

Center for Teaching Old Models New Tricks (TOMNET)
A USDOT Tier 1 University Transportation Center

PROJECT PROPOSAL: 2019-2020

Title: Attitudes Towards Emerging Mobility Options and Technologies – Phase 3: Survey Data Compilation, and Analysis

Principal Investigator: Sara Khoeini, Ph.D., School of Sustainable Engineering and the Built Environment, Assistant Research Professor

Co-Principal Investigator: Ram Pendyala, Ph.D., School of Sustainable Engineering and the Built Environment, Professor

1. Introduction/Problem Statement

Emerging mobility options and technologies including autonomous vehicles and mobility-on-demand services are bringing transformative changes in the transportation landscape. To enhance transportation forecasting models considering the increasing penetration of disruptive forces, people’s attitudes towards and perceptions of these technologies and services need to be measured and understood. Armed with such an understanding, it will be possible to specify and develop behavioral models that account for attitudes and perceptions, adoption cycles, and adaptation patterns. This project proposes data analysis and modeling for a sample of 1,071 individuals across the Phoenix metro area that has been collected during the second phase of the project.

Autonomous vehicles (AV) (also referred to as driverless cars or self-driving cars) are capable of navigating without human input using an array of technologies such as radar, lidar, GPS, odometry, and computer vision. Most industry experts suggest that autonomous vehicles will be on the road within a few years (1). The Secretary of Transportation in the US stated at the 2015 Frankfurt Auto show that he expects driverless cars to be in use all over the world by 2025 (2). Google plans to have its driverless cars on the market no later than 2018 (3). The Institute of Electrical and Electronics Engineers (IEEE) is predicting that up to 75% of all vehicles will be autonomous by 2040 (4). Virtual ridehailing companies such as Uber and Lyft are beginning to change the transportation landscape in significant ways as they provide door-to-door mobility-on-demand through the use of mobile apps. In general, information technology is making rideshare and transit travel options more convenient using location-aware services and real-time data analytics.

With the emergence of new transportation technologies and services, it is critical for transportation forecasting models to be enhanced to account for market dynamics that will result from increased penetration of disruptive forces in the transportation domain. To enhance transportation forecasting models, people’s attitudes towards and perceptions of these technologies and services need to be measured and understood. Armed with such an understanding, it will be possible to specify and develop behavioral models that account for attitudes and perceptions, adoption cycles, and adaptation patterns. It is envisioned that such models will help decision-makers better plan transportation infrastructure systems and design marketing and policy strategies that maximize the benefits of these disruptive technologies. Attitudes and perceptions are likely to vary by socioeconomic characteristics, existing travel patterns and mobility experiences, and land use and built environment attributes.

Phase 1 of this project started in August 2017 and lasted for a year. A comprehensive literature review with respect to survey design and methodology was performed. A complete list of survey goals, objectives, and detailed research questions was compiled. Accordingly, survey questionnaire has been designed with the following main sections: A) Attitudes and Preferences; B) Residential Choice and Vehicle Ownership; C) Current Travel Patterns; D) Mobility on Demand and Shared Mobility Services; E) Autonomous Vehicles, and F) Household and Individual Attributes.

The second phase of this large-scale survey-based research study to understand people's preferences and choices when it comes to future mobility options and technologies included the Pilot and full deployment data collection. TOMNET consortium members, Georgia Tech, and the University of South Florida, as well as a sister University Transportation Center (called D-STOP) led by the University of Texas at Austin, are joining forces with Arizona State University (ASU) and collected the same survey data from a sample of residents in the four metropolitan regions of Tampa, Austin, and Atlanta in addition to Phoenix metro area.

Pilot data collection efforts yielded a respondent sample of 256 individuals from the Greater Phoenix metropolitan area collected through both online and paper platform during fall 2018. Full data collection efforts across Phoenix yielded a respondent sample of 1071 individuals collected through an online platform during summer 2019. With the addition of the sample collected at Atlanta, Tampa, and Austin, the total survey sample size reached at 3740 completed responses across four southern metro areas. Two comprehensive reports summarize all the steps taken so far in survey design, pilot data collection in the Phoenix metro area, and the full deployment data collection in the Phoenix, Atlanta, and Tampa metro areas (5, 6).

