Center for Teaching Old Models New Tricks (TOMNET)

A USDOT Tier 1 University Transportation Center

PROJECT PROPOSAL 2018-2019

Title: Millennials Vehicle Miles of Travel Compared to Generation X

Principal Investigator: Ram Pendyala, Professor, School of Sustainable Engineering and the Built Environment, Arizona State University

Co-Principal Investigator: Sara Khoeini, Assistant Research Professor, School of Sustainable Engineering and the Built Environment, Arizona State University

1. Introduction/Problem Statement

Millennials are now all grown up, and yet there continues to be much interest in a multitude of domains in analyzing their choices, consumption patterns, lifestyle preferences, attitudes and values, and activity-travel behaviors (Lee et al., 2019; Krueger et al., 2019; Etezady et al., 2019). Based on the Pew Research Center (2019a) definition that anyone born in the years of 1981 through 1996 is a millennial, this generation of consumers surpassed baby boomers (generation born in the years of 1946 through 1964) in 2019 as the largest adult population group in the United States (Searing, 2019). Although Generation Z (the post-millennial generation), born 1997 and after, is larger in total numbers than any other generation in the United States (in 2019), many in the Generation Z cohort are not yet adults and hence do not yet command the marketplace as millennials do today (Kasasa, 2019). In 2019, all millennials are adults and they are projected to reach 73 million, while the boomer population is expected to decline to 72 million (Searing, 2019).

The commentary about millennials in the literature and popular press has evolved over time. When millennials entered adulthood in the early part of the decade, much was made about the many differences they depicted when compared with prior generations. In the transportation and urban planning literature, a number of studies documented that millennials made fewer trips, owned and used automobiles less, did not obtain driver's licenses at the same rate as prior generations, used transit and alternative modes more, preferred living in denser-multimodal urban environments, and embraced the sharing economy while shunning conventional models of ownership (Tiedeman and Circella, 2018; Tiedeman et al., 2017; Zhong and Lee, 2014). A number of articles in the popular press had also alluded to differences depicted by millennials – both in behaviors and attitudes, suggesting that this generation is going to fundamentally transform how the nation works, consumes, shares, interacts, and lives (Kasasa, 2019; Searing, 2019; Zipcar, 2015; Badger, 2014). There was considerable speculation that millennials are fundamentally different in their attitudes, perceptions, and preferences – and will therefore bring about a permanent and lasting shift in the urban ecosystem.

More recently, however, the commentary has shifted. As millennials aged into adulthood and increasing amounts of longitudinal data became available (thus enabling a study of trends over time), it appeared that millennials are beginning to increasingly resemble and mimic behavioral patterns depicted by prior generations (Lavieri et al., 2017; Delbosc et al., 2018). A number of studies in the transportation domain alone suggest that millennials are not necessarily all that different from prior generations (e.g., Garikapati et al., 2016; Lee et al., 2019; Chatterjee et al., 2018; Ralph, 2017). Articles in the popular press have also begun to note that millennials are choosing to live, work, and travel in ways that are similar to generations that preceded them (Cox, 2019; Schwantes, 2018; Cappelli, 2019). A survey by the National

Association of Home Builders suggests that two-thirds of Millennials want to live in the suburbs, 24 percent want to live in rural areas, and only 10 percent want to live in urban city centers (Hudson, 2015). Many of these studies and articles note that differences depicted by millennials in early stages of adulthood may have been due to circumstances wrought by the severe prolonged recession that began in 2007-2008, the effects of which continue to reverberate throughout the US and global economies despite the strong economic recovery and record low unemployment rates of the past few years (Thompson, 2012; Kasasa, 2019). Although millennials continue to evolve, in terms of their lifestyle and travel choices, and increasingly look like generations that preceded them, some differences in activity-travel patterns, residential location, and car ownership and use linger (Garikapati et al., 2016; Krueger et al., 2019; Lee et al., 2019). In addition, early millennials (i.e., those born in the early 1980s) are quite different in activity and time-use patterns than late millennials (i.e., those born in the mid-1990s); the heterogeneity within the millennial generation makes it difficult (and potentially inappropriate) to draw broad and generalizable conclusions about the entire cohort (Garikapati et al., 2016).

