Center for Teaching Old Models New Tricks (TOMNET)

A USDOT Tier 1 University Transportation Center

PROJECT PROPOSAL: 2020-2021

Title: Mode Substitutional Patterns of Ridehailing and Micro-mobility Services

Principal Investigator: Giovanni Circella, PhD, School of Civil and Environmental Engineering, Senior Research Engineer

Co-Principal Investigator: Patricia L. Mokhtarian, PhD, School of Civil and Environmental Engineering, Professor

Other non-TOMNET Collaborator: Yongsung Lee, PhD, University of Hong Kong, Assistant Professor

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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 1,021 individuals across the Atlanta region that has been collected during the previous phase of the project, eventually together with the other datasets collected by the partner TOMNET institutions in other Southern US cities.

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). For example, 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 also revealed to have plans to operate its driverless cars on the market no later than 2018 (3). The Institute of Electrical and Electronics Engineers (IEEE) predicted that up to 75% of all vehicles will be autonomous by 2040 (4). While some of the forecasts regarding the deployment of AVs have turned to be overly optimistic, and the deployment of autonomous vehicles has been postponed to future years, clearly emerging transportation technologies are reshaping transportation with the possibility that vehicle ownership and mobility patterns in future years might look very different from previous trends observed in the recent past. Among other disruptions, virtual ridehailing companies such as Uber and Lyft are already changing 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. Further, the recent introduction of fleets of

shared e-scooters are providing additional options for shorter trips in urban areas, further enriching the suite of mobility options in US cities.

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.

Previous phases of related research started in August 2017: 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 were 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. As part of this large-scale survey-based research framework to understand people's preferences and choices when it comes to future mobility options and technologies, pilot and full deployment data collections were carried out. TOMNET consortium members, Arizona State University (ASU), and the University of South Florida, as well as a sister University Transportation Center (D-STOP) led by the University of Texas at Austin, joined forces with Georgia Tech and collected the same survey data from a sample of residents in the four metropolitan areas in Phoenix, AZ, Tampa, FL, and Austin, TX, along with the Atlanta region. The data collection efforts in the Atlanta region yielded a sample collected among 1,021 individuals through an online platform during summer 2019. With the addition of the sample collected at Phoenix, Tampa, and Austin, the total survey sample size reached 3,740 completed responses across four southern metro areas. Two comprehensive reports summarized 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 Atlanta, Phoenix, and Tampa metropolitan 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.

In the following sections, we explain the scope of our research activities during this new research project in which we capitalize on the rich dataset collected in the previous research to examine the travel-behavior implications of shared mobility services and autonomous vehicles. With rigorous data analyses and in-depth discussion, we expect to inform planners and policymakers of effective ways to promote the mobility-enhancing capabilities of these disruptive technologies, while managing transportation infrastructure, regulating excessive use of private vehicles, and making sure to share benefits with various segments in society.

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 by 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

In previous related research, our research team conducted 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 was 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 was designed (5) and the pilot phase of data collection accomplished in October-December 2018 with a sample size of 262 by the research partners at Arizona State University 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 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 a previous research report (6). Another important lesson 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 commutating 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 was significantly upgraded and advanced compared to the pilot phase. The new AV section has all the questions in the pilot phase including the familiarity, expected use, and attitudes toward AVs and new questions 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 Atlanta region was desired. To gather a sample with such characteristics, a random address-based sample from 15 core counties in the region was purchased from a marketing company (InfoUSA). The survey targeted individuals 18 years old and older residing inside these counties. Two independent samples were acquired from the marketing vendor: a sample of 30,000 emails and a sample of 30,000 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 0.53 percent and the postcard response rate was 2.78 percent which generates 1,021 completed responses in total from the Atlanta region, collected during Summer and Fall 2019. The final data set considered uniquely submitted responses, with the home location in the 15 counties. 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 15.6 percent of the final dataset, and the responses through the postal invitation are responsible for the remaining 84.3 percent. The unit price per completed response was $19.91 which is lower than the average cost of the pilot survey administration. After data collection, data extraction and data cleaning process were conducted. Furthermore, the dataset was weighted to reflect the attributes of the general population residing in the Atlanta region. Another data processing step during this phase was the geocoding of all the addresses and locations provided in the survey responses. After a clean sample was prepared for each participating metro area (Phoenix, Atlanta, Tampa, and Austin), the datasets were aggregated and a unique full dataset was 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 were conducted throughout 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 was conducted in June 2020 to present preliminary

findings from this study related to various research questions. Some initial research questions that the research team started to investigate are:

- 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 research project.