The results of the pilot survey deployment show that half of the respondents are familiar with ridehailing services but not using them, while 12 percent stated using them monthly and 4 percent stated using them weekly in the Phoenix metro area. The ridehailing services usage rate significantly decreases for older people. Respondents generally agree that ridehailing services are good alternatives when away from home (76 percent), to avoid impaired driving (88 percent), when transit is not available (80 percent), to access transit (44 percent), when a personal vehicle is temporarily not available (73 percent), and to save time and money on parking (74 percent). The respondents also stated that they make 16 percent fewer transit trips, 10 percent fewer bike trips, and 12 percent fewer walk trips after starting using the ridehailing services. Only 29 percent of the respondents believe that the reduced cost worth choosing shared ridehailing modes to private ridehailing with longer travel time and the potential existence of strangers in the ride. Feeling uncomfortable sharing a ride with strangers is less among men (39 percent) compared to women (50 percent) and should be considered in any policymaking which is trying to promote sharing behavior.

With respect to autonomous vehicles, by average, 63 percent of the respondents are somewhat or very familiar with this technology. The familiarity with autonomous vehicles increases with the increase of the household annual income which reaches 77 percent for people with very high income (\$150,000 or more). With respect to using AVs, 27 percent of survey respondents stated that they never use an AV; 47 percent stated that they use it alone or with people they know, and only 20 percent stated that they are willing to share AVs with strangers. Moreover, 19 percent of the respondents are likely to make additional trips with the presence of AVs, and 23 percent are likely to make farther trips. Moreover, only 16 percent of respondents think that AVs are safer than human driver and 65 percent are concerned about the safety of pedestrians and bicycles on the streets.

This document explains the scope of the work for the third phase of the project including the full deployment data cleaning, weighting, geocoding, compiling, comprehensive analysis, and production of the required reports and documentation. It is envisioned that such outputs will help decision-makers better plan transportation infrastructure systems and design marketing and policy strategies that maximize the benefits of these disruptive technologies.

2. Project Objectives

The overall goal of this project is to conduct a rich set of analysis to better understand people's travel behavior and their attitudes towards and perceptions of advanced transportation technologies and mobility options with a view to developing robust behavioral models of technology adoption capable of reflecting impacts of these disruptive forces on traveler behavior and values.

3. Proposed Methodology and Data

During phase 1 of the project, a complete review of previous studies on attitudes towards and behavioral impacts of autonomous transportation technologies and innovative mobility services have been conducted. A comprehensive review of previous studies helped identify data needs and behavioral dimensions of interest to focus in this study. According to these findings, the survey goals and objectives have been defined clearly.

The goal of the T4 survey is to understand people's perceptions towards new transportation technologies, as well as to measure how general attitudes (e.g., technology savviness, environment friendliness, etc.) influence attitudes towards new transportation technologies. Furthermore, the study aims at understanding the role of current travel behavior and current use of mobility-on-demand services on perceptions of automated mobility, and willingness to adopt autonomous vehicles. The questionnaire was designed to identify how people's travel patterns, residential choices, vehicle ownership, and mode choice decisions will change in response to transformative changes in transportation. The goal is to obtain a database able to enlighten the study of long-term impacts on people's lifestyle and well-being, as well as the general impacts on energy consumption, emissions, congestion, and urban planning, and thus revise future demand models and activities forecasting models accounting for adaptation of these new transportation technologies. Based on the defined goals and objectives, the survey instrument has been designed during the first phase of the project.

According to the established goals, the survey questionnaire has been designed (5) and the pilot phase of data collection is accomplished in October-December 2018 with a sample size of 262, in the Phoenix metropolitan area. One important benefit of the pilot survey was the existence of both online and paper survey recruitment methods in one data collection. Even the people who received the paper booklet had the option to fill out the survey online. Comparing online to the paper survey instrument, each has its advantages and disadvantages.

In the Phoenix metro area, considering all the attributes of this survey, the cost of a complete response with mail invitations is two times larger than the cost of a complete response with an email invitation. Therefore, the research team decided to collect the data mainly with email invitations directed to an online platform. To consider the potential bias that an email survey invitation may produce by eliminating people with limited email/internet access, some postcard invitations have also been decided to be sent out to a random mail-based sample of Phoenix area residents. More detailed information about the pilot and the full deployment recruitment method is presented in this report (6).