The fundamental questions that motivate this research are largely identical to those which have motivated prior research studies: *Are millennials fundamentally different in their travel behavior than generations that preceded them? What is the extent to which millennials are different, after controlling for all other confounding factors?*

2. Project Objectives

This study aims to analyze the extent to which millennials are different from the immediately preceding generation (Generation X – born in the years of 1965 through 1980). The objective of the study is to isolate and quantify the "millennial effect", after controlling for all other factors that could contribute to differences between the two generations.

3. Proposed Methodology and Data

With the availability of recent national travel and time use survey data sets in the United States, it is now possible to analyze the extent to which millennials are truly different from the preceding generation (Generation X) while controlling for many other factors that have changed over time. In particular, the 2017 National Household Travel Survey (NHTS) data offers detailed socio-economic, demographic, and activity-travel information for a large national sample of individuals in the nation. The 2017 American Time Use Survey (ATUS) data set is also a rich source of information for analyzing activity-travel patterns of a large national sample but does not offer the same level of information about transportation choices as the NHTS does. Moreover, the ATUS series commenced only in 2003, presenting a shorter longitudinal window within which to study and compare multiple generations while controlling for myriad factors.

The nature of the problem being addressed in this study is characterized by a high degree of endogeneity. There are a number of inter-related dependent variables; not only are the variables inter-related, but there may be a number of unobserved attributes and traits that affect multiple behavioral dimensions. The prevalence of multiple inter-related dependent variables coupled with the need to account for correlated unobserved attributes that affect them called for the development, specification, and estimation of a simultaneous equation model system that could capture these complex relationships. However, decisions had to be made as to the exact variables that would be used as dependent (endogenous) variables and the variables that would be included in the specification as exogenous variables.

4. Work Plan

Task 1: Literature Review, and Data Assembly

During this task, a comprehensive review of the literature at the intersection of travel and wellbeing will be conducted. Furthermore, all the datasets from ATUS and NHTS which are needed to be analyzed will be assembled with the right sample size and list of variables in SPSS.

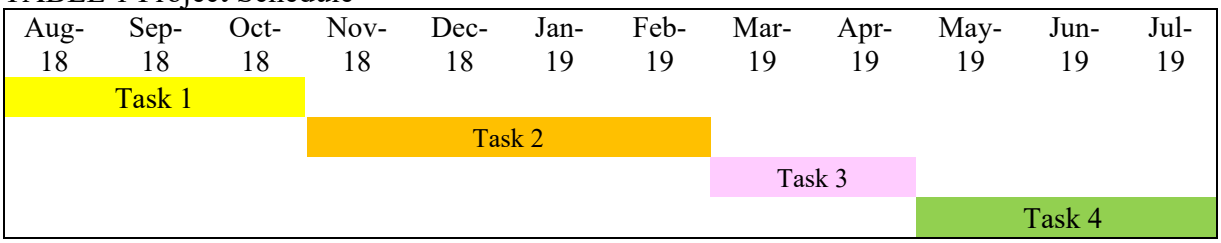
Task 2: Joint Model of Activity-Travel Choices Estimation
During this task, a simultaneous equation modeling framework will be developed and estimated which will include several endogenous and exogenous variables. The goal for the application of this modeling framework is to separate the true effect of the millennial factor from other related factors. So this procedure needs significant attention and it is expected that it takes the majority of the project time.

Task 3: Explanatory Analysis of the Results
The supplementary statistical analysis will be conducted in this step to clearly and quantitatively explain the modeling results and estimate the "millennials effect" compared to other envolving factors.

Task 4: Project Deliverables
The project deliverables, including the research report, conference and journal papers, will be prepared in this step.

5. Project Schedule (1/2 – 1 page)
Table 1 illustrates the timeline for all the tasks explained in the previous section.

TABLE 1 Project Schedule



6. Relevance to the Center Theme/Mission
Over the past decade, considerable attention has been paid to the activity-travel choices of millennials, primarily because they appeared to depict patterns of behavior that differed from those of predecessor generations. Although there has been considerable research on millennial travel behavior, most studies have not been able to systematically isolate and quantify the millennial (cohort) effect in explaining differences in activity-travel choices. As there are many confounding factors that may contribute to changes in activity-travel choices across generations, estimation of effect sizes is not straightforward and requires data that would allow for a controlled comparison and analysis of multiple generations. This study attempts to shed light on the "millennial difference", i.e., the true cohort effect that contributes to differences seen among millennials with respect to activity-travel behaviors. The true cohort effect of millennials can be added to travel demand models to account for differences between generations in travel perceptions, preferences, and behaviors which is very well in line with the mission of TOMNET to enhance travel demand models by incorporating new pieces of users attributes.

7. Anticipated Outcomes and Deliverables
It is anticipated that this project sheds light on many claims in favor and against the existence of a "millennials effect" in travel behavior and demand modeling. If it turns out that there is a significant difference between millennials and the prior generation, this project will provide a modeling framework to account for the "millennials effect" in travel demand models and improve their prediction power. Additionally, the project will also result in the publication of a final report and the preparation of presentations that document the entire study.

8. Research Team and Management Plan

The research team is led by Dr. Ram Pendyala, who will serve as the Principal Investigator for the project at ASU. Sara Khoeini will serve as the co-principal investigator for the project. The project will support one highly qualified Ph.D. student completely, and a few graduate research assistants (who will assist with different data assembly and model estimation practices) partially.

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 Behaviour 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 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. The University of Technology in Iran.

Ram Pendyala will be the primary point of contact for all aspects related to this research and will manage all aspects of the project. He will work closely with graduate students to accomplish the project tasks. Sara Khoeini will assist with various project tasks and provide significant input on the analytical and modeling work of the project.

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, teleconference). Project team members will prepare articles 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.

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 literature review, data assembly, and model estimation. 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

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Etezady, A., F. Atiyya Shaw, P.L. Mokhtarian, and G. Circella. What Drives the Gap? Decomposing Differences between Millennials and Generation X in Transportation-Related Attitudes. Presented at the 98th Annual Meeting of the Transportation Research Board Annual Meeting, Washington, D.C., 2019.

Garikapati, V.M., R.M. Pendyala, E.A. Morris, P.L. Mokhtarian, and N. McDonald. Activity Patterns, Time Use, and Travel of Millennials: A Generation in Transition? *Transport Reviews*, 36(5), 2016, 558-584.

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Lavieri, P.S., V.M. Garikapati, C.R. Bhat, and R.M. Pendyala. Investigation of Heterogeneity in Vehicle Ownership and Usage for the Millennial Generation. *Transportation Research Record: Journal of the Transportation Research Board*, 2664, 2017, 91-99.

Lee, Y., G. Circella, P.L. Mokhtarian, and S. Guhathakurta. Are Millennials More Multimodal? A Latent-Class Cluster Analysis with Attitudes and Preferences among Millennial and Generation X Commuters in California. *Transportation*, https://doi.org/10.1007/s11116-019-10026-6, 2019.

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

RAM M. PENDYALA
Professor, Sustainable Engineering and the Built Environment
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

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. **S. Khoeini**, and R. Guensler. "Socioeconomic Assessment: Conversion of I-85 High-Occupancy Vehicle to High-Occupancy Toll in Atlanta, Georgia"; Transportation Research Record: Journal of the Transportation Research Board, National Academy of Sciences; No. 2450.1, pp. 52-61, 2014.
2. **S. Khoeini**, R. Guensler. "Using Vehicle Value In place of income For Pricing Economic Analysis: A case study on Atlanta I-85 HOT lane"; Research in Transportation Economics, Special issue on "road pricing in US", Vol. 44, pp. 33-42, 2014.
3. F. Castrillon, M. Roell, **S. Khoeini**, R. Guensler. "The I-85 HOT Lane's Impact on Atlanta's Commuter Bus and Vanpool Occupancy"; Transportation Research Record Journal of the Transportation Research Board, National Academy of Sciences; No. 2470, pp. 169-177, 2014.
4. V. Elango, **S. Khoeini**, Y. Xu, R. Guensler. "Longitudinal GPS Travel Data and Breach of Privacy via Enhanced Spatial and Demographic Analysis"; Transportation Research Record: Journal of the Transportation Research Board, National Academy of Sciences; No. 2345, pp. 86-98, 2013.
5. **S. Khoeini**, R. Guensler, M. Rodgers, V. Elango. "Sensitivity of commuters' demographic characteristics to license plate data collection specifications: A case study for HOV-to-HOT project in I-85 corridor, Atlanta, GA"; Transportation Research Record: Journal of the Transportation Research Board, National Academy of Sciences; No. 2308, pp. 37-46, 2012.

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

13.Budget Including Non-Federal Matching Funds

Institution: Arizona State University

Project Title: Millennials Vehicle Miles of Travel Compared to Generation X

Principal Investigator: Ram Pendyala

Budget Period: 8/1/2018 - 07/31/2019

CATEGORY	Budgeted Amount from Federal Share	Budgeted Amount from Matching Funds	Explanatory Notes; Identify Source of Matching Funds
Faculty Salaries			
Other Staff Salaries			
Student Salaries			
Fringe Benefits			
Total Salaries & Benefits			
Student Tuition Remission			
Operating Services and Supplies			
Domestic Travel			
Other Direct Costs (specify)			
Other Direct Costs (specify)			
Total Direct Costs			
F&A (Indirect) Costs			
TOTAL COSTS			

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

UTC Project Information	
Project Title	Millennials Vehicle Miles of Travel Compared to Generation X
University	Arizona State University
Principal Investigator	Ram Pendyala
PI Contact Information	Address: 660 S College Ave, CAVC Email: Ram.Pendyala@asu.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	
Total Project Cost	
Agency ID or Contract Number	
Start and End Dates	8/1/2018 - 07/31/2019
Brief Description of Research Project	This project is motivated by a desire to understand and quantify the extent to which millennials are truly different in their activity-travel behavior when compared with Generation X that preceded them. In order to conduct the inter-generational comparison and control for a number of confounding factors in determining the "millennial difference", data from the 2001 and 2017 National Household Travel Survey (NHTS) is utilized. In computing the sizes of various effects in explaining differences in VMT between the two cohorts, it is found that the socio-economic and demographic effect size is the largest. All other effect sizes are very small; the millennial effect, although statistically significant, is tiny in comparison to the socio-economic and demographic effect size. The isolation of the millennial effect size is, however, not straightforward because the other effects may themselves be influenced by the cohort effect. Nevertheless, the millennial effect appears very small, suggesting that there is no substantial fundamental difference in attitudes, values, and preferences between generations. Changes in the transportation landscape are likely to be driven largely by technological innovation, economics, and public policy rather than by any inter-generational differences.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	It is anticipated that this project sheds light on many claims in favor and against the existence of a "millennials effect" in travel behavior and demand modeling. If it turns out that there is a significant difference between millennials and the prior generation, this project will provide a modeling framework to account for the "millennials effect" in travel demand models.
Impacts/Benefits of Implementation (actual, not anticipated)	According to the findings of the study, the inclusion of millennials' effect in travel demand models can improve their prediction power and accuracy subject to its significance. If it turns out that the millennials' effect is not

	significant in size, all the previous claims on this matter will be responded with quantitative evidence.
Web Links • Reports • Project Website	