement on TOMNET website. The recorded webinars are available on TOMNET's website for further reference. Table 4 presents a list of TOMNET-sponsored seminars for the period covered by this SAPR. Speakers met with TOMNET faculty and students, thus enabling the development of collaborative ties.

Table 4. Key TOMNET-Sponsored Technology Transfer Seminars

Title of Seminar	Speaker Name and Affiliation	Date	Atten.
Locating Platforms and Scheduling a Fleet of Drones for Emergency Delivery of Perishable Items	Pitu Mirchandani, PhD Professor & AVNET Chair, Arizona State University	10/12/18	30
Innovations in Rubberized Asphalt Technology	Douglas D. Carlson Vice President of Asphalt Products, Liberty Tire Recycling	10/19/18	30
Automating Special Generator Traffic Counts Using Video and Wifi/Bluetooth Detection	Peter R. Stopher, PhD Professor Emeritus, University of Sydney, Australia	10/26/18	30
Integrating Shared Autonomous Fleet Services in	Hani S. Mahmassani, PhD	11/02/18	30

Urban Mobility: Dynamic Network Models for System Operation and Evaluation	Professor, Northwestern University		
Multi-Scale Analysis of Transportation Electrification to Quantify Physical and Economic Impacts of Vehicle Grid Integration	Colin Sheppard, PhD Senior Scientific Engineering Associate, Lawrence Berkeley National Laboratory	11/09/18	30
Synthesizing Household and Person-Level Attributes Jointly for Individual Geographies Using Hidden Markov Model	Karthik C. Konduri, PhD Senior Research Scientist, Amazon	11/30/18	30
Time in Cyber-Physical Systems	Aviral Shrivastava Professor, Arizona State University	01/31/19	30
Highway Design and Modeling	Paul Balch Project Manager, Dibble Engineering	02/07/19	30
Phoenix Light Rail Collision Study and Results	Paul Basha, PE, PTOE Transportation Director, City of Scottsdale, Arizona	02/14/19	30
Multi-Objective Location Modeling and Genetic Algorithms	Mark S. Daskin, PhD Clyde W. Johnson Professor, University of Michigan	02/21/19	30
ADOT Transportation Systems Management & Operations (TSMO)	Brent Cain Arizona Department of Transportation	02/28/19	30
User Exchanges of Transportation Supply and New Operational Paradigms in a Shared-Connected-Autonomous Future	R. Jayakrishnan Professor, University of California at Irvine	03/21/19	30
Why is Public Transit Losing Riders: A View from California	Brian D. Taylor, PhD Professor, University of California at Los Angeles	03/28/19	30

TOMNET has launched a **TOMNET Leadership Webinar Series** featuring research by core/lead faculty members of the TOMNET Center during the reporting period of this SAPR. Table 5 presents a list of TOMNET-sponsored leadership webinars for the period covered by this SAPR.

Table 5. Key TOMNET-Sponsored Technology Transfer Webinars

Title of Webinar	Speaker Name and Affiliation	Date	Atten.
Using Hybrid Choice Models to Differentiate Opinion Neutrality and Unfamiliarity	Michael Maness, PhD University of South Florida	12/05/18	30
Promises of Big Data in Transportation Planning Applications	Cynthia Chen, PhD University of Washington	12/13/18	30
How to Integrate Deep Learning Methods with Transportation Model Calibration: A Computational Graph-Based Approach with Multiple Data Sources	Xuesong Zhou, PhD Associate Professor, Arizona State University	02/01/19	30
The Role of Temporal Instability in Transportation Modeling: The Example of Highway Accident Data	Fred L. Mannering, PhD University of South Florida	02/19/19	30
Travel Behaviors and Vehicle Ownership in the Era of the "3 Revolutions" in Transportation	Giovanni Circella, PhD Georgia Institute of Technology	03/22/19	30

Additionally, all of the other TOMNET partner institutions have transportation seminar series that are open to the public and professionals in the community. These seminars are generally held on a weekly basis at each of the institutions and include a mix of attendees comprising of students, professionals, academics, scholars, and members of the public. TOMNET faculty members are participating in existing transportation seminar series at each institution, and helping to organize specific seminars that are badged as TOMNET-sponsored seminars. These seminars, delivered by renowned speakers, specifically address topic areas of relevance to TOMNET and are of broad interest to the professional community.

During December 10-14, 2018, TOMNET offered a four-day **Workshop on Travel Survey Methods for Behavioral Analysis** at Arizona State University. This workshop introduced participants to all aspects of the conceptualization, design, administration, and quality control of sample surveys. The workshop included a detailed treatment of sampling methods, design of surveying instruments, conducting pilot

surveys and pretests, and how to administer surveys in cost-efficient ways while maintaining strict survey ethics and robust quality control protocols. The primary instructor of the workshop was **Professor Peter R. Stopher**, an internationally renowned expert and authority in transport survey methods, disaggregate travel demand forecasting, and modeling traveler behavior and values. The workshop offered reduced registration fee for Public Agencies, Universities, Government, Full-time Students, TOMNET Sponsors and TOMNET Partners. Professor Patricia Mokhtarian and Ram Pendyala served as guest workshop lecturers.

The other major technology transfer event sponsored by TOMNET during this SAPR reporting period is a short course entitled "Connected and Autonomous Vehicles 101" Education for Arizona Small Towns and Satellite Cities. This "CAV 101" course was approved for 5.0 hours of Certification Maintenance (CM) credit for the American Institute of Certified Planners (AICP). This full-day seminar explored key aspects of the Autonomous Vehicle Economy and the infrastructure and policy changes that satellite cities, small towns and rural communities need to make in order to take advantage of electrification and self-driving technologies. The list of workshop speakers which includes TOMNET center director Dr. Pendyala is provided in Table 6. For more information about this course and its administration in other places can be found at the course website (<https://cav101seminars.jimdofree.com>).

Table 6. Short Courses/Workshops Hosted or Conducted by TOMNET Core Faculty

Title of Workshop/Short Course	Workshop Instructors	Date	Location	Atten.
Travel Survey Methods for Behavioral Analysis	Peter R. Stopher, PhD Professor Emeritus, Institute of Transport & Logistics Studies, University of Sydney, Australia	12/10/18-12/14/18	ASU	19
CAV101 - Connected and Autonomous Vehicle Basics for Arizona Municipalities	Dale Neef Technology and Economics Writer Founder, DNA Solutions	03/14/19	ASU	57

In addition to the official outreach activities stated above, TOMNET faculty and researchers participated in a number of other activities. Patricia Mokhtarian has written several blogs reflecting on graduate school and academic careers in transportation (<https://medium.com/zephyrfoundation/sage-musings-volume-1-issue-2-8351a29de38>). These activities help demystify grad school/academia to undergraduate students and early-career professionals who may be contemplating an advanced degree but not having role models or friends they can ask about it. Patricia Mokhtarian also recorded a podcast November 5, 2018 (<https://podcast.coe.gatech.edu/podcasts/uncommon-engineer/travel-behavior-pat-mokhtarian>), in which she was interviewed about her research by the Dean of Engineering at Georgia Tech. The podcasts in this series are widely disseminated to market Georgia Tech to all audiences. Patricia Mokhtarian participated in a faculty chat with students (primarily graduate students, but including undergraduates) hosted by the Women’s Transportation Seminar Georgia Tech chapter on April 9, 2019.

Together with undergraduate student Elyse Kats, TOMNET faculty Deborah Salon organized a session and presented research on home location choices at the 2019 American Geographers Association Annual Meeting. This was qualitative research, based on interviews conducted over the past year. This work will also be the subject of an upcoming TOMNET webinar given by Salon in May 2019.

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

TOMNET has a number of activities planned for the next reporting period to ensure rapid growth in the portfolio of accomplishments of the center. In the *research* domain, TOMNET faculty members will continue making progress on year 2 research projects and the results will be disseminated widely through various channels. Moreover, TOMNET team will meet again during the next reporting period at Georgia Tech to discuss TOMNET progress and future plans, including the recently selected projects.

In the *education and workforce development* domain, TOMNET faculty members will continue to teach undergraduate and graduate courses at their respective institutions while enhancing the content to reflect new discoveries and trends in the profession. In particular, TOMNET faculty members are introducing concepts related to traveler behavior and values, attitudes and perceptions, and data fusion and machine learning technologies in their courses. TOMNET faculty members will continue to mentor students and guide them to completion of their studies and towards appropriate career pathways in transportation.

TOMNET faculty Deborah Salon and PhD student Matthew Conway are coordinating a student learning and research experience for a mixed class of advanced undergraduates and graduate students in Fall 2019 at ASU. The course will focus on teaching students to read, understand, and evaluate the portion of the literature that is at the core of the TOMNET concept: the role of attitudes in determining travel-related choices. The goal is to finish the semester with a comprehensive draft review of this literature which will be co-authored by all participating students. Moreover, TOMNET faculty member Deborah Salon will participate in the Transportation YOU high school program in Mesa, AZ, which introduces high school students to transportation research and related careers.

TOMNET faculty member, Patricia Mokhtarian will continue to write blogs in the “Sage Musings” series and she will report TOMNET research in a Mobility Lab blog on April 2, 2019 (<https://mobilitylab.org/2019/04/02/convenience-has-bigger-effect-on-transit-ridership-than-multitasking-study-finds/>). Several additional activities are being planned to further advance the educational component of the TOMNET portfolio of accomplishments. First, TOMNET will be launching a data science challenge, inviting students from around the world to participate in a data challenge and student paper competition. Students will be required to submit entries that aim to enhance the profession’s understanding of the relationships between traveler attitudes, behaviors, perceptions, and preferences, while clearly explaining how their submissions can be translated into real-world tools and models that can be implemented in planning agencies to advance the state-of-the-practice. This data challenge and student paper competition will be launched in Fall 2019. Second, TOMNET scholars will continue to engage in considerable K-12 and community college outreach activities.

In the *technology transfer* domain, the TOMNET team will continue to organize and conduct webinars/seminars/short courses such as those listed previously in Table 4, 5, and 6. These webinars will be recorded and archived at the TOMNET website for the benefit of those who could not attend the webinars live and in-person. The seminars and webinars will be publicized via various distribution lists and e-mail listservs. Discussions are underway to organize an annual symposium, called the A⁴ Symposium. This symposium will focus on Attitudes, Automation, Autonomy, and Access (hence, A⁴) and bring together the many key themes addressed by TOMNET. The first symposium will likely be held in Fall 2019, with a view to bring together a diverse worldwide audience working in these domains and discuss methods, tools, and models that can help leverage data about attitudes and behaviors to understand how the future of transportation may evolve in an era of automation and autonomy (as well as *sharing*).

TOMNET will expand the reach of its newsletter and launch a blog within the next reporting period to greatly enhance the impact and reach of its technology transfer activities. The newsletter will be sent to an e-mail list of more than 1,500 professionals that TOMNET partners have carefully assembled through their respective networks. TOMNET also plans on participating in social networks to communicate its research and education achievements via social media platforms. In addition, TOMNET will present its accomplishments in USDOT’s 2019 last quarter newsletter.

Needless to say, TOMNET researchers and scholars will continue to engage in many traditional technology transfer activities that involve presenting research results at conferences and symposia around the country and world, writing papers for publication in journals and conference proceedings, preparing manuscripts for publication in edited books and volumes, and guest editing special issues of journals dedicated to topics of interest to TOMNET.

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

TOMNET researchers have been actively collaborating with a number of organizations and partners in academia and industry. TOMNET has actively pursued partnerships and engaged with a number of entities so that the research projects and products are of value to a broad set of stakeholders and constituents. As mentioned in the previous PPPR, TOMNET has a very significant ongoing partnership with the Maricopa Association of Governments (MAG), the regional metropolitan planning organization (MPO) for the Greater Phoenix Metropolitan Area. This partnership continues to provide many opportunities for students to engage in tackling real-world planning problems, and for testing TOMNET products in an agency setting.

What organizations have been involved as partners?

- City of Westport, Westport, WA: Collaborative research, supplied facilities
- Georgia Department of Transportation, Atlanta, Georgia: In-kind support, data sets, collaborative research, funding of matching-project research
- Laurelhurst Earthquake Action Preparedness, Seattle, WA: Collaborative research, supplied facilities
- Maricopa Association of Governments, Phoenix, Arizona: In-kind support, data sets, collaborative research
- Oak Ridge National Laboratory: models, data sets, collaborative research
- Westport Tsunami Safety Committee, Westport, WA: Collaborative research

Have other collaborators or contacts been involved?

- City of Seattle Office of Emergency Management, Seattle, WA
- Farzad Alemi, Ph.D. Institute of Transportation Studies, University of California, Davis (several papers published, under review, and in progress)
- Grays Harbor County Emergency Management
- Laurie Garrow (Civil & Environmental Engineering) and Brian German (Aerospace Engineering), Professors of Georgia Tech (a journal article under peer review; new data analysis underway)
- Northwest Healthcare Response Network
- Ocosta Public School District
- Patrick Singleton, an Assistant Professor at Utah State University (one paper under revision for resubmission for review)
- Rolf Moeckel of the Technical University of Munich (TUM) on the annual Transportation Research Board Doctoral Dissertation Workshop, and as a partner in a TUM-funded project
- Shoalwater Bay Tribe
- South Beach Regional Fire Authority
- Sungtaek Choi, Ph.D., a visiting postdoc from Hongik University, South Korea (one paper nearing submission to a journal, and others in progress)
- Washington Emergency Management Division
- Washington State Parks
- Westport Police Department
- Zhenhong Lin of the Energy and Transportation Science Division, Oak Ridge National Laboratory

TOMNET researchers have a very close working relationship with members of the D-STOP University Transportation Center led by the Center for Transportation Research at the University of Texas at Austin. TOMNET and D-STOP have elevated their level of cooperation in the past year, generating four jointly authored papers that were all presented at the 98th Annual Meeting of the Transportation Research

Board being held in January 2019. A key element of the strategic partnership between the two centers is the participation of D-STOP in the multicity survey on attitudes towards and adoption of transformative transportation technologies. The University of Texas at Austin D-STOP researchers are participating in the development of the survey and will be administering the same survey in Austin, Texas, thus enabling the addition of another city to the overall project effort (thus, the survey is going to be administered in Phoenix, Tampa, Atlanta, and Austin). TOMNET team members are pursuing close working relationships with other University Transportation Centers. Currently, there is a close working relationship with the Regional UTC in the Pacific Northwest, the National UTC led by the University of California at Davis, and the Regional UTC in Region 9 led by the University of Southern California.

TOMNET has played a critical role in the formation of new collaborative partnerships. TOMNET has facilitated meetings with a number of industry stakeholders. TOMNET Director, Ram Pendyala, has played a key role in advancing conversations with a number of industry partners. These conversations are ongoing and areas of collaboration are being identified. These conversations include the formation of an Institute for Automated Mobility (IAM) in Arizona that involves all three major public universities in Arizona, industry partners, and the Arizona Commerce Authority (ACA). TOMNET has participated in conversations with the City of Tempe on adaptive planning for automated vehicles, and with Intel to serve as the inaugural private industry partner in IAM. TOMNET is also collaborating with staff at Maricopa County Department of Transportation and Arizona Department of Transportation on data fusion, data analysis, and experimental testing of new models and methods developed by TOMNET.

3. OUTPUTS

The following is a list of **publications and conference papers** produced by TOMNET core faculty members during the reporting period covered by this PPPR. To the extent possible, papers and presentations likely to be listed in other UTC PPPR documents have been omitted to avoid double-counting products.

Arizona State University

Forthcoming Publications Accepted for Publication in Reporting Period

1. Dias, F.F., P.S. Lavieri, T. Kim, C.R. Bhat, and R.M. Pendyala (2019) Fusing multiple sources of data to understand ride-hailing use. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).
2. Long, K., D. Capasso da Silva, F.F. Dias, S. Khoeini, A.C. Bhat, R.M. Pendyala, and C.R. Bhat (2019) The role of childhood context and experience in shaping activity-travel choices in adulthood. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).
3. Nair, G.S., C.R. Bhat, R.M. Pendyala, B.P.Y. Loo, and W.H.K. Lam (2019) On the use of probit based models for ranking data analysis. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).

Papers Published Within Reporting Period

1. Hutchinson, J., D.C. Silva, F.F. Dias, C.R. Bhat, S. Khoeini, R.M. Pendyala, & W.H.K. Lam (2019) Exploring patterns of heterogeneity in activity-travel behaviors of older people. *Transportation Research Board 98th Annual Meeting* (19-03074)
2. Musili, C., & Salon, D. (2019). Do Private Transport Services Complement or Compete against Public Transit? Evidence from the Commuter Vans in Eastern Queens, New York. *Urban Science*, 3(1), 24.
3. Nair, G. S., S. Astroza, C.R. Bhat, S. Khoeini, & R.M. Pendyala (2018) An application of a rank ordered probit modeling approach to understanding level of interest in autonomous vehicles. *Transportation*, 45 (6), 1623-1637.
4. Salon, D., Conway, M. W., Wang, K., & Roth, N. (2019). Heterogeneity in the relationship between biking and the built environment. *Journal of Transport and Land Use*, 12(1).

5. Sharda, S., D.C. Silva, S. Khoeini, & R.M. Pendyala (2019) What contributes to risky driving behaviors and secondary task engagement: A descriptive analysis of naturalistic driving data. *Proceedings of the 5th Conference of the Transportation Research Group of India*, Springer Procedia.
6. Sharda, S., D.C. Silva, K.J. Grimm, S. Khoeini, & R.M. Pendyala (2019) Modeling determinants of risky driving behaviors and secondary task engagement using naturalistic driving study data. *Transportation Research E-Circular E-C243*, Transportation Research Board, National Academies, Washington, D.C., pp. 41-56.
7. Sharda, S., S. Astroza, S. Khoeini, I. Batur, R.M. Pendyala, & C.R. Bhat (2019) Do attitudes affect behavioral choices or vice-versa: Uncovering latent segments within a population. *Transportation Research Board 98th Annual Meeting (19-03183)*.
8. Sharda, S., D.C. Silva, K.J. Grimm, S. Khoeini, & R.M. Pendyala (2019) Modeling determinants of risky driving behaviors and secondary task engagement using naturalistic driving data. *SHRP 2 Safety Data Student Paper Competition*, 41.
9. Silva, D.C., S. Khoeini, & R.M. Pendyala (2019) The effect of attitudes on women's willingness to share autonomous vehicles. *Proceedings of the 6th International Conference on Women's Issues in Transportation*, Transportation Research Board, National Academies, Washington, D.C.
10. Vinayak, P., F.F. Dias, S. Astroza, C.R. Bhat, R.M. Pendyala, & V.M. Garikapati (2018) Accounting for multidimensional dependencies among decision-makers within a generalized model framework: An application to understanding shared mobility service usage levels. *Transport Policy*, 72, 129-137

Presentations Within Reporting Period

1. Salon, D. (2019) How do we choose where to live? *American Association of Geographers Annual Meeting*. Washington, D.C., April.
2. Kats, E. (2019) Residential choice theory and sustainable transit. *American Association of Geographers Annual Meeting*. Washington, D.C., April.
3. Salon, D. & Conway, M. (2019) Variation in the cost of car ownership in the United States. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
4. Conway, M. (2019) Utilization rates and fleet sizes for shared autonomous vehicles. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
5. Conway, M., Salon, D., & King, D. (2019) Trends in taxi usage and the advent of ridehailing, 1995–2017. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
6. Salon, D., & Gulyani, S. (2019) Commuting in urban Kenya: Insights from a large household survey. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
7. Sharda, S., Silva, D.C., Grimm, K.J., Khoeini, S., & Pendyala, R.M. (2019) Modeling determinants of risky driving behaviors and secondary task engagement using naturalistic driving study data. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
8. Hutchinson, J., Silva, D.C., Dias, F., Bhat, C.R., Khoeini, S., Pendyala, R.M., & Lam, W.H.K. (2019) Exploring patterns of heterogeneity in activity travel behaviors of the elderly. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
9. Sharda, S., Astroza, S., Khoeini, S., Batur, I., Pendyala, R.M., & Bhat, C.R. (2019) Do attitudes affect behavioral choices or vice versa? uncovering latent segments within a population. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
10. Nair, G.S., Bhat, C.R., Pendyala, R.M., Loo, B.P.Y., & Lam, W.H.K. (2019) On the use of probit based models for ranking data analysis. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
11. Long, K., Silva, D.C., Dias, F.F., Khoeini, S., Bhat, A.C., Pendyala, R.M., & Bhat, C.R. (2019) The role of childhood context and experience in shaping activity-travel choices in adulthood. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
12. Dias, F.F., Lavieri, P.S., Kim, T., Bhat, C.R., & Pendyala, R.M. (2019) Fusing multiple sources of data to understand ride-hailing use. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.

13. Pendyala, R.M. (2018) Potential implications of autonomous vehicles on travel demand. Invited Speaker at the APWA ASCE Joint Luncheon, Phoenix, AZ, November.
14. Pendyala, R.M. (2018) It's all about the size of the effects: The case of the millennials difference and the influence of the built environment. Invited Seminar presentation at the Department of Civil and Environmental Engineering, University of Washington, Seattle, WA, November.
15. Pendyala, R.M. (2018) Innovative solutions & applications for congestion mitigation. Invited presentation at the IRF R2T Conference & Expo, International Road Federation, Las Vegas, NV, November.
16. Salon, D., & Gulyani, S. (2018) Commuting in urban Kenya: Insights from a large household survey. *Association of Collegiate Schools of Planning Conference*. Buffalo, NY, October.

Georgia Institute of Technology

Forthcoming Publications Accepted for Publication in Reporting Period

1. Clark, C., Mokhtarian, P.L., Circella, G., & Watkins, K.E. (2019) User preferences for bicycle infrastructure in communities with emerging cycling cultures. *Transportation Research Record*.

Papers Published Within Reporting Period

1. Alemi, F., Circella, G., Mokhtarian, P.L., & Handy, S. (2019) What drives the use of ridehailing in California? Ordered probit models of the usage frequency of uber and lyft. *Transportation Research C* 102, 233-248.
2. Malokin, A., Circella, G., & Mokhtarian, P.L. (2019) How do activities conducted while commuting influence mode choice? Using revealed preference models to inform public transportation advantage and autonomous vehicle scenarios. *Transportation Research A* 124, 82-114.
3. Mishra, G.S., Mokhtarian, P.L., Clewlow, R.R., & Widaman, K.F. (2019) Addressing the joint occurrence of self selection and simultaneity biases in the estimation of program effects based on cross-sectional observational surveys: Case study of travel behavior effects in carsharing. *Transportation* 46, 95-123. <http://dx.doi.org/10.1007/s11116-017-9791-1>.
4. Mokhtarian, P.L. (2019) Subjective well-being and travel: Retrospect and prospect. *Transportation* 46(2), 493-513. <https://doi.org/10.1007/s11116-018-9935-y>.
5. Mokhtarian, P.L. (2018) The times they are a-changin': What do the expanding uses of travel time portend for policy, planning, and life? *Transportation Research Record* 2672(47), 1-11. <https://doi.org/10.1177/0361198118798602>.

Book Chapter Published Within Reporting Period

1. Borning, A., & K. Watkins (2019) The Land Use, Transportation, and Environmental Projects. in *Value Sensitive Design: Shaping Technology with Moral Imagination*. MIT Press.

Presentations Within Reporting Period

1. Mokhtarian, P.L. (2019) The Evolution of the Value of Time Spent in Transportation. Presented at InOut 2019, Rennes, France, March.
2. Etezady, A., Shaw, F.A., Circella, G., & Mokhtarian, P.L. (2019) What drives the gap? Decomposing transport-related attitudinal differences between millennials and generation X. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
3. Lee, Y., Circella, G., Mokhtarian, P.L., & Guhathakurta, S. (2019) Heterogeneous residential preferences among millennials and the members of generation x in California: A latent-class approach. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
4. Kim, S.H., Circella, G., & Mokhtarian, P.L. (2019) Identifying latent mode-use propensity segments in an all-AV era. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
5. Shaw, F.A., Malokin, A., Mokhtarian, P.L., & Circella, G. (2019) Who doesn't mind waiting? A revealed-preference study of Northern California commuters. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.

6. Watkins, K. (2018). How driverless cars will change the world. Panel sponsored by *Newsweek*, Atlanta, GA, December.
7. Clark, C., Mokhtarian, P.L., Circella, G., & Watkins, K. (2018) Bicyclist facility preferences and impacts on perceived safety, perceived comfort, and willingness to try cycling. Presented at the *International Cycling Safety Conference*, Barcelona.

University of South Florida

Forthcoming Publications Accepted for Publication in Reporting Period

1. Maness, M., & Lin, Z. (2019) Free charging: Exploratory study of its impact on electric vehicle sales and energy. Forthcoming in *Transportation Research Record: Journal of the Transportation Research Board*.
2. Sheela, P., & Mannering, F. (2019) The effect of information on changing opinions toward autonomous vehicle adoption: An exploratory analysis. Forthcoming in the *International Journal of Sustainable Transportation*, <https://doi.org/10.1080/15568318.2019.1573389>.

Papers Published Within Reporting Period

1. Alnawmasi, N., & Mannering, F. (2019) A statistical assessment of temporal instability in the factors determining motorcyclist injury severities. *Analytic Methods in Accident Research* 100090, 1-20.
2. Barbour, N., Zhang, Y., & Mannering, F. (2019) A statistical analysis of bikesharing use and its potential as an auto-trip substitute. *Journal of Transport and Health* 12, 253-262.
3. Menon, N., Barbour, N., Zhang, Y., Pinjari, A., & Mannering, F. (2019) Shared autonomous vehicles and their potential impacts on household vehicle ownership: An exploratory empirical assessment. *International Journal of Sustainable Transportation* 13(2), 111-122.

Presentations Within Reporting Period

1. Maness, M., & Lin, Z. (2019) The Value of Free Electric Vehicle Charging Infrastructure: An Exploratory Analysis. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
2. Maness, M. (2018) Exploring the Effects of Social Resources on Leisure Activity and Autonomous Vehicle Intention. Presented at the *2018 INFORMS Annual Meeting*.
3. Maness, M. (2018) Developing a Survey for Modeling Autonomous Vehicle Adoption Through Weak Tie Social Capital and Diffusion of Innovation Constructs. Presented at the *2018 Behavior, Energy, and Climate Change Conference*, Washington, DC.

University of Washington

Presentations Within Reporting Period

1. Idziorek, K., Chen, C. & Abramson, D.B. (2019) The contribution of social networks and resource sharing to community adaptive capacity. Presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
2. Idziorek, K. (2019) Participatory GIS for coastal resilience. Poster presented at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., January.
3. Idziorek, K., & Abramson, D.B. (2018). Enhancing community health with resilient socio-technical networks. Paper presented at the Association of Collegiate Schools of Planning National Conference, Buffalo, NY. October.

In summary, TOMNET core faculty generated 18 publications in well-respected journals within the reporting period covered by this SAPR. These publications are directly attributable to funding provided by the TOMNET UTC. Within reporting period of this SAPR, the 98th Annual Meeting of the Transportation Research Board took place in Washington, DC during January, 2019. TOMNET was well-represented with 20 presentations and TOMNET faculty and scholars were actively represented in different venues of this event serving as committee members and chairs, session chairs, etc. There are many other publications and presentations, made possible through several complementary and collaborative initiatives, including

student theses and dissertations, that address and advance the discourse on TOMNET topics and themes. However, they are not listed here for the sake of brevity.

In addition to the 20 presentations delivered at 98th Annual Meeting of the Transportation Research Board, TOMNET researchers delivered presentations at other conferences, symposia, seminars, and events around the world. In summary, TOMNET core faculty, post-docs, and students delivered a total of 29 presentations during the reporting period covered by this SAPR. Many of these presentations are directly attributable to work being undertaken under the auspices of TOMNET, and serve as a mechanism for making the broader community aware of the research and technology transfer activities of the Center.

On February 21, 2019, Ms. Trang Luong was recognized as the Student Engineer of the Year for the University of South Florida Engineering Alumni Society (USF EAS) at the Tampa Bay Engineers Week Banquet. This award was a recognition for Ms. Luong's long-time involvement with USF EAS. She helped promote EAS memberships among graduating seniors and served as a student liaison to connect engineering students with young alumni. She represented EAS in campus-wide events such as homecoming parades and homecoming football games. Since 2015, she has worked with the EAS Board to help plan and host the signature Bullarney annual event to fundraise more than \$5000 of student scholarships.

Website(s) or other Internet site(s)

One major product of the center is the TOMNET website that is being continuously enhanced to support the mission of the center. The website, <http://www.tomnet-utc.org>, is a portal with comprehensive information about activities of the Center. Research project descriptions have also been entered in the RiP (Research in Progress) database (eight projects can be seen by doing a keyword search on TOMNET). In addition, individual faculty members maintain their own websites with information about their publications, presentations, research projects, professional activities, and courses. A few websites of interest and relevance to advancing the TOMNET mission include the following:

1. <http://www.mobilityanalytics.org>: This is the website of the research group of Professor Ram Pendyala, the Director of TOMNET.
2. <https://sustainability.asu.edu/person/deborah-salon/>: This is the website of Professor Deborah Salon, who serves as an Associate Director of TOMNET.
3. <http://mokhtarian.ce.gatech.edu/>: This is the website of Professor Patricia Mokhtarian, who serves as the Research Director of TOMNET.
4. <http://cee.eng.usf.edu/faculty/flm/>: This is the website of Professor Fred Mannering, who serves as an Associate Director of TOMNET.
5. <http://www.michaelmaness.com>: This is the website of Michael Maness, postdoctoral scholar who serves as a Senior Investigator for TOMNET
6. <http://depts.washington.edu/thinklab/>: This is the website of Professor Cynthia Chen's laboratory and research group. Professor Chen is an Associate Director of TOMNET.

Over time, the TOMNET UTC website will be enhanced further to serve as a major resource to the broader community of scholars and practitioners in the transportation industry.

Software Programs, Codes, and Products

During the reporting period covered by this SAPR, the TOMNET team has worked diligently towards developing a few key products that would be of value to the transportation planning and modeling community. First, as reported in the previous PPPR, the TOMNET team has been diligently working towards deploying a **synthetic population generator called PopGen** in the cloud. A beta version is now available and being tested. It is anticipated that worldwide release will occur in about 6-12 months, as

the cloud-based systems need to be fully setup to allow remote execution of PopGen and saving of results to a personal private account.

Over the past year, TOMNET has developed comprehensive **survey instruments** that can be used to measure behaviors, attitudes, perceptions, and preferences in the domain of future transportation technologies and mobility options. These survey instruments have been shared with a number of agencies, industry partners, and cities and counties so that they can replicate data collection efforts for their own planning purposes. The University of Washington team has developed a standardized **survey instrument** that can be used to collect data on how communities access information and respond to disaster situations and crises. This survey is a product that the TOMNET team envisions making available to any community that may wish to collect such data.

As mentioned earlier, TOMNET is developing two major software products. The integrated Transportation and Residential Energy Analysis Tool (iTREAT) is under development. The beta version of this calculator is already implemented and researchers are working to improve the validation as well as the application and visualization features of the tool. This integrated model system provides a methodology to estimate total household and transportation energy expenditure and can be used for planning and policy making in the context of reducing household energy consumption. In addition, TOMNET is developing the Wellbeing Estimator for Activities and Travel (WBEAT). This special model is intended to serve as an add-on module for any activity-based travel demand model system. The methodology embedded in the module calculates a wellbeing index for each person in the simulation based on the activities (predicted to be) undertaken by that individual (including “travel” episodes) over the course of a day.

Databases and Research Materials

In a number of TOMNET projects, integrated datasets have been developed (or are under development) using data fusion techniques with a view 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 automated vehicle technologies. Some of the data sets are based on native survey data collection efforts undertaken by the TOMNET team. Other data sets have been assembled by integrating and fusing data that is already available in the public domain. For example, for modeling the energy footprint of households, data from the Residential Energy Consumption Survey (RECS) data has been fused with data from the National Household Travel Survey (NHTS). Similarly, for modeling wellbeing that is derived by individuals from their daily activity-travel patterns, data from the American Time Use Survey (ATUS) is being fused with data from the NHTS. All of the data sets assembled by TOMNET will be made available (without personally identifiable information) via the TOMNET website for the broader community within the next 6-12 months after fulfilling necessary IRB Human Subjects Research protocols. The rich set of data collected during the pilot phase of new transportation technology survey from 260 respondents have been cleaned, compiled and the data dictionary is ready. This dataset includes variables on socioeconomics, general attitudes, residential and vehicle ownership information, and perception, attitudes and potential use of new transportation options such as ridehailing and autonomous vehicles.

At this time, the TOMNET team does not have any other products to report under the following categories: *Technologies or techniques; Inventions, patent applications, and/or licenses; Other products (Physical collections, Software or NetWare, Instruments or equipment)*

4. OUTCOMES

TOMNET outputs have contributed to Increases in the body of knowledge, for example:

- Identified 7 meaningful population segments with respect to mode-use propensities in an AV-era;
- Decomposed attitudinal differences between millennials and Gen Xers into specific sources;

- Empirically measured and modeled attitudes toward waiting;
- Empirically demonstrated a typology of benefits and disadvantages of performing activities while traveling, shining a spotlight on *motivations for and outcomes of* travel-based multitasking;
- Increased understanding and awareness of transportation issues in hazard mitigation and planning as well as transportation challenges faced everyday by remote coastal communities.

TOMNET activities have contributed to improved techniques in addressing transportation issues:

- Demonstrated proof-of-concept of a new approach for imputing attitudinal variables into large-scale travel behavior datasets (such as the National Household Travel Survey);
- Demonstrated a meaningful way to estimate the impact of the ability to work productively while traveling on mode choice, with a realistic scenario applied to the diffusion of automated vehicles;
- Demonstrated how the travel time coefficient in a mode choice model can be discounted to reflect the benefit of travel-based multitasking, using attitudinal and other information from a small, specialized dataset; the intelligently-discounted coefficient can then be applied in a large-scale regional travel modeling context;
- Identified and evaluated multiple ways of assessing how much the apparent impact of the built environment on travel behavior should be discounted due to residential self-selection;
- Development of a new protocol for engaging communities around multiple future scenarios based on both chronic (everyday) and episodic (rare and infrequent) hazard threats; and
- The further use and development of methods for engaging communities and discipline experts on transportation issues using participatory GIS.

Enlargement of the pool of trained transportation professionals:

- PhD completion of Alex Malokin, student at Georgia Tech (advisor: Dr. Patricia Mokhtarian)
- A doctoral student, Natalia Barbour, completed her dissertation defense in civil engineering with a specialization in transportation. The title of her dissertation is “Statistical Analysis of the Role of Socio-Demographic and Health Factors in Shared Mobility Related Behaviors and Usage Likelihood.” It is expected that after graduating, she will continue in a career in research and/or academia in the field of transportation. She is currently looking for post-doctoral opportunities.

The TOMNET T2 plan called for conducting two workshops per year to enhance capacity for implementing new technologies. TOMNET conducted a number of workshops this year, including two workshops within the reporting period covered by this SAPR. The travel survey methods workshop in December 2018 and the CAV101 seminar/workshop/short course conducted in March 2019 are two workshops that enhanced capacity. Another outcome outlined in the T2 plan is the improved accuracy of travel forecasts in the context of emerging technologies and new mobility options. TOMNET research products and data have been used by MAG to implement a new trip generation and car ownership modeling methodology to analyze future AV and ride-hailing mobility option scenarios. Thus TOMNET research has enabled agencies to enhance their modeling practice, and obtain forecasts of greater accuracy that reflect behavioral intentions stated by individuals in attitudinal and stated preference surveys. The enhanced models replicated survey data better than existing models, resulting in a greater than 10% improvement in travel prediction accuracy.

5. IMPACTS

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

Charting a sustainable pathway for smart cities of the future requires detailed data about people’s movements, transportation preferences, and attitudes and perceptions about new mobility options and

technologies. The advent of new mobility options that are disrupting transportation in cities has rendered planning for the future extremely challenging and fraught with uncertainty. TOMNET is addressing this challenge by equipping planners and analysts with the data, algorithms, and models they need to predict how cities might evolve under a wide variety of future transportation scenarios.

Moreover, the data gathered from the community outreach activities and surveys will help to inform both transportation and emergency planners about what actions people anticipate they will take in the event of a large earthquake (and, for the coastal areas, accompanying tsunami). Where will they seek health care and medications? What resources are located within communities that could serve alternative purposes in a time of need? How can different kinds of transportation and communications sources be enhanced or better leveraged through social relationships and local knowledge?

What is the impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

The University of Washington effort is building upon earlier work to test and promote an appreciative inquiry approach to disaster mitigation planning that highlights community strengths over vulnerabilities. Such an approach to hazard planning has the potential to help communities develop mitigation strategies that will benefit them on an everyday basis as well as in the case of a disaster.

A significant undertaking of TOMNET researchers at ASU involved transferring knowledge to Maricopa Association of Governments (MAG) so that they could effectively update their trip generation and car ownership models to address future AV and ride-hailing scenarios. ASU researchers conducted a comprehensive literature review on the survey-based evidence of the potential impacts of AVs and ride-hailing services, combined the findings of the literature review with results from the pilot version of the TOMNET AV survey, and provided information to MAG on how trip generation and car ownership modeling steps may be modified to account for the advent and increasing market penetration of AVs and ride-hailing services. This “adoption of new practice” is a tangible impact of TOMNET research.

What is the impact on the body of scientific knowledge?

Until now, attempts to impute attitudes into datasets that don’t have them have met with abysmal results. The machine learning-based approach we are developing as part of our TOMNET mission is showing great promise for predicting attitudes well enough for them to add meaningful value to our traditional travel demand forecasting models. There is much yet to be learned, but initial results are very encouraging and it is anticipated that agencies will find value in adopting TOMNET outputs in their modeling practice.

Numerous studies have assessed the potential impacts of automated vehicles on VMT by simply guessing the factor by which a travel time coefficient, or the monetized value of travel time, should be discounted to account for the increased ability to use travel time productively. Our approach brings solid empirical evidence to bear on producing the appropriate discount factor, and represents an actionable link between small-scale, attitudinal, research-oriented travel behavior studies and large-scale, in-practice travel demand forecasting models. MPO efforts to analyze AV scenarios of the future are being informed by results of TOMNET-sponsored research.

The community-engaged workshop and survey protocol that is being developed through this Center by the University of Washington will help to inform future research and action regarding region-wide resilience strategies. By engaging both urban and rural communities, we will be able to understand better the differences between the needs of communities representing a range of demographic and socioeconomic profiles. Within the fields of urban and hazard mitigation planning for example, the further development of appreciative inquiry-based protocols for hazard mitigation planning is a new development that holds much promise for informing future hazard planning approaches that can better take local needs, resources, knowledge, and strengths into account.

What is the impact on transportation workforce development?

At Georgia Tech, Patricia Mokhtarian significantly revised the content of the CEE Transportation graduate program's core (required) course on Statistics in Transportation (CEE 6601), providing a balance between technical rigor and application philosophy/best practice, and making the course accessible to a diverse set of students with varying degrees of preparation. The course notes are available to anyone on request.

At USF, through independent study, the program provided training in travel survey design and administration to two women graduate students, Trang Luong and Divyamitra Misha. Dr. Michael Maness met with the students twice weekly to discuss the total survey error framework and how it applies to web based travel surveys. The students were responsible for modifying a web-based survey on leisure activity participation including question design and the testing of the survey on a trial participants. Their work has aided in the analysis of the survey trial and the redesign of the survey for full deployment in the next reporting period.

At University of Washington, Center activities have engaged undergraduate, graduate and PhD students in community-engaged research about transportation issues in rural and remote areas, particularly as related to emergency planning and hazard mitigation. Students were trained to use WeTable participatory GIS equipment to engage collaboratively with experts in urban planning, transportation planning, and hazard mitigation planning on potential interventions for remote coastal communities. In the community workshops, we provided opportunities for the public to learn disaster planning best practices and to share local knowledge with planners and hazard mitigation specialists.

In the TOMNET T2 plan, goals regarding impacts included adoption of methods and models in practice and the improvement of mobility for transportation disadvantaged groups. While the second category of impacts is not yet measurable, the first category of impacts is indeed measurable as evidenced by the impact of TOMNET research results on MAG's travel demand modeling practice. The goal for 2019 was to have one agency adopt practices informed by TOMNET data and methods, and that has been met.

6. CHANGES/PROBLEMS

There are no changes to or problems with the scope, mission, budget, or operations of TOMNET. There have been some issues with internal controls and tracing of packages and documents; these issues are being addressed at the highest levels of the university and will not surface again. In addition, principal investigators on various projects were slightly delayed in submitting 2017-2018 project reports; hence the reports have not yet been entered in RiP and the TOMNET website. However, all reports have been received now, and are being formatted and revised to be in full compliance. They will be posted and sent to appropriate places/libraries/databases by May 30, 2019. Finally, 2018-2019 project start dates were delayed due to delays in obtaining funding, but they are now on an accelerated schedule so that TOMNET activities stay on course and good progress is made towards achieving center goals.

7. SPECIAL REPORTING REQUIREMENTS

TOMNET is working to ensure compliance with all reporting requirements. All 2017-2018 projects are entered in the RiP database and the 2018-2019 projects are in the process of being entered. Delays in obtaining 2018-2019 funds contributed to some delays in initiating projects. Project information will be entered in RiP by May 30, 2019. All information for 2018-2019 projects will be posted to the TOMNET UTC website at the same time. All TOMNET researchers have been requested to obtain a unique ORCID and the investigator ORCID will be tagged to all research projects. In addition, final research reports for 2017-2018 projects are currently being formatted, reviewed for compliance, and revised; they will be posted on the TOMNET website and sent to research.hub@dot.gov, NTLDigitalSubmissions@dot.gov, and TRIS-TRB@nas.edu by May 30, 2019. The reports will also be sent to the respective transportation libraries as outlined in the Grant Deliverables and Reporting Requirements document.