Another important lesson that we learned by accomplishing the pilot survey was the quality of the responses to different questions. We found that people may have not understood a few questions as we were expecting and so we revised the survey questionnaire in response to that. Moreover, the online-only survey platform provides the option to smartly use logic and enhance the survey presentation. For example, people who mentioned that they are physically commuting were entered into the section with extra questions about commute trips, and that section was automatically skipped for the rest of the respondents. This removes the extra burden from the respondents and increases the quality of the responses.

In addition to the explained changes, the AV section of the full survey questionnaire has been significantly upgraded and advanced compared to the pilot phase. The new AV section has all the sections in the pilot phase including the familiarity, expected use, and attitudes toward AVs and new sections with respect to potential impacts of AV on travel behavior, vehicle ownership, residential choice, and willingness to pay. The project report for phase 2 presents the updated survey questionnaire for full deployment (6).

To conduct the full deployment, a random sample of the population from the Greater Phoenix Metropolitan area was desired. To gather a sample with such characteristics, a random address-based sample of Maricopa County residents was purchased from a marketing company (InfoUSA). The survey targeted individuals 18 years old and older residing inside Maricopa County. Two independent samples were acquired from the marketing vendor: a sample of 50,000 emails and a sample of 10,000 mail addresses (for which emails were not available). The email list was purchased for sending the online survey link via email while the physical addresses were purchased to send the online survey link using the postcard invitations. The email response rate was 2 percent and the postcard response rate was 2.13 percent which generates 1,071 completed responses in total from Phoenix Metro Area collected during Summer and Fall 2019. The final data set considered uniquely submitted responses, with the home location in Arizona. Responses with inconsistencies, such as the number of drivers in the household larger than household size, or respondents who marked the same answer on a large set of attitudinal questions were flagged as problematic on these particular questions but kept in the dataset to be used for other measured aspects. Responses from the online invitations represent 80.4 percent of the final dataset, and the responses through the postal invitation are responsible for the remaining 19.6 percent. The unit price per completed response was \$12.83 which is significantly lower than the cost of the pilot survey administration which included paper survey booklets.

After data collection, data extraction and data cleaning process will be conducted in phase 3 of the project. Furthermore, the dataset will be weighted to reflect the attributes of the general population residing in the Phoenix Metro area. Another data processing step during this phase is the geocoding of all the addresses and locations provided in the survey responses. Once a clean sample is prepared for each participating metro area (Phoenix, Atlanta, Tampa, and Austin), the datasets will be aggregated and a unique full dataset will be prepared for various research analyses and modeling. The comprehensive analysis of the data including developments of econometric models to understand people's perceptions and potential behavior toward new transport technologies will be conducted during the third phase (Year 3) of the project.

For presenting and disseminating the results to the broader community of the academics, practitioners, and government a one day webinar is planned to cover different research questions that this survey was planned to answer around Summer 2020. A full descriptive paper that summarizes all the survey questions in a basic descriptive fashion will be the first official journal article out of this survey. Following these two main channels of outreach, more in-depth and focused research papers will investigate various research questions around the perception and use of new transportation technologies and services with the inclusion of attitudinal variables. Some initial titles of studies are listed below:

- How do various survey administration methods affect sample attributes and attitudes?
- How women's willingness to share autonomous vehicles are different and why?
- How many people are willing to pay for buying/riding autonomous vehicles using stated preference questions?
- What are people's attitudes and perceptions toward policies and restrictions related to the operation and deployment of autonomous vehicles?
- What is the relationship between the current use of ridehailing services and willingness to adopt autonomous vehicles in the future?
- What might be the potential impacts of autonomous vehicles on mobility patterns/choices?
- How much socioeconomics, attitudes, vehicle, and residential choice, and current mobility choices explain the adoption of new mobility options?
- Who are the current users/non-users of ridehailing services? An in-depth attitudinal examination.
- How much location matters in multi-city and intra-city comparison and analysis of perceptions towards and (potential) adoption of new mobility options?
- What types of trips are made by current ridehailing services and shared bicycle and e-scooter services and how other modes are impacted?
- When people make shared ridehailing trip choices using stated preference data?

- How people make transportation mode choices in a world of shared autonomous vehicles and ridehailing services? Rank-order analysis approach.
- Are there any generational differences in attitudes towards and potential adoption of emerging transportation technologies?

4. Work Plan (Project Tasks)

The following tasks will be undertaken in this project.