Task 1 – *Project management and coordination:* the research team will meet regularly to coordinate the project, and will engage relevant stakeholders and partners at other TOMNET institutions to coordinate the development of the research. In this project task, necessary updates to the (on-going) review of the scientific literature will be conducted, to make sure that our research builds on the best knowledge available to date in the transportation research community.

Task 2 – *Impacts of ridehailing adoption on other travel modes:* In this project, we examine the ways that ridehailing users change their use of other means of transportation since they began to use ridehailing services. In so doing, we hypothesize that changes in mode-use patterns in relation to ridehailing differ across individuals, in a way that the sample consists of multiple "unobserved" groups, each of which presents unique patterns of behavioral changes. To test this hypothesis, we employ a latent-class cluster analysis with which we uncover unobserved groups of ridehailing users in the data. Members of each group will share similar behavioral patterns, which differ from those of the other groups. We analyze cases collected from all four study regions, and we discuss regional variations and policy implications.

Task 3 – *Substitution patterns by micromobility*: With the growing market penetration of micromobility services (e.g., shared bikes and electric scooters) and its integration into the existing set of mobility tools and services in cities, scholars and planners are called for to identify effective planning and policy responses with which to promote its mobility-enhancing capability for short distances, while reducing dependence on private vehicles (and responding to safety issues). Although the micromobility literature has been rapidly growing in recent years, the impacts of mobility on the use of other travel modes have been studied mostly via descriptive analyses, in part because of a lack of rich microdata and rigorous analyses. In this project, we examine the substitution patterns of the last trip taken by electric scooters at the individual level with the data from the four study regions. In so doing, we consider a comprehensive set of explanatory variables including trip attributes, individual/household characteristics, land-use attributes of home and work/school, typical mode-use patterns (aka travel modality), adoption of other shared mobility services, and most importantly, attitudes and preferences. With findings and discussions, we expect to contribute to the ongoing public discourse on the travel behavior after the pandemic. After all, attitudes and preferences will be more critical in the context of individualized active modes such as shared bikes and electric scooters (e.g., safety concerns and social distancing)

Task 4 – *Preparation of final project report and scientific papers*: The research team will prepare a set of scientific papers for publication and a final project report that will be disseminated with the funding agency and partner institutions. Presentations for scientific conferences and an online webinar will also be prepared to disseminate the research from the research.

5. Project Schedule

The project schedule is shown in Figure 1 below.

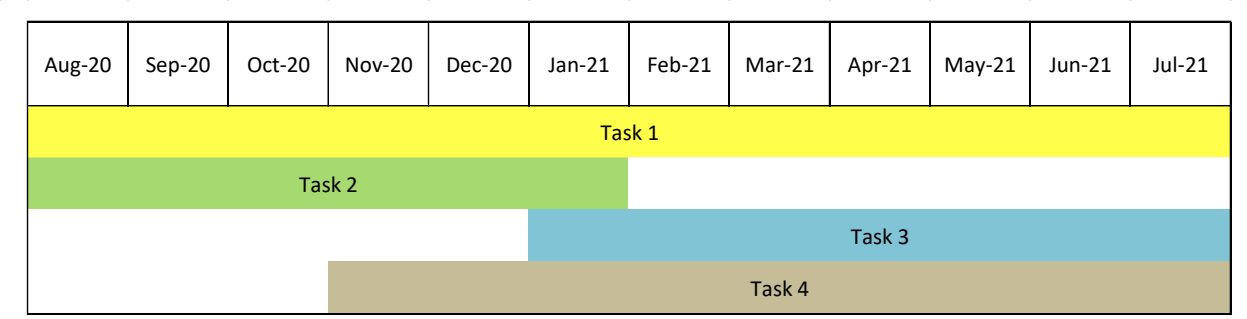

Figure 1 Project Schedule

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 summarizes the work carried out in the various project tasks. The datasets and related documentation are already 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. Giovanni Circella, who will serve as the Principal Investigator for the project at Georgia Tech. Professor Patricia L. Mokhtarian will serve as the co-principal investigators for the project and will assist in each and every project task.

Giovanni Circella is a Senior Research Engineer in the School of Civil and Environmental Engineering at Georgia Tech, and the Director of the 3 Revolutions Future Mobility Program at the University of California, Davis. His interests include travel behavior, travel demand modeling, survey design, the mobility of millennials, the impact of personal attitudes and preferences, the adoption of shared mobility services and information and communication technologies, the adoption of autonomous vehicles, and the estimation of quantitative models of travel behavior, vehicle ownership and energy use. Dr. Circella has extensive experience designing large data collection using mobility surveys and other methodologies, he has authored many scientific journal papers and has advised multiple graduate students working on related grants and previous research connected to this project. Dr. Circella will lead the development of the present study, provide guidance on and lead the data cleaning, data integration and handling, model estimation and the interpretation of the results. He will write portions of – and edit all – the project reports and scientific papers, and maintain regular communications with interested agencies and provide presentations to report and disseminate the results of the research.

Patricia Mokhtarian is a professor in the School of Civil and Environmental Engineering at Georgia Tech, who has more than 35 years of experience in travel behavior research, transportation

planning, and discrete choice modeling. Her specialties include the measurement of attitudes and lifestyles and their incorporation into behavioral models, and the analysis of the impacts of ICT on travel behavior.

Yongsung Lee is an assistant professor at the University of Hong Kong, and his expertise includes transportation planning, travel behavior research, travel demand modeling, data collection and quantitative methods of data analysis. While not formally a partner of the TOMNET UTC, Dr. Lee will contribute to the research *pro bono* and will support the data analysis and development of scientific deliverables and publication in this project.

Giovanni Circella 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 a graduate student to accomplish the project tasks. He 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. Patricia L. Mokhtarian and Yongsung Lee will assist in various project tasks and provide significant input on the data analysis and paper writing.

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 proposes to conduct a webinar event to present results from the project to the community around July 2021. 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 graduate student as graduate research assistant. The doctoral and/or master's student will be involved in all aspects of the project including data preparation and data analysis. In addition, 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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12. Qualifications of Investigators (One-page CV per Investigator)

A two-page CV is provided for both the principal investigator, Dr. Giovanni Circella, and the co-principal investigator, Dr. Patricia L. Moktarian in the following pages.

GIOVANNI CIRCELLA, Ph.D.
Senior Research Engineer
School of Civil and Environmental Engineering, Georgia Institute of Technology, *and*
Director, 3 Revolutions Future Mobility Program and Assistant Professional Researcher
Institute of Transportation Studies, University of California, Davis
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Website: https://3rev.ucdavis.edu/giovanni-circella/ LinkedIn: giovannicircella

EDUCATION

Politecnico di Bari (Technical Univ. of Bari, Italy), Ph.D. in Transportation Planning (2008)

Specializations: land use transportation modeling, transportation planning, environmental economics, policies for sustainable transportation

Dissertation: *Integrated Land Use and Transportation Planning for Sustainable Transport Solutions*

University of California, Davis, M.S. in Agricultural and Resource Economics (2009)

Politecnico di Bari (Technical Univ. of Bari, Italy), Italian Laurea (B.A.+M.S.) Degree (summa cum laude) in Civil Engineering (2004)

SELECTED PROFESSIONAL SERVICE AND AWARDS

Director, 3 Revolutions Future Mobility Program, Institute of Transportation Studies, National Center for Sustainable Transportation, UC Davis (2017 – present).

Honda Distinguished Scholar on New Mobility Studies: Endowment from American Honda Co., UC Davis (2018 - present).

Assistant Professional Researcher, Institute of Transportation Studies, National Center for Sustainable Transportation, UC Davis, 2015 - present.

Senior Research Engineer, School of Civil and Environmental Engineering, Georgia Institute of Technology, 2016 – present (Research Engineer, 2013 - 2016).

Post-Doc Researcher, Institute of Transportation Studies, University of California, Davis, 2009 - 2015.

Research Faculty Senate, Georgia Institute of Technology*:* Representative of Research Faculty of the School of Civil and Environmental Engineering, 2014 - 2017.

Licensed Professional Engineer (P.E.): Italy, #7374 – Bari.

Chair, Standing Committee on Transportation and Information Communication Technologies (ADB20) Committee, Transportation Research Board (2018 - present).

Member, Standing the Committees on Transportation and Sustainability (ADD40) and Travel Behavior and Values (ADB10), Transportation Research Board.

Keynote Speaker: Trailways Annual Conference, Fort Myers, FL, February 2016.

Fulbright Fellowship: Research Scholar at UC Davis (2006 –2007).

Visiting Researcher Fellowship: University of Leeds (UK), 2016.

Research Scholarship: Technische Universität Wien (Austria), 2008.

Award for the Best Research Thesis, City of Bari, Italy, 2006.

Socrates-Erasmus Fellowship: Universidad Politécnica de Valencia, Spain, 2003.

PROFESSIONAL EXPERIENCE

Giovanni Circella is the Honda Distinguished Scholar for New Mobility Studies and the Director of the 3 Revolutions Future Mobility Program at the University of California, Davis, and a Senior Research Engineer in the School of Civil and Environmental Engineering of the Georgia Institute of Technology. Dr. Circella's interests

include travel behavior and emerging transportation services, sustainable transportation, travel demand modeling, travel survey methods, and policy analysis. His recent research has focused on the impacts of information and communication technology (ICT), new mobility (including shared mobility, micromobility and ridehailing) and vehicle automation on travel behavior and auto ownership, the evolving lifestyles and mobility patterns of specific population segments (e.g. "millennials") and in various regions of the U.S., Europe, South America and the Middle East. Dr. Circella is the Chair of the TRB Committee on ICT and Transportation (ADB20), and a member of the Transportation and Sustainability (ADD40) and the Travel Behavior and Values (ADB10) committees. He also serves in the NCHRP 20-102, 20-102(01), 20-102(09) and 20-102(19) and TCRP B-47 project panels on the impacts of connected and automated vehicles and other emerging transportation technologies. Dr. Circella regularly cooperates with metropolitan planning organizations (MPOs), other agencies and non-profit organizations in the U.S., Europe and South America.

SELECTED RECENT PUBLICATIONS

"Will Autonomous Vehicles Change Residential Location and Vehicle Ownership? Glimpses from Georgia", by S. H. Kim, P. L. Mokhtarian and G. Circella, *Transp. Research Part D* (*forthcoming*).

"How, and for Whom, Will Activity Patterns Be Modified by Self-driving Cars? Expectations from the State of Georgia", by S. H. Kim, P. L. Mokhtarian and G. Circella, *Transp. Research Part F* (*forthcoming*).

"What Drives the Gap? Applying the Blinder–Oaxaca Decomposition Method to Examine Generational Differences in Transportation-related Attitudes", by A. Etezady, A. Shaw, P. L. Mokhtarian and G. Circella, *Transportation* (*forthcoming*).

"Who Doesn't Mind Waiting? Examining the Relationships between Waiting Attitudes and Person- and Travel-Related Attributes", by A. Shaw, A. Malokin, P. L. Mokhtarian and G. Circella, *Transportation* (*forthcoming*).

"What Drives the Use of Ridehailing in California? Ordered Probit Models of the Usage Frequency of Uber and Lyft", by F. Alemi, G. Circella, P. L. Mokhtarian and S. L. Handy *Transp. Research Part C*, 102, 2019, 233-248.

"Heterogeneous Residential Preferences among Millennials and Members of Generation X in California: A Latent-class Approach", by Y. Lee, G. Circella, P. L. Mokhtarian and S. Guhathakurta, *Transp. Research Part D*, 76, 2019, 289-304.

"Are Millennials More Multimodal? A Latent Class Analysis with Attitudes and Preferences", by Y. Lee, G. Circella, P. L. Mokhtarian and S. Guhathakurta, *Transportation*, 2019, https://doi.org/10.1007/s11116-019-10026-6.

"It's Not All Fun and Games: An Investigation of the Reported Benefits and Disadvantages of Conducting Activities while Commuting", by A. Shaw, A. Malokin, G. Circella and P. L. Mokhtarian, *Travel Behaviour and Society*, 17, 2019, 8-25.

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"Identifying Latent Mode-use Propensity Segments in an All-AV Era", by S. H. Kim, G. Circella and P. L. Mokhtarian, *Transp. Research Part A*, 130, 2019, 192-207.

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"Panel Study of Emerging Transportation Technologies and Trends in California: Phase 2 Data Collection", by G. Circella, G. Matson, F. Alemi and S. L. Handy, Project Report, National Center for Sustainable Transportation. University of California, Davis, 2019.

"Exploring the Latent Constructs behind the Use of Ridehailing in California", by F. Alemi, G. Circella, S. L. Handy and P. L. Mokhtarian, