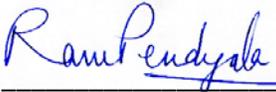


PROGRAM PROGRESS PERFORMANCE REPORT (PPPR #1)

TOMNET **Center for Teaching Old Models New Tricks**



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INTRODUCTION

This document constitutes the Program Progress Performance Report (PPPR) 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 May 31, 2017 (the period covered by this PPPR) in establishing procedures and protocols, recruiting staff to assist in various activities and reporting requirements of the center, and setting up a number of initiatives related to research, education, workforce development, and technology transfer activities of the center. This PPPR will not only describe what has been accomplished during the first six months of the center, but also highlight upcoming activities and initiatives that depict the depth and breadth of the center's enterprise.

1. ACCOMPLISHMENTS: What was done? What was learned?

The information provided in this section allows the OST-R grants official to assess whether satisfactory progress has been made during the reporting period.
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The Center for Teaching Old Models New Tricks (hereafter, TOMNET) aims to serve as a global center of excellence for research and learning in the study of: traveler behavior and values; the role of attitudes, values, perceptions, and preferences in shaping people's transportation-related choices; the application of machine learning and data fusion methods to understand underlying relationships among different variables by harnessing information contained in disparate data sets; the nature of the two-way relationships between attitudinal constructs and behavioral choices; and methods and tools to enhance the predictive accuracy of transportation demand forecasting models by incorporating new attitudinal and latent constructs that have been omitted from such models thus far in practice.

The center is rather unique in that it has a focused mission – one that is dedicated to providing deep insights on human attitudes and behaviors, and how these aspects will affect transportation systems in the future. Through such deep insights, the center intends to improve travel demand forecasting models so that they are more responsive and sensitive to emerging transportation technologies and mobility paradigms, more accurate in their predictions of behavior, and more valuable to decision-makers who strive to design and plan transportation infrastructure systems that serve the mobility needs of all – regardless of socio-economic and demographic characteristics.

What are the major goals of the program?

TOMNET has a three-pronged mission, not unlike any other university transportation center (UTC). These include a *research* mission, an *education* and *workforce development* mission, and a *technology transfer* mission.

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 center aims to accomplish this by fusing information about attitudes, behaviors, socio-economic characteristics, built environment attributes, and transportation networks contained in different data sets using machine learning algorithms; and developing new models capable of providing deep insights into underlying relationships among the myriad variables in the fused data sets. TOMNET aims to lead a number of inter-related research projects that involve survey design and data collection, data fusion and machine learning, modeling and forecasting,

and policy simulation and analysis. Through a portfolio of well-coordinated research projects, TOMNET will provide new insights on traveler behavior and values under alternative futures, as well as new methods, models, tools, and algorithms for forecasting travel demand in regional planning processes.

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. Through a multi-disciplinary approach to education and training, the center aims to train a cadre of professionals who can work in industry, public agencies, academia, and non-profit organizations. These individuals will be equipped to design transportation solutions of the future while taking advantage of emerging technologies and paradigms *and* addressing the occasionally competing challenges of economic growth, quality of life, community resiliency, equity and environmental justice, affordability, health, and energy and environmental sustainability. 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. Finally, TOMNET aims to empower the current transportation workforce by offering a number of workshops, continuing education (short) courses, symposia, and professional development seminars/webinars on cutting edge topics and methods that will help professionals address emerging and complex transportation issues.

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. TOMNET recognizes that transportation plays an important part in affecting the quality of life, health, and resilience of communities; therefore, TOMNET aims to transfer knowledge and communicate accurate information about traveler behavior and values to various stakeholders who are affected by and/or make decisions regarding the future transportation system. By developing and disseminating open source software tools and methods, new algorithms and modeling approaches, and research reports and policy briefs, TOMNET aims to inform decision-makers and empower communities. TOMNET will enhance the capabilities of the workforce of today and tomorrow by providing new and rich data about behaviors, choices, and attitudes; conducting hands-on training workshops and boot camps; and organizing specialized executive courses and information sessions specifically aimed at decision-makers.

What was accomplished under these goals?

TOMNET has been in existence for about six months, with much of the effort during this period dedicated to establishing and setting up the center. Considerable effort went into staffing the center, executing contractual agreements and finalizing budgets for all TOMNET institutional partners, setting up dedicated space for the center, building an initial TOMNET website, preparing and submitting the center's data management plan, aligning cost share commitments and budgets to be in compliance with institutional requirements and grant stipulations, and establishing communication protocols and procedures among team partners. TOMNET partners worked together to define operational principles and develop an organizational chart and structure for the center. Individuals that would be invited to serve on the external advisory board (EAB) were identified and efforts are underway to finalize the duties, responsibilities, and scope of activities of the EAB. Nevertheless, the center has made considerable progress on a number of fronts, with significant progress envisioned to take place in the next reporting period (June 1, 2017 to November 30, 2017).

In the *research* domain, TOMNET jump-started its activities by organizing and conducting a two-day workshop on April 27-28, 2017. During this workshop, all of the TOMNET team members assembled at Arizona State University in Tempe and delivered presentations about their ongoing research activities as well as proposed research activities for the first year of TOMNET’s operations. In addition to presentations by TOMNET’s core faculty members, the workshop featured presentations by a number of affiliated faculty members from a wide variety of disciplines including geographical sciences and urban planning, economics, health solutions, and computer science. These presentations facilitated a multi-disciplinary exchange of ideas with a view to engender cross-disciplinary research activities under the TOMNET research umbrella. The workshop also included presentations by the project management team from the US Department of Transportation Office of Science, Technology, and Research. Through wide-ranging discussions at the workshop, that included a project idea factory session, the TOMNET team was able to develop a portfolio of multi-disciplinary collaborative research projects for year 1. These projects are listed (with principal investigator) in Table 1.

Table 1. Year 1 TOMNET Research Projects

Project Topic/Title	Lead Institution	Lead Institution PI
Attitudes Towards Mobility Options/Technologies – A Multi-region Data Collection Effort	ASU	Sara Khoeini
Data Fusion Using Novel Machine Learning Algorithms for Large Synthetic Population Data Sets: A Case Study of Human Attitudes and Behaviors	ASU	Jingrui He
Review of Attitudes-Travel Behavior Literature	ASU	Deborah Salon
Assembling Integrated Data Sets for Analyzing Connections between Travel Behavior, Attitudes, and the Built Environment	ASU	Deborah Salon
Attitudes Towards Mobility Options/Technologies – A Multi-region Data Collection Effort	Georgia Tech	Giovanni Circella
An Investigation of the Contribution of Targeted Marketing Data to the Prediction of Attitudes	Georgia Tech	Patricia Mokhtarian
Attitudes Towards Mobility Options/Technologies – A Multi-region Data Collection Effort	USF	Abdul Pinjari/ Michael Maness
Exploring Unobserved Heterogeneity and Temporal Instability of Safety Outcomes	USF	Fred Mannering
Role of Attitudes in Shaping Resilience Behavior - Developing a Scalable Survey Methodology	UW	Cynthia Chen

Note: ASU = Arizona State University; USF = University of South Florida; UW = University of Washington

It should be noted that the institutions comprising the TOMNET team are collaborating in a big way on the project titled “Attitudes Towards Mobility Options/Technologies – A Multi-region Data Collection Effort”. The idea is to collect attitudinal data (related to emerging transportation technologies and mobility services) simultaneously in the Greater Phoenix metropolitan region (which is home to ASU), Greater Atlanta metropolitan region (which is home to Georgia Tech), and the Tampa Bay metropolitan region (which is home to USF). Through such a coordinated data collection effort, TOMNET aims to provide deep insights on geographical differences in attitudes and behaviors related to emerging

transportation technologies. Discussions are currently underway with the D-STOP University Transportation Center (led by Professor Chandra Bhat of the University of Texas at Austin) to explore the possibility of conducting a similar survey data collection effort in the Austin region. Similar discussions are underway with partners at institutions around the world including South America, India, China, Japan, Australia, Israel, and Europe. It should also be noted that TOMNET is enhancing diverse leadership through its portfolio of projects. Among the project principal investigators, five are women (across three different disciplines), four are junior scholars/faculty members in early stages of their career, and one belongs to a minority group. All of the projects will be underway very shortly (following the completion of a peer review process on proposals submitted) with interim progress expected to be reported by the end of the calendar year.

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 the 2016-2017 academic year (that spans the reporting period covered by this PPPR). Table 2 offers a rather detailed summary of the courses offered by faculty members closely affiliated with the TOMNET center. 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 PPPR 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.

Table 2. Courses Offered by Mission-Critical Faculty Members of TOMNET

Semester	Course Level	Course Number	Course Title	Number of Students	Instructor	Unit
Arizona State University						
Fall 2016	Undergrad	CEE372	Transportation Engineering	100	Ram Pendyala	SSEBE
Fall 2016	Undergrad /Grad	CEE474	Transportation Systems Planning	36	Mikhail Chester	SSEBE
Fall 2016	Graduate	CEE573	Transportation Operations	11	Xuesong Zhou	SSEBE
Fall 2016	Graduate	CEE598	Traffic Simulation Modeling & Apps	16	Xuesong Zhou	SSEBE
Fall 2016	Graduate	CEE598	Transportation Engineering Seminar	7	Mikhail Chester	SSEBE
Fall 2016	Graduate	PUP642	Urban and Regional Economic Analysis	30	Deborah Salon	SGSUP
Fall 2016	Graduate	PUP593	Transportation Capstone Project	2	Deborah Salon	SGSUP

Fall 2016	Graduate	PUP591	Transportation Professional Seminar	10	Jason Kelley	SGSUP
Spr 2017	Undergrad	CEE372	Transportation Engineering	99	Xuesong Zhou	SSEBE
Spr 2017	Undergrad	CEE498	Airport Design	17	Jeff Stempihar	SSEBE
Spr 2017	Undergrad	PUP424	Planning Methods	35	Deborah Salon	SGSUP
Spr 2017	Graduate	CEE598	Public Transportation	5	Xuesong Zhou	SSEBE
Spr 2017	Graduate	CEE598	Activity-Travel Behavior Modeling	7	Ram Pendyala	SSEBE
Spr 2017	Graduate	CEE598	Transportation Engineering Seminar	9	Benjamin Underwood	SSEBE
Spr 2017	Graduate	PUP550	Transportation and the Environment	13	Deborah Salon	SGSUP
Spr 2017	Graduate	PUP593	Graduate Transportation Capstone	4	Deborah Salon	SGSUP
Georgia Institute of Technology						
Fall 2016	Undergrad /Graduate	CP4310	Urban Transportation	43	Alex Karner	SCaRP
Fall 2016	Undergrad /Graduate	CEE4090	Senior Capstone Design - Transportation	39	Kari Watkins	CEE
Fall 2016	Undergrad /Graduate	CEE4610	Multimodal Transportation	40	Kari Watkins	CEE
Fall 2016	Undergrad	CEE3770	Probability and Statistics – Data Science	55	Patricia Mokhtarian	CEE
Fall 2016	Graduate	CP6542	Transportation & GIS	28	Alex Karner	SCaRP
Fall 2016	Graduate	CEE6623	Transportation Survey Methods	10	Patricia Mokhtarian	CEE
Fall 2016	Graduate	CEE6602/CP6311	Urban Transport Planning	20	R Guensler & C Ross	CEE & SCARP
Spr 2017	Undergrad /Graduate	CEE4090	Senior Capstone Design – Transportation	76	Kari Watkins	CEE

Spr 2017	Graduate	CEE6650	Discrete Choice Modeling	12	Patricia Mokhtarian	CEE
University of Washington						
Fall 2016	Undergrad /graduate	CEE 416/580	Urban Transportation Planning and Design	55	Cynthia Chen	CEE
Fall 2016	Graduate	CEE561	Transportation Planning and Design	10	Ryan Avery	CEE/ST
Fall 2016	Graduate	CEE563	Transportation Technology and Choices	10	Scott Rutherford	CEE/ST
Fall 2016	Graduate	URBDP600	Resilience in the Built Environment	6	Daniel Abramson	Urban Planning
Fall 2016	Undergrad /Graduate	URBDP424 /524	Site Planning	10	Daniel Abramson	Urban Planning
Spr 2017	Undergrad	CEE416	Urban Transportation Planning and Design	10	Jae Hyun Lee	CEE
Spr 2017	Graduate	CEE581	Travel Demand Forecasting	20	Cynthia Chen	CEE
University of South Florida						
Fall 2016	Undergrad	TTE4004	Transportation Engineering I	94	Achilles Kourtellis	CEE
Fall 2016	Graduate	TTE6507	Travel Demand Modeling	9	Abdul Pinjari	CEE
Fall 2016	Graduate	CGN6933.010	Statistical and Econometric Methods I	25	Fred Mannering	CEE
Spring 2017	Graduate	CGN6933.901	Statistical and Econometric Methods II	11	Fred Mannering	CEE
Fall 2016	Graduate	TTE5501	Transportation Planning & Economics	24	Chanyoug Lee	CEE
Fall 2016	Graduate	TTE5205	Traffic Systems Engineering	28	Pei-sung Lin	CEE
Fall 2016	Undergrad	TTE4003	Transportation and Society	16	Jennifer Flynn	CEE
Spring 2017	Undergrad	TTE4003	Transportation and Society	15	Jennifer Flynn	CUTR

Spring 2017	Undergrad	TTE4005	Transportation Engineering II	82	Xiaopeng LI	CEE
Spring 2017	Graduate	TTE6651	Public Transportation	25	Steve Polzin	CEE
Spring 2017	Graduate	TTE6315	Transportation Safety	25	Zhenyu Wang	CEE

Notes:

Arizona State University

- SSEBE = School of Sustainable Engineering and the Built Environment
- SGSUP = School of Geographical Sciences and Urban Planning
- CIDSE = School of Computing, Informatics, and Decision Systems Engineering

Georgia Institute of Technology

- CEE = School of Civil and Environmental Engineering
- SCaRP = School of City and Regional Planning

University of Washington

- CEE = Department of Civil and Environmental Engineering
- CEE/ST = Civil and Environmental Engineering/Sustainable Transportation Online Program
- Urban Planning = Department of Urban Design and Planning

University of South Florida

- CEE = Department of Civil and Environmental Engineering

In summary, core faculty affiliated with TOMNET taught 17 undergraduate courses and 26 graduate courses across the TOMNET consortium during the reporting period covered by this PPPR. Hundreds of students were enrolled in these courses and were exposed to concepts related to TOMNET research activities.

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. It should be noted that not all of these students are receiving financial support or stipends through TOMNET funding; however, they are all engaged in research and education activities on topics of direct relevance to TOMNET and are hence considered TOMNET scholars.

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

Name of Scholar	Level	Major/ Unit	Supervisor/ Advisor	Gender	Minority?
Sara Khoeini	Asst Research Professor	SSEBE	Ram Pendyala	Female	No
Monirehalsadat Mahmoudi	PhD Student	SSEBE	Xuesong Zhou	Female	No
Jiangtao Liu	PhD Student	SSEBE	Xuesong Zhou	Male	No

Sumit Kumar	MS Student	CIDSE	Ram Pendyala	Male	No
Aman Srivastava	MS Student	CIDSE	Ram Pendyala	Male	No
Georgia Institute of Technology					
Giovanni Circella	Senior Research Engineer	CEE	Patricia Mokhtarian	Male	No
Aliaksandr Malokin	PhD Student	CEE	Patricia Mokhtarian	Male	No
University of Washington					
Katie Idziorek	PhD student	Urban Planning	Cynthia Chen/ Dan Abramson	Female	No
University of South Florida					
Dr. Michael Maness	Postdoctoral Associate	CEE	Fred Mannering and Abdul Pinjari	Male	Yes
Parvathy Vinod Sheela	PhD Student	CEE	Abdul Pinjari	Female	No
Suryaprasanna Balusu	PhD Student	CEE	Abdul Pinjari and Fred Mannering	Male	No
Divyakant Tahlyan	PhD Student	CEE	Abdul Pinjari and Fred Mannering	Male	No

In the *technology transfer* domain, TOMNET has undertaken a few key activities that have had a global reach. All of the TOMNET partner institutions have transportation seminar series that are open to the public and professionals in the community. These seminars are held generally on a weekly basis at each of the institutions and include a mix of attendees comprising students, professionals, academics, scholars, and members of the public. Because each of the institutions already has a vibrant transportation seminar series, TOMNET institutions have not launched separate seminar series that would unnecessarily compete with and dilute the audience for existing transportation seminar series. Rather, 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 and academic community. The TOMNET-sponsored seminars cover topic areas related to traveler behavior and values, relationships between attitudes and behavior, traveler choices under emerging technological and mobility service scenarios, and driver behaviors that impact safety outcomes. The center plans to enhance its seminar and webinar offerings into the future to further disseminate TOMNET research and facilitate technology transfer. Table 4 presents a summary of the TOMNET-sponsored seminars for the period covered by this PPPR.

Table 4. Key TOMNET-Sponsored Technology Transfer Events

Institution	Title of Seminar/ Webinar	Speaker Name and Affiliation	Date of Event	Number of Attendees
Arizona State University	(How) Can We Improve the Behavioral Realism of Large-Scale Land Use/Transportation Models?	Patricia Mokhtarian, Professor, Georgia Institute of Technology	3/31/2017	20
Arizona State University	Engineering Urban Freight	Anne Goodchild, Professor, University of Washington	3/24/2017	20
Arizona State University	Do Ride-Sharing Services Affect Traffic Congestion? An Empirical Study of Uber Entry	Yili (Kevin) Hong, Professor, Arizona State University	3/17/2017	20
Arizona State University	An Alternative Approach to Safety Analysis	Mohamed Abdel-Aty, Professor, University of Central Florida	2/17/2017	20
University of Washington	Magnitude 9 Earthquake Scenarios – Probabilistic Modeling, Warnings, Response and Resilience in the Pacific Northwest, for the Canadian Hazus Users Group (CanHUG)	Daniel Abramson, Assoc Professor, University of Washington	12/1/2016	20

In addition to organizing seminars, TOMNET faculty members offered two major short courses during the reporting period covered by this PPR. Both of the short courses were offered in India as part of international collaborative activities undertaken by TOMNET. One of the courses was an executive style course of a half-day duration, while the second course was an intensive five-day boot camp with hands-on computer-based instruction in emerging activity-based travel modeling and simulation tools. Table 5 lists these key technology transfer events, conducted by TOMNET within one month of the award of the center.

How have the results been disseminated?

TOMNET has been in existence for just about six months and hence there has been rather limited opportunity to disseminate TOMNET research and workforce development outcomes at this point in time. However, TOMNET has initiated some dissemination activities to help advance the research and education goals of the center.

In the *research* domain, TOMNET center faculty have begun making presentations at various venues, conferences, and seminars to describe the research questions to be addressed and the research methods to be developed by the center. These presentations provide an overview of TOMNET and its objectives, describe a number of concepts related to traveler attitudes and behaviors, articulate the key research questions and unknowns that merit deep exploration, and offer a detailed explanation of the major

methodological approaches and tools that the center intends to employ to address the research questions of interest. In addition, the presentations cover the empirical or behavioral contexts of interest, data needs and collection methods, and policy relevance of potential research outcomes. In the interest of brevity, these presentations are not listed here, but are listed in the next section (Products). In addition, it should be noted that TOMNET faculty members have been engaged in TOMNET-related research (examining traveler behavior, attitudes, and values) and been disseminating their research findings through presentations and publications. The next section provides a listing of presentations and publications that TOMNET core faculty members have produced during the reporting period covered by this PPPR.

Table 5. Short Courses/Workshops Hosted or Conducted by TOMNET Core Faculty

Organizing Institution	Title of Workshop or Short Course	Workshop Instructors	Date of Event	Location of Event	Number of Attendees
Arizona State University	Emerging Methods for Activity-Travel Demand Modeling and Simulation	Ram Pendyala and Venu Garikapati, Arizona State University	December 26-30, 2016	National Institute of Technology, Warangal, India	72
Arizona State University	Open Source Tools for Activity-Based Travel Behaviour Modeling	Ram Pendyala and Venu Garikapati, Arizona State University	December 20, 2016	Indian Institute of Technology, Mumbai, India	55

In the *education* and *workforce development* arena, TOMNET researchers have taught a number of undergraduate and graduate courses, and these courses have reached hundreds of students across four different institutions. They are also supervising and mentoring graduate students and undergraduate assistants to train the workforce and leaders of the future. At this time, TOMNET has not yet engaged in dissemination activities related to education and workforce development, but several activities are underway to facilitate the dissemination of these activities and products.

In terms of *technology transfer* activities, TOMNET researchers have conducted two major short courses within the reporting period covered by this PPPR. Dissemination of these technology transfer activities took place through distribution channels including e-mail lists, listservs, and websites. Seminars were held to facilitate technology transfer and exchange of information (as shown in Table 4); announcements regarding these seminars were distributed to large e-mail lists maintained by each institution. These e-mail lists include professionals, academics, students, and other members of the public who sign up to be included in the list. Much of TOMNET’s technology transfer takes place through presentations delivered by TOMNET researchers around the world at many different venues, and the production and distribution of papers, articles, and research reports. TOMNET is currently enhancing its technology transfer infrastructure to streamline information sharing and dissemination. At this time, information about TOMNET research, events, and education and workforce development activities are being disseminated through the TOMNET website (which is a work in progress) at <http://www.tomnet-utc.org>.

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

TOMNET is in the process of establishing considerable infrastructure and implementing a number of initiatives to enhance the scope and impact of its activities across the three major dimensions of research, education and workforce development, and technology transfer.

As part of its research portfolio, TOMNET is about to launch eight projects across four institutions. These research projects include native survey data collection, analysis and fusion of existing data sets, and development of sophisticated modeling methodologies and tools to advance the science of modeling traveler attitudes, behaviors, and values. Research news and updates will be regularly posted to the TOMNET website.

As part of its education and workforce development portfolio, TOMNET faculty members will continue to teach undergraduate and graduate courses in their respective units. However, they will significantly enhance their course content to introduce concepts related to traveler attitudes, behaviors, and values – i.e., concepts and methods near and dear to TOMNET. In this way, students will become familiar with new and emerging concepts related to transportation systems planning, and modeling of traveler behavior. TOMNET faculty members will meet with prospective undergraduate and graduate students and encourage promising students to enroll in transportation programs and participate in TOMNET-related research and development activities. Through graduate student mentorship, TOMNET will ensure that the workforce of the future is highly trained in advanced methods.

Major initiatives to be undertaken very soon include the development of a TOMNET Scholar program. The TOMNET Scholar program will operate at four key levels; **first**, it will facilitate the participation of promising (potentially, under-represented) high school students in TOMNET activities – both during the school year (say, through after-school activities) and during the summer session; **second**, middle and high school teachers (potentially from schools in under-represented communities) will be recruited to participate in summer research programs and develop lesson plans and presentations on TOMNET-related transportation research and methods, so that they can go back and incorporate these lesson plans in their school curriculum thus reaching a much larger number of students at the K-12 level; **third**, the program will attract undergraduate students from various programs to participate in TOMNET-related research and technology transfer activities through a summer undergraduate internship program as well as undergraduate research initiatives (similar to the Research Experience for Undergraduates or REU program of NSF); and **fourth**, visiting scholars and professors from around the world will be invited to participate in TOMNET-related research and education activities by spending time in residence at one of the TOMNET institutions. Through such visits, TOMNET will create new collaborative relationships while further disseminating methods, tools, and research results to a broad worldwide audience.

In addition, TOMNET researchers are working with graduate students to develop activities and presentations that can be used to engage middle and high school students. All of the TOMNET institutions conduct summer engineering and college experience camps for middle and high school students. TOMNET faculty and students plan to develop a set of materials and activities that can be included in the camp program so that students participating in the camps are exposed to transportation research and concepts. These activities and materials will be posted on the TOMNET website so that university transportation centers around the country can use them in their own middle and high school outreach efforts. These materials can be used in the context of students attending camps at the university as well as in the context of delivering presentations and explaining transportation concepts to students in their school/classroom setting.

To further attract students and individuals to the transportation field, and get people excited about the challenges that lie ahead for transportation professionals, TOMNET is seeking to establish a TOMNET data science challenge and competition that is open to students worldwide. This competition may take a number of forms and discussions are underway to determine the exact nature, scope, and format of the competition. TOMNET may provide specialized data sets and challenge the student community to present novel analysis to unravel and visualize interesting relationships; or simply conduct an open student paper competition with the stipulation that papers must be related to a topic of direct relevance and interest to TOMNET. Ideas are still being discussed and this competition will be launched in late 2017 or early 2018.

From a technology transfer perspective, TOMNET is embarking on the development of a webinar series, preparation of research briefs (that provide summaries of research findings and results, and their implications for decision-making in the policy planning context), and the organization of a calendar of short courses or professional development workshops (of various lengths) that meet the diverse needs of the community. In addition, TOMNET faculty members will continue to organize specially branded TOMNET-sponsored seminars within their respective institutions. Webinars organized by TOMNET will include those delivered by TOMNET researchers and scholars, as well as those involving invited speakers; the idea is that TOMNET will serve as a vehicle to disseminate technology and transfer ideas and information for the community as a whole – focusing on the concepts and subject areas of relevance to TOMNET. Similarly, TOMNET will organize workshops so that professionals may obtain continuing education and use new methods and tools in their policy and planning work. These workshops will cover such topics as survey and data collection methods, data science applications including machine learning and deep learning, activity-travel behavior modeling methods, statistical and econometric methods for transportation data analysis, and microsimulation methods for travel demand forecasting including population synthesis and analytics.

Finally, TOMNET will be leveraging the website to help disseminate information related to center activities. The center website, <http://www.tomnet-utc.org>, will be used to share research results, announce activities, disseminate reports and instructional materials, and provide information of potential interest to the community. The website will serve as a one-stop shop for all things related to TOMNET. In order to enhance and motivate the community to visit the website and get involved in the activities of the center, TOMNET is about to embark on the distribution of an e-newsletter on a quarterly basis. This e-newsletter will be sent out to the CUTC e-group as well as a database of more than 1000 individuals and professionals that the various TOMNET partners have been compiling over the past month. This e-newsletter will be sent out using an appropriate platform (such as Constant Contact or MailChimp) so that dissemination and subscriptions can be managed effectively and professionally.

<p>2. PRODUCTS: What has the program produced?</p>
<p>Publications are the characteristic product of research projects funded by the UTC Program. OST-R may evaluate what the publications demonstrate about the excellence and significance of the research and the efficacy with which the results are being communicated to colleagues, potential users, and the public, not the number of publications. Many research projects (though not all) develop significant products other than publications. OST-R may assess and report both publications and other products to Congress, communities of interest, and the public.</p>

TOMNET has been in existence for about six months and TOMNET faculty members have been busy launching a number of projects in support of TOMNET objectives and goals. For this reason, products of the center comprise publications and presentations that TOMNET researchers have produced and

delivered via a number of outlets and avenues. 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 one-stop shop for all things related to the center's activities. 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://abdulpinjari.weebly.com>: This is the website of Professor Abdul Pinjari, who serves as an Associate Director of 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.

The following is a list of **publications and conference papers** produced by TOMNET core faculty members during the reporting period covered by this PPPR.

Arizona State University

Forthcoming Publications Accepted for Publication in Reporting Period

1. Liu, J., J.E. Kang, X. Zhou, and R.M. Pendyala (2017) Reformulating Constraints in Household Activity Pattern Problem Through Space-Time-State Networks. *Transportation Research Procedia*, 22nd International Symposium on Transportation and Traffic Theory (forthcoming).
2. Garikapati, V.M., D. You, W. Zhang, R.M. Pendyala, S. Guhathakurta, M. Brown, and B. Dilkina (2017) Estimating Household Travel Energy Consumption in Conjunction with a Travel Demand Forecasting Model. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).
3. Lavieri, P.S., V.M. Garikapati, C.R. Bhat, and R.M. Pendyala (2017) An Investigation of Heterogeneity in Vehicle Ownership and Usage for the Millennial Generation. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).
4. Lavieri, P.S., V.M. Garikapati, C.R. Bhat, R.M. Pendyala, S. Astroza, and F.F. Dias (2017) Modeling Individual Preferences for Ownership and Sharing of Autonomous Vehicle Technologies. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).
5. Dias, F.F., P. Lavieri, V.M. Garikapati, S. Astroza, R.M. Pendyala, and C.R. Bhat (2017) A Behavioral Choice Model of the Use of Car-Sharing and Ride-Sourcing Services. *Transportation* (forthcoming).
6. Astroza, S., V.M. Garikapati, C.R. Bhat, R.M. Pendyala, P. Lavieri, and F.F. Dias (2017) Analysis of the Impact of Technology Use on Multi-Modality and Activity-Travel Characteristics. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).

Papers Published Within Reporting Period

1. Pendyala, R.M., D. You, V.M. Garikapati, K.C. Konduri, and X. Zhou (2017) Paradigms for Integrated Modeling of Activity-Travel Demand and Network Dynamics in an Era of Dynamic Mobility

Management. *Proceedings of the 96th Annual Meeting of the Transportation Research Board*, National Research Council, Washington, D.C.

2. Ye, X., V.M. Garikapati, D. You, and R.M. Pendyala (2017) A Practical Method to Test the Validity of the Standard Gumbel Distribution in Logit-Based Multinomial Choice Models of Human Travel Behavior. *Proceedings of the 96th Annual Meeting of the Transportation Research Board*, National Research Council, Washington, D.C.
3. Mahmoudi, M., V.M. Garikapati, L. Tong, X. Zhou, and R.M. Pendyala (2017) How Many Trip Requests Could We Support? An Activity-Based Vehicle Scheduling Approach. *Proceedings of the 96th Annual Meeting of the Transportation Research Board*, National Research Council, Washington, D.C.
4. Garikapati, V.M., D. You, R.M. Pendyala, T. Patel, J. Kottommannil, and A. Sussman (2016) Design, Development, and Implementation of a University Travel Demand Modeling Framework. *Transportation Research Record 2563*, *Journal of the Transportation Research Board*, pp. 105-113.
5. Kumar, V., C.R. Bhat, R.M. Pendyala, D. You, E. Ben-Elia, and D. Ettema (2016) The Impacts of an Incentive-Based Intervention on Peak Period Traffic: Experience from The Netherlands. *Transportation Research Record 2543*, *Journal of the Transportation Research Board*, pp. 166-175.
6. Lavieri, P., C.R. Bhat, R.M. Pendyala, and V.M. Garikapati (2016) Introducing Latent Psychological Constructs in Injury Severity Modeling: A Multi-Vehicle and Multi-Occupant Approach. *Transportation Research Record 2601*, *Journal of the Transportation Research Board*, pp. 110-118.
7. Konduri, K.C., D. You, V.M. Garikapati, and R.M. Pendyala (2016) Application of an Enhanced Population Synthesis Model that Accommodates Controls at Multiple Geographic Resolutions. *Transportation Research Record 2563*, *Journal of the Transportation Research Board*, pp. 40-50.

Georgia Institute of Technology

Forthcoming Publications Accepted for Publication in Reporting Period

1. Mishra, G.S., P.L. Mokhtarian, R.R. Clewlow, and K.F. Widaman (2017) 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. Online First, *Transportation*. DOI: 10.1007/s11116-017-9791-1.
2. Zhai, Q., X. Cao, P. Mokhtarian, and F. Zhen (2017) The Interactions between E-shopping and Store Shopping in the Shopping Process for Search Goods and Experience Goods. *Transportation* (forthcoming).

Papers Published Within Reporting Period

1. Lee, R.J., I.N. Sener, P.L. Mokhtarian, and S.L. Handy (2017) Relationships Between the Online and In-Store Shopping Frequency of Davis, California Residents. *Transportation Research A 100*, pp. 40-52.
2. Stillwater, T., K.S. Kurani, and P.L. Mokhtarian (2017) The Combined Effects of Driver Attitudes and In-vehicle Feedback on Fuel Economy. *Transportation Research D 52*, pp. 277-288.

University of Washington

Forthcoming Publications Accepted for Publication in Reporting Period

1. Abramson, D. (2017) Planning Histories in China. Forthcoming Chapter for the Routledge Handbook on Planning History, edited by Carola Hein (Robert Freestone, Advisor).

Papers Published Within Reporting Period

1. Chen, C., J. Ma, Y. Susilo, Y. Liu, and M. Wang (2016) The Promises of Big Data and Small Data for Travel Behavior (aka Human Mobility) Analysis. *Transportation Research Part C, 68*, pp. 285-299.

2. Guan, X., C. Chen, and D. Work (2016) Tracking the Evolution of Infrastructure Systems and Mass Responses Using Publically Available Data. *PLOS ONE*, **11**(12), e0167267. DOI: [10.1371/journal.pone.0167267](https://doi.org/10.1371/journal.pone.0167267).
3. Abramson, D. (2016) Periurbanization and the Politics of Development-as-City-Building in China: a Case for a Social-Ecological Perspective. *Cities* **53**, pp. 156-162.

University of South Florida

Forthcoming Publications Accepted for Publication in Reporting Period

1. Astroza, S., A.R. Pinjari, C.R. Bhat, and S.R. Jara-Diaz (2017) A Microeconomic Theory-based Latent Class Multiple Discrete-Continuous Choice Model of Time Use and Goods Consumption. *Transportation Research Record, Journal of the Transportation Research Board* (forthcoming).
2. Sarwar, M., P. Anastasopoulos, S. Ukkusuri, P. Murray-Tuite, and F.L. Mannering (2017) A Statistical Analysis of the Dynamics of Household Hurricane-Evacuation Decisions. *Transportation*, DOI:10.1007/s11116-016-9722-6 (forthcoming).

Papers Published Within Reporting Period

1. Patil, P.N., S.K. Dubey, A.R. Pinjari, E. Cherchi, R. Daziano, and C.R. Bhat (2017). Simulation Evaluation of Emerging Estimation Techniques for Multinomial Probit Models. *Journal of Choice Modelling*, **23**, pp. 9-20.
2. Kamali, M., A. Ermagun, K. Viswanathan, and A.R. Pinjari (2016) Deriving Truck Route Choice from Large GPS Data Streams. *Transportation Research Record: Journal of the Transportation Research Board*, **2563**, pp. 62-70.
3. Behnood, A., and F. Mannering (2016) An Empirical Assessment of the Effects of Economic Recessions on Pedestrian-Injury Crashes Using Mixed and Latent-Class Models. *Analytic Methods in Accident Research* **12**, pp. 1-17.
4. Abay, K., and F. Mannering (2016) An Empirical Analysis of Risk-taking in Car Driving and Other Aspects of Life. *Accident Analysis and Prevention* **97**, pp. 57-68.
5. Zamenian, H., F. Mannering, Abraham, D., and T. Iseley (2017) Modeling the Frequency of Water Main Breaks in Water Distribution Systems: A Random Parameters Negative Binomial Approach. *Journal of Infrastructure Systems* **23**(2), 04016035.
6. Behnood, A. and F. Mannering (2017) The Effects of Drug and Alcohol Consumption on Driver-Injury Severities in Single-Vehicle Crashes. *Traffic Injury Prevention* **18**(5), pp. 456-462.
7. Behnood, A. and F. Mannering (2017) The Effect of Passengers on Driver-Injury Severities in Single-Vehicle Crashes: A Random Parameters Heterogeneity-in-Means Approach. *Analytic Methods in Accident Research* **14**, pp. 41-53.
8. Zamenian, H., K. Faust, F.L. Mannering, D. Abraham, and T. Iseley (2017) An Empirical Assessment of Unobserved Heterogeneity and Polyvinyl Chloride Pipe Failures in Water Distribution Systems. *Journal of Performance of Constructed Facilities* **31**(5), 04017073.
9. Seraneeprakarn, P., S. Huang, V. Shankar, F.L. Mannering, N. Venkataraman, and J. Milton (2017) Occupant Injury Severities in Hybrid-Vehicle Involved Crashes: A Random Parameters Approach with Heterogeneity in Means and Variances. *Analytic Methods in Accident Research* **15**, pp. 41-55.

The following is a list of **presentations** delivered by or involving TOMNET core faculty members during the reporting period covered by this PPPR.

Arizona State University

1. Lavieri, P., V.M. Garikapati, C.R. Bhat, R.M. Pendyala, S. Astroza, and F. Dias (2017) Modeling Individual Preferences for Ownership and Sharing of Autonomous Vehicle Technologies.

Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.

2. Pendyala, R.M., V.M. Garikapati, and S. Guhathakurta (2017) Integrated Models of Travel Demand and Energy Consumption: Methodological Challenges and Data Needs. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
3. Dias, F., P. Lavieri, V.M. Garikapati, S. Astroza, C.R. Bhat, and R.M. Pendyala (2017) Behavioral Choice Model of Use of Carsharing and Ride-Sourcing Services. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
4. Ye, X., V.M. Garikapati, D. You, and R.M. Pendyala (2017) A Practical Method to Test the Validity of the Standard Gumbel Distribution in Logit-Based Multinomial Choice Models of Human Travel Behavior. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
5. Pendyala, R.M., D. You, V.M. Garikapati, K.C. Konduri, and X. Zhou (2017) Paradigms for Integrated Modeling of Activity-Travel Demand and Network Dynamics in an Era of Dynamic Mobility Management. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
6. Mahmoudi, M., V.M. Garikapati, L. Tong, X. Zhou, and R.M. Pendyala (2017) How Many Trip Requests Could We Support? Activity-Travel-Based Vehicle Scheduling Approach. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
7. Lavieri, P., V.M. Garikapati, C.R. Bhat, and R.M. Pendyala (2017) Investigation of Heterogeneity in Vehicle Ownership and Usage for the Millennial Generation. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
8. Garikapati, V.M., D. You, W. Zhang, R.M. Pendyala, S. Guhathakurta, M. Brown, and B. Dilkina (2017) Estimating Household Travel Energy Consumption in Conjunction with a Travel Demand Forecasting Model. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
9. Astroza, S., V.M. Garikapati, C.R. Bhat, R.M. Pendyala, P. Lavieri, and F. Dias (2017) Analysis of the Impact of Technology Use on Multi-Modality and Activity-Travel Characteristics. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
10. Seo, K., D. Salon, F. Shilling, and M. Kuby (2017) Pavement Condition and Residential Property Value: A Spatial Hedonic Price Model for Solano County, CA. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
11. Wang, K., D. Salon, N. Roth, and S. Handy (2017) The Relationship Between Bicycling and the Built Environment Revisited: New Evidence from California. *Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, January.*
12. Pendyala, R.M. (2016) Behavioral Implications of Transformative Disruptions in Transportation. *Invited Keynote Presentation at the 12th International Conference on Transportation Planning and Implementation Methodologies for Developing Countries, Indian Institute of Technology, Mumbai, India, December.*

Georgia Institute of Technology

1. Mokhtarian, P.L. (2017) (How) Can we improve the behavioral realism of large-scale land use/transportation models? *Keynote Speech Presented at the 17th Swiss Transport Research Conference, Monte Verita, Switzerland, May 17-19.*
2. Patricia L. Mokhtarian (2016) Telecommunications and Travel Demand: A Typology of Roles. *Presentation to the **Transportation Research Board Study Committee on The Future of Interstate Travel**, Washington, DC, December 19.*

University of Washington

1. Abramson, D. (2017) Long-term Social-Ecological Resilience in the Dujiangyan Irrigation District: Implications for Land Policy, Settlement Planning, and Community Governance/Development. *Presented at Sichuan University, Schools of Public Administration (March 24) and Economics (March 29), and Southwest Jiaotong University College of Architecture and Design (April 28).*
2. Abramson, D. (2017) Ancient and Current Resilience: Adaptive Planning and Governance in the Chengdu Plain, Sichuan, China. *Presented at Workshop on Resilient Cities for Human Flourishing: Governing the Asia-Pacific Urban Transition in the Anthropocene*, National University of Singapore Asian Research Institute, Singapore, March.
3. Guan, X. and C. Chen (2017) From Warnings to Awareness and Actions: Insights from Hurricane Sandy. *Presented at the 96th Annual Meeting of the Transportation Research Board*, Washington, DC, January.
4. Yan, P. and C. Chen (2017) Stable Matching and Price of Stability in Real-time Ridership Systems. *Presented at the 96th Annual Meeting of the Transportation Research Board*, Washington, DC, January.
5. Liao, C., C. Chen, and Y. Fan (2017) Review of State of the Art Smartphone Apps for Travel Data Collection and Energy-efficient Strategies. *Presented at the 96th Annual Meeting of the Transportation Research Board*, Washington, DC, January.
6. Chen, C. (2017) Tracking the Evolution of Infrastructure Systems and Mass Responses Using Publicly Available Data. Tokyo Institute of Technology, Tokyo, Japan, March.

University of South Florida

1. Bhat, C.R., A.R. Pinjari, S. Dubey, and A.S. Hamdi (2017) A Joint Mixed Spatial Model of Household Residential Choice, Vehicle Ownership, Commute Travel Mode Choice and Children's School Travel Mode Choice. *Presented at the 96th Annual Meeting of the Transportation Research Board*, Washington, DC, January.
2. Lavasani, M., H. Asgari, X. Jin, and A.R. Pinjari (2017) Investigating the Willingness to Pay for Autonomous Vehicles and the Likelihood of Residential Relocation. *Presented at the 96th Annual Meeting of the Transportation Research Board*, Washington, DC, January.

The TOMNET research team plans to work towards the development of a number of products that can be shared with the research and practitioner communities. TOMNET faculty are developing new algorithms and tools including a synthetic population generator which can be used in the context of activity-based microsimulation modeling and forecasting of travel demand, machine learning and deep learning programs that can be used to fuse disparate data sets, and software programs and codes for model estimation, calibration, and validation in open source programming languages such as Python and R. TOMNET researchers are using a number of publicly available data sets to undertake TOMNET-related research activities, and will provide specially assembled versions of these data sets for use by a community of scholars and researchers that will help further advance the science of travel behavior modeling.

TOMNET faculty members and students are also building a collection of instructional materials that can be used by faculty members for college level courses and K-12 outreach activities. Professor Mannering has already developed a number of instructional modules and resources in conjunction with the publication of the sixth edition of the book titled *Principles of Highway Engineering and Traffic Analysis* (Wiley). These resources are already available to faculty members and students who use the textbook for teaching undergraduate and graduate transportation engineering courses at the college level. Over the life of the center, TOMNET faculty envision developing instructional resources and materials, including sample data sets and homework assignments, that researchers and practitioners can use for their own

educational purposes. All of these materials will be made available to the community through the TOMNET website.

At this time, the TOMNET team does not have any other products to report under the following categories:

Databases and data sets

Instructional materials and audio/video files

Software programs, codes, and products

Technologies or techniques

Inventions, patent applications, and/or licenses

Other products

3. PARTICIPANTS & COLLABORATING ORGANIZATIONS: Who has been involved?
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OST-R needs to know who has worked on the project to gauge and report performance in promoting partnerships and collaborations.

TOMNET has been working to develop collaborative relationships with a number of organizations and entities. The center is in the process of putting together an External Advisory Board (EAB) that will include a mix of industry professionals, agency personnel, academics, and professionals with non-profit organizations. The EAB will further help the center advance its mission of engendering collaborative relationships with various organizations. In addition, TOMNET researchers have a strong network of contacts throughout the academic arena, and this network of contacts will be leveraged to work collaboratively with a number of academics, including scholars at other UTCs. Given the large number of UTCs in operation at this time, TOMNET faculty feel that it would be beneficial to develop collaborative relationships with UTCs that address complementary themes, so that the collaborating UTCs can collectively achieve more than they would have achieved operating purely within their individual silos.

What organizations have been involved as partners?

A number of organizations have begun to partner with TOMNET researchers and have provided financial or in-kind support. These include:

- Maricopa Association of Governments, Phoenix, Arizona: In-kind support, data sets, collaborative research
- Georgia Department of Transportation, Atlanta, Georgia: Financial support, survey research, data sets, collaborative research
- Atlanta Regional Commission, Atlanta, Georgia: Data sets
- Florida Department of Transportation, Tallahassee, Florida: Financial support, survey research, data sets, collaborative research
- Puget Sound Regional Council, Seattle, Washington: Data sets
- AAA Traffic Safety Foundation, Washington, DC: In-kind support, collaborative survey research, data sets
- Cambridge Systematics, Inc., Cambridge, Massachusetts: Financial support, survey research, data sets, collaborative research
- Resource Systems Group, Inc., White River Junction, Vermont: Survey research, data sets, collaborative research
- D-STOP University Transportation Center, Center for Transportation Research, University of Texas at Austin, Austin, Texas: In-kind support, collaborative research, data sets

- University of California at Santa Barbara, Department of Geography, Santa Barbara, California: In-kind support, collaborative research, data sets
- University of California at Davis, Institute of Transportation Studies, Davis, California: In-kind support, collaborative research, data sets
- National Summer Transportation Institute - Federal Highway Administration, Arizona State University Polytechnic Campus, Mesa, Arizona (<https://outreach.engineering.asu.edu/project/summer-transportation-institute/>): In-kind support and collaborative efforts on high school student outreach and workforce development

The above constitutes a list of some of the significant collaborative partnerships that core members of the TOMNET team have advanced in substantial ways through TOMNET-related activities. There are many other universities, consulting firms, and public agencies with whom TOMNET members collaborate on a regular basis; in the interest of brevity, every single entity with whom collaborative relationships exist is not listed here. In subsequent progress reports, additional collaborative partners who are specifically engaged in or contributing to TOMNET-related activities and research programs will be identified.

TOMNET is currently negotiating a Memorandum of Understanding (MOU) with the Maricopa Association of Governments (MAG), the metropolitan planning organization (MPO) for the Greater Phoenix metropolitan region. Through this MOU, TOMNET is seeking to obtain consistent matching support for at least one PhD student who will be engaged in TOMNET research, education, and workforce development activities. The MOU also includes provisions for a member of MAG staff to work on-site at ASU within the TOMNET laboratory space, contributing to research and development as well as technology transfer activities of the center. Through such a close working relationship, it is envisioned that MAG will serve as a real-world test-bed for the methods and tools developed by TOMNET. TOMNET is seeking to strike similar partnerships with other partner agencies, such as San Francisco County Transportation Authority, Atlanta Regional Commission, Florida Department of Transportation, Georgia Department of Transportation, and Puget Sound Regional Council.

Have other collaborators or contacts been involved?

TOMNET faculty are collaborating with organizations and scholars at institutions around the world. Although not every collaboration is specifically sponsored by TOMNET, virtually all of these collaborative activities contribute to advancing the center's mission. For example, members of the TOMNET team have a close working relationship with members of the D-STOP UTC at the Center for Transportation Research of the University of Texas at Austin. It is envisioned that D-STOP and TOMNET will partner on specific research projects that advance the mission of developing state-of-the-art behavioral choice models that incorporate attitudinal constructs.

There are a number of collaborative relationships that TOMNET core faculty members are building with partners within their respective institutions. Partnerships at Arizona State University have been established with researchers in the: School of Computing, Informatics, and Decision Systems Engineering, including Professors Pitu Mirchandani, Jingrui He, and Hanghang Tong; WP Carey School of Business, including Professor Nick Kuminoff; School of Public Affairs, including Professors Andrew Waxman and Eric Welch; School of Geographical Sciences and Urban Planning, including Professors Michael Kuby and David King; School of Electrical, Computer, and Energy Engineering, including Professor Hongbin Yu who directs a National Science Foundation Industry-University Cooperative Research Center dedicated to Sustainable Transportation Systems; and the College of Health Solutions, including Professor Barbara Ainsworth. The TOMNET Director is providing advice to the ASU student team that is among the finalists for the SpaceX

Hyperloop Competition (<https://www.facebook.com/AZLoopHyperloop/>).

Similar partnerships have been established at other partner universities with a view to ensure that multi-disciplinary perspectives are front-and-center in addressing the key questions of interest to TOMNET. Other collaborative partnerships are being established with institutions around the world. Some of the institutions with which TOMNET researchers are seeking to establish formal relationships include the Indian Institute of Science-Bangalore, Indian Institutes of Technology in India, Tongji University and Beijing Transport Institute in China, University of New South Wales and University of Queensland in Australia, American University in Dubai, and KTH Royal Institute of Technology in Sweden.

<p>4. IMPACT: What is the impact of the program? How has it contributed to transportation education, research and technology transfer?</p>

As TOMNET has been in existence for just about six months, it is somewhat premature to attempt to measure and articulate the impacts of the center's programs. Nonetheless, the center is already beginning to have an impact in the research, education and workforce development, and technology transfer domains through its initial activities.

What is the impact on the development of the principal discipline(s) of the program?

Discussions to date have focused on the generation of research ideas and methods to accomplish the mission of TOMNET. The methods proposed by the TOMNET team can be used to better leverage information contained in different data sets and realized improved predictions of how, when, where, why, and with whom people will travel in the future which is likely to be characterized by radically different and new mobility options and technologies.

What is the impact on other disciplines?

TOMNET faculty members are collaborating with scholars in a number of different disciplines as noted earlier in this report. The work proposed by the TOMNET team will help computer and data scientists identify new applications in the transport sector in which their machine learning and deep learning algorithms can be used to better understand the influence of social, economic, and psychological factors on the amount of travel that people undertake by various means of transportation, the choices they make related to safe driving practices, and the choices they make with respect to where to live, work, and go to school. The methods proposed by TOMNET will impact work in urban planning, public affairs, and sustainability science.

What is the impact on the development of transportation workforce development?

TOMNET faculty members are teaching a number of courses at the undergraduate and graduate level to train a new and diverse workforce in advanced methods for explaining how people use the transportation infrastructure. In addition, TOMNET faculty members are advising and mentoring a number of students, including women and minorities, to become future leaders in the industry. TOMNET is developing new instructional materials and activity plans that can be used to attract middle and high school students into the transportation profession.

What is the impact on physical, institutional, and information resources at the university or other partners?

TOMNET has provided vital resources to enhance the research, education and workforce development,

and technology transfer activities at each of the consortium partners. At Arizona State University, a new dedicated space has been assigned to the center. This space facilitates inter-disciplinary collaboration. In addition, the institution has provided new computer resources to support high-performance computing and ensure data security and confidentiality. Across the consortium, TOMNET funding has made it possible for researchers to enhance collaborative efforts with various organizations. TOMNET faculty members are engaged in a number of synergistic activities, including leadership on the Transportation Research Board Innovations in Travel Modeling (ITM) 2018 conference scheduled to be held in Atlanta in June and leadership on the International Association for Travel Behaviour Research (Professor Patricia Mokhtarian is the Chair, while Professor Abdul Pinjari is the Secretary/Treasurer). TOMNET has made it possible to enhance media coverage and public outreach efforts, thus enabling improved dissemination of the importance of transportation-related research to the general public. In addition, TOMNET has established a website that serves as a key technology transfer mechanism.

What is the impact on technology transfer?

Work undertaken by TOMNET researchers is being disseminated through seminars, webinars, and short courses and professional development opportunities. These activities are helping to move methods, data, and products from the research domain to practice. TOMNET researchers are actively working in collaboration with a number of public agency and private industry professionals to implement methods and products developed by the team. A number of short courses are being planned to further advance the use of these methods in practice. The TOMNET team is not inclined to commercialize or patent processes or methods; rather TOMNET researchers believe in making products and tools developed through public funding available to the community at no charge using open-source licensing arrangements. It is likely that TOMNET will follow this operational principle to ensure maximum access and utilization of TOMNET products.

What is the impact on society beyond science and technology?

By incorporating concepts from different disciplines within various courses, TOMNET is creating a workforce of the future that can design and plan transportation systems of the future that meet mobility needs for all safely, efficiently, and sustainably. TOMNET research projects and results will be disseminated widely to the public as well as policy-makers via a variety of mechanisms to better inform decision-making and industry practices. Tools, methods, and models developed by TOMNET will contribute to an enhanced ability to forecast demand for transportation infrastructure, thus improving transportation planning processes. Work undertaken by TOMNET researchers will help advance the planning of transportation systems; implementation of safety interventions and policies; development of transportation- and infrastructure-related strategies to improve resilience and health of communities. In the end, TOMNET is all about improving the quality of life in communities across the country and world through improved understanding of the aspirations of the population for accessibility and mobility.

5. CHANGES/PROBLEMS

There are no changes to or problems with the scope, mission, budget, or operations of TOMNET.