Task 1 - Survey Data Cleaning: The first task is to conduct data cleaning of the Phoenix metro area full deployment sample. Data cleaning includes monitoring all the cases and flag problematic cases. Moreover, new variables as combinations of existing variables may need to be created in this step to make sure that the dataset contains all the necessary variables. The dataset will be assessed in all respects and complete data documentation and data dictionary will be developed at this stage so that the other project partners follow the same path to conduct the data dictionary.

Task 2 – Survey Data Weighting and Geocoding: The dataset needs to be weighted correctly to be a representative sample of the entire population. PopGen (7) will be used for this purpose. Depending on the completeness of the key socioeconomic variables, some data imputations may also be conducted. The data weighting will be conducted at each responsible research institute separately with coordination. The other important step at this stage is the geocoding of all the addresses and locations provided by the respondents to produce latitudes and longitudes. The produced coordinates will be further used in the data analysis phase to extract parcel or land-use variables in addition to estimating length and other network analysis.

Task 3 - Survey Data Compilation: The four datasets collected at the four southern research institutes will be compiled to produce a multi-jurisdiction final dataset. This step is very important to make sure everything undertaken with complete attention and precision without any potential mistake or flaw in the aggregated dataset.

Task 4 – Survey Results Analysis: The Phoenix area full deployment weighted dataset will go under basic to advanced statistical analysis. To start, descriptive uni-variate graphs will be produced for all the survey questions to show the response patterns. Based on the observed patterns the more detailed research questions will be defined and further analysis and model estimations will be performed.

Task 5 – Survey Results Outreach: The findings of the previous step will be disseminated to the community through various channels of conducting webinars, writing research papers, and presenting at conferences.

Task 6 - Submission of final deliverables: Lastly, the analysis results conducted during the one year study period will be summarized in the annual research report while the research on the dataset will be continued for the following years.

5. Project Schedule

The project schedule is shown in Figure 1 below.

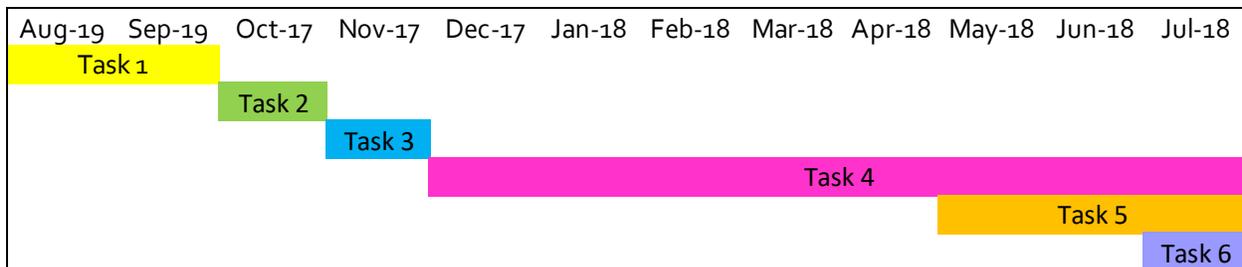


Figure 1 Project Schedule

6. Relevance to the Center Theme/Mission

This research project involves the analysis of attitudinal data to better understand how people perceive and value autonomous vehicles, mobility-as-a-service options, and other disruptive and transformative transportation technologies. Transportation planning agencies are increasingly seeking to forecast travel demand and mobility patterns/choices under alternative future states; however, they are limited in their ability to do so due to a severe paucity of data and behavioral models on how individuals may adopt and adapt to various disruptive transportation services and technologies. Many studies to date have not gathered data about attitudinal variables, which are likely to play a very important role in shaping the behavioral responses to alternative technologies and services. This project directly addresses the theme of the center by collecting attitudinal data together with behavioral and socio-economic information. The resulting data set will be used to develop new behavioral forecasting models that explicitly account for attitudes, perceptions, and values. Therefore, the attitudinal data collection and analysis effort contemplated in this project directly address the mission of TOMNET, namely, to advance data and methods to explicitly reflect the role of attitudes, perceptions, values, and preferences in activity-travel behavior and mobility choice models.

7. Anticipated Outcomes and Deliverables

The proposed project will result in the development of a rich dataset with series of analyses about people's socioeconomic attributes, current travel behavior, attitudes toward and perception of new mobility choices and advanced technologies in transportation, and expected impact of advanced mobility options on traveler behavior and values. The project will result in the delivery of harmonized data sets that can be pooled or analyzed separately in subsequent phases (years) of the overall research enterprise. Furthermore, this project includes the estimation of models to model users' perceptions and predict the impacts of new mobility services and technologies on different choices (residential/work location, vehicle ownership, and activity-travel patterns).

The project will result in the publication of a final report that documents the entire study including data cleaning, weighting, geocoding, compilation, and analysis. The data sets and documentation will be made available to all members of the TOMNET team to facilitate collaborative data analysis and modeling efforts. It is anticipated that the compiled dataset and the subsequent analytical outputs developed in this research effort can be used by any jurisdiction in the country interested in collecting similar data within its metropolitan region or context. Moreover, the application of different analytical and modeling outputs produces complementary insights into the advantages and disadvantages of the new transportation technologies and services, and how to include them in the existing demand models and plan for the most practical and timely policies to maximize their positive impact and minimize their negative impacts.

8. Research Team and Management Plan

The research team is led by Dr. Sara Khoeini, who will serve as the Principal Investigator for the project at ASU. Professor Ram Pendyala will serve as the co-principal investigator for the project and will assist in

each and every project task. The project will support one highly qualified Ph.D. student, and a few undergraduate research assistants (who will assist with survey administration and data entry).

Sara Khoeini is an Assistant Research Professor of Transportation Systems in the School of Sustainable Engineering and the Built Environment at Arizona State University. She is the Assistant Director of TOMNET. Sara has extensive experience in the study of traveler behavior and attitudes, particularly in the context of managed lane operations. She has deep expertise in statistical analysis of transportation data and travel behavior modeling. She has conducted special-purpose surveys to collect information about changes in travel behavior in response to changes in transportation system conditions. She has published her work in a variety of journals and has been active in several professional organizations. Sara has her Ph.D. from the Georgia Institute of Technology, MS from Clemson University, and her undergraduate degree from K.N.T. University of Technology in Iran.

Ram M. Pendyala is a Professor of Transportation Systems in the School of Sustainable Engineering and the Built Environment at Arizona State University. He serves as the Director of TOMNET. Pendyala is an expert in activity-travel behavior modeling and has led the development of a number of large-scale behaviorally robust microsimulation model systems. He has published extensively in the literature and serves as the Chair of the Transportation Research Board's Planning and Environment Group (2015-2018). He previously served as Chair of the Travel Analysis Methods Section (2009-2015) as well as the Traveler Behavior and Values Committee (2003-2009). He has also served as the Chair of the International Association for Travel Behavior Research (IATBR). He is currently an Associate Editor for Transportation Research Part D. He has his Ph.D. and MS degrees in Civil and Environmental Engineering with a specialization in transportation from the University of California at Davis, and his Bachelor's degree in Civil Engineering from the Indian Institute of Technology-Madras in India.

Sara Khoeini will be the primary point of contact for all aspects related to this research and will manage all aspects of the project. She will work closely with a graduate student and a few undergraduate students to accomplish the project tasks. She will also coordinate efforts with other research groups conducting the same survey in other US metropolitan areas to ensure consistency in the survey data and products. Ram Pendyala will assist in various project tasks and provide significant input on the design of the survey and sampling plan.

9. Technology Transfer Plan

The project team believes in executing an effective technology transfer plan by disseminating project information and results widely to the professional community. During the one-year duration of this particular project, each milestone will be disseminated using one of the TOMNET communication mechanisms (e.g., website, webinar, seminar, and teleconference). Project team members will prepare articles about the survey, data set, and modeling results for publication in refereed journals and conference proceedings. Project team members will participate in conferences and deliver presentations about this work and the outcomes of the effort. The project will also result in the preparation of data and survey products that can be shared with the broader professional community so that other jurisdictions can mimic the study without any difficulty. Particularly, the project team will conduct a one-day webinar event with a dozen presentations to present an in-depth summary of the survey results to the community around June 2020. All the webinars, seminars and, interim reports, and technical memoranda will be posted online at the TOMNET website.

10. Workforce Development and Outreach Plan

The project incorporates a strong workforce development and outreach plan. The project will employ a full-time Ph.D. graduate student as a graduate research associate. The doctoral student will be involved in all aspects of the project including data preparation and data analysis. At ASU, project team members will

engage with the National Summer Transportation Institute, a three-week residential summer program for high school students that aims to expose them to transportation-related careers. Finally, the project will also welcome high school students who may be interested in serving as volunteer researchers under the TOMNET Scholar Initiative. Findings from the project will be integrated into graduate-level courses taught at various institutions in the consortium so that the research and workforce development activities of the center are seamlessly blended together.

11. References

- John D. Stoll, The Wall Street Journal (2016, May 10). Retrieved on 2017, June 6 from: <https://www.wsj.com/articles/gm-executive-credits-silicon-valley-for-accelerating-development-of-self-driving-cars-1462910491>
- Jan Hauser, Wirtschaft (2015, Oct 19). Retrieved on 2017, June 6 from: <http://www.faz.net/aktuell/wirtschaft/unternehmen/verkehrsminister-foxx-selbstfahrende-autos-in-10-jahren-standard-13811022.html>
- Driverless car market watch. Retrieved on 2017, June 6 from: http://www.driverless-future.com/?page_id=384
- IEEE 2012 news. Retrieved on 2017, June 6 from: http://www.ieee.org/about/news/2012/5september_2_2012.html.
- Attitudes towards Emerging Mobility Options and Technologies – Phase 1: Survey Design. Center for Teaching Old Models New Tricks (TOMNET) Tier 1 University Transportation Center, 2018.
- Attitudes towards Emerging Mobility Options and Technologies – Phase 2: Pilot and Full Survey Deployment. Center for Teaching Old Models New Tricks (TOMNET) Tier 1 University Transportation Center, 2019.
- PopGen Synthetic Population Generator Software. Retrieved on 2020, May 10 from: <https://www.mobilityanalytics.org/popgen.html>.

12. Qualifications of Investigators (One-page CV per Investigator)

SARA KHOEINI

Assistant Research Professor, Sustainable Engineering and the Built Environment
Arizona State University (ASU), Tempe, AZ 85287-3005 Email: Sara.Khoeini@asu.edu

Education

Ph.D., Civil Engineering (Transportation), Georgia Institute of Technology, May 2014.

M.Sc., Civil Engineering (Transportation), Clemson University, Dec 2009.

B. Sc., Civil Engineering, K.N. Toosi University of Technology, Aug 2007.

Employment and Professional Experience (last 25 years)

Assistant Research Professor, Sustainable Engineering and the Built Environment, ASU, March 2017 – present

Research Affiliate, School of Civil and Environmental Engineering, Georgia Institute of Technology, April 2015 – Feb 2017

Research Scientist I, School of Civil and Environmental Engineering, Georgia Institute of Technology, March 2014 – March 2015

Fields of Interest and Expertise

(1) Urban transportation systems planning; (2) Travel behavior analysis; (3) Transportation demand modeling and forecasting; (4) Geographic Information Systems; (5) Statistical analysis of transportation data; (6) Travel survey methods and data collection; (7) Sustainability and energy

5 Recent Relevant Publications

1. R. Guensler, J. Ko, D. Kim, S. Khoeini, A. Sheikh and Xu, Y. “Factors affecting Atlanta commuters’ high occupancy toll lane and carpool choices”; International Journal of Sustainable Transportation, 2019, 10.1080/15568318.2019.1663961.
2. K. Long, D. Silva, F. Dias, S. Khoeini, A. Bhat, R. Pendyala, C. Bhat. “Role of Childhood Context and Experience in Shaping Activity-Travel Choices in Adulthood”; Transportation Research Record: Journal of the Transportation Research Board, National Academy of Sciences, 2019; 036119811984033.
3. S. Sharda, D. Silva, K. Grimm, S. Khoeini, and R. Pendyala. “Modeling Determinants of Risky Driving Behaviors and Secondary Task Engagement Using Naturalistic Driving Data”; Transportation Research E-Circular E-C243, Transportation Research Board, National Academies, 2019, pp. 41-56.
4. H. Li, J. Cebe, S. Khoeini, Y. Xu, and R. Guensler. “A Semi-Automated Method to Generate GIS-Based Sidewalk Networks for Asset Management and Pedestrian Accessibility Assessment”; Transportation Research Record: Journal of the Transportation Research Board, National Academy of Sciences, 2018; 0361198118757981.
5. G. S. Nair, S. Astroza, C. Bhat, S. Khoeini, and R. Pendyala. “An Application of a Rank Ordered Probit Modeling Approach to Understand Level of Interest in Autonomous Vehicles”; Transportation, 1-15, 2017; 10.1007/s11116-018-9945-9.

Honors and Awards

Student of The Year, Georgia Tech National Center for Sustainable Transportation, 2013

WTS Helene M. Overly Memorial Scholarship, 2013

Best Student Paper Award, Freeway & Managed Lane Operations Meeting and Conference, Atlanta, GA, 2013

Ranked 2nd, Nationwide Graduate School Entrance Examination, Civil Engineering-Surveying, Iran, 2007

RAM M. PENDYALA

Professor, Sustainable Engineering and the Built Environment
Senior Sustainability Scientist - Global Institute of Sustainability
Arizona State University (ASU), Tempe, AZ 85287-3005 Email: pendyala@asu.edu

Education

Ph.D., Civil Engineering (Transportation), University of California-Davis, December 1992.

M.S., Civil Engineering (Transportation), University of California-Davis, June 1990.

B.Tech., Civil Engineering, Indian Institute of Technology-Madras, June 1988

Employment and Professional Experience (last 25 years)

Professor, Sustainable Engineering and the Built Environment, ASU, 2006-2014 & 2016-present.

Frederick R. Dickerson Chair Professor, School of Civil and Environmental Engineering, Georgia Institute of Technology, 2014-2016

Senior Sustainability Scientist - Global Institute of Sustainability, ASU, 2011-Present.

Asst/Assoc/Professor, Civil & Environmental Engineering, Univ of South Florida, 1994-2006.

Assistant Professor, Civil Engineering, University of Louisiana at Lafayette, 1992-1994.

Fields of Interest and Expertise

(1) Multimodal transportation systems planning; (2) Activity-travel behavior analysis; (3) Transportation demand modeling and forecasting; (4) Mobility analytics and visualization; (5) Statistical and econometric analysis of transportation data; (6) Dynamic mobility management; (7) Travel survey methods and data collection; (8) Built environment – transportation – energy

5 Recent Relevant Publications (from over 200)

1. Garikapati, V. M., Pendyala, R. M., Morris, E. A., Mokhtarian, P. L., and McDonald, N. (2016). Activity Patterns, Time Use, And Travel of Millennials: A Generation in Transition? *Transport Reviews*, 36(5), pp. 558-584.
2. Pinjari, A. R., Augustin, B., Sivaraman, V., Imani, A. F., Eluru, N., and Pendyala, R. M. (2016). Stochastic Frontier Estimation of Budgets for Kuhn–Tucker Demand Systems: Application to Activity Time-Use Analysis. *Transportation Research Part A*, 88, pp. 117-133.
3. Shin, J., Bhat, C. R., You, D., Garikapati, V. M., and Pendyala, R. M. (2015). Consumer Preferences and Willingness to Pay for Advanced Vehicle Technology Options and Fuel Types. *Transportation Research Part C*, 60, pp. 511-524.
4. Garikapati, V. M., You, D., Pendyala, R. M., Jeon, K., Livshits, V., and Vovsha, P. S. (2015). Tour Characterization Framework Incorporating Activity Stop–Sequencing Model System. *Transportation Research Record: Journal of the Transportation Research Board*, 2494, pp. 77-86.
5. Archer, M., Paleti, R., Konduri, K., Pendyala, R., & Bhat, C. (2013). Modeling the connection between activity-travel patterns and subjective well-being. *Transportation Research Record: Journal of the Transportation Research Board*, 2382, pp. 102-111.

Graduate Student Supervision/Advising

Graduated: 10 PhDs (includes 2 women), 50 Masters; **Current Supervision:** 4 PhDs

Recent Honors and Awards

Pyke Johnson Award for Best Paper in Planning and Environment, Transportation Research Board of the National Academies, 2011 and 2013

Invited Speaker, Distinguished Lecture Series, Department of Civil and Environmental Engineering, Florida International University, 2015

Invited Keynote Speaker at 5 International/National Conferences, 2014-2016

13. Budget Including Non-Federal Matching Funds

Institution: Arizona State University

Project Title: Attitudes towards Emerging Mobility Options and Technologies – Phase 1: Data Collection

Principal Investigator: Dr. Sara Khoeini, Assistant Research Professor

Budget Period: 8/1/2018 to 7/31/2019

| CATEGORY | Budgeted Amount from Federal Share | Budgeted Amount from Matching Funds | Explanatory Notes; Identify Source of Matching Funds |
|---|------------------------------------|-------------------------------------|--|
| Faculty Salaries | | \$20,000 | ASU: Dr. Khoeini = \$15,000 Dr. Pendyala = \$5,000 |
| Other Staff Salaries | | | |
| Student Salaries (includes data entry costs) | \$20,000 | | |
| Fringe Benefits | \$2,946 | \$5,954 | Faculty: 29.77% of salaries Grad RA: 14.73% of salaries |
| Total Salaries & Benefits | \$22,946 | \$25,954 | |
| Student Tuition Remission | \$17,228 | | Full calendar year tuition |
| Operating Services and Supplies (data storage) | | \$500 | ASU: Pendyala Startup Funds |
| Domestic Travel | | \$1,000 | ASU: Pendyala Startup Funds |
| Other Direct Costs (specify): Survey Related Costs (address database, URL, printing and mailing) | \$20,000 | | |
| Other Direct Costs (specify) | | | |
| Total Direct Costs | \$60,174 | \$27,454 | |
| F&A (Indirect) Costs: 54.5% of MTDC (excludes tuition) | \$23,406 | \$14,962 | |
| TOTAL COSTS | \$83,580 | \$42,416 | Total Project Cost: \$125,996 |

Grant Deliverables and Reporting Requirements for UTC Grants (November 2016)
Exhibit F

| UTC Project Information | |
|---|--|
| Project Title | Attitudes towards Emerging Mobility Options and Technologies – Phase 1: Data Collection |
| University | Arizona State University |
| Principal Investigator | Sara Khoeini |
| PI Contact Information | Address: 660 S College Ave, CAVC Room 549 PO Box 873005, Tempe, AZ, 85287-3005 Email: Sara.Khoeini@asu.edu |
| Funding Source(s) and Amounts Provided (by each agency or organization) | US Department of Transportation (Federal UTC): \$83,580 Arizona State University (Cost Share): \$42,416 |
| Total Project Cost | \$125,996 |
| Agency ID or Contract Number | |
| Start and End Dates | 8/1/2017 - 07/31/2018 |
| Brief Description of Research Project | Emerging transportation technologies including electric and autonomous vehicles and emerging mobility services such as ride-hailing and vehicle sharing are bringing about transformative changes in the transportation landscape. With the emergence of new transportation technologies and services, it is critical that transportation forecasting models be enhanced to account for behavioral dynamics that will result from the increasing penetration of disruptive forces in the transportation marketplace. To enhance transportation forecasting models, people’s attitudes towards and perceptions of emerging technologies and services need to be measured and understood. Armed with such an understanding, it will be possible to specify and develop behavioral models that account for attitudes and perceptions, adoption cycles, and adaptation patterns. It is envisioned that such models will help decision-makers better plan transportation infrastructure systems and design marketing and policy strategies that maximize the benefits of these disruptive technologies. This project aims to collect survey data from a sample of 1000 residents in the Phoenix metro area to understand how the market perceives, adopts, and adapts to transformative transportation technologies. During the one-year duration of the project, the research team will review relevant behavioral studies, design the survey instrument and sampling plan, conduct a survey pre-test, perform full-fledged data collection through the administration of a comprehensive attitudinal and behavioral survey, compile and clean data, and produce reports and documentation. Thus, the focus of this phase-I effort is to |

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| | collect a rich dataset of users' attributes and current mobility choices, together with attitudes, perceptions and stated preferences towards new mobility options and technologies. It is envisioned that this project will result in the development of a data collection protocol and methodology that can be widely adopted in any jurisdiction interested in replicating the study. (285 words) |
| Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here | The main outcome of this project at the end of this project year is a harmonized comprehensive survey about users' attitudes and perceptions toward new transport technologies. The survey questionnaire and deployment plan can be widely adopted anywhere in the country. The collected dataset will be used to shed light on questions regarding users' responses to new transport choices. |
| Impacts/Benefits of Implementation (actual, not anticipated) | Eventually, the collected valuable dataset will help transport modelers to more accurately account for new transport choices in their models and will assist policy-makers to place more effective policies to maximize the positive impacts and minimize the negative impacts of these transformative forces. |
| Web Links <ul style="list-style-type: none"> • Reports • Project Website | https://www.tomnet-utc.org/asu-av-survey-project.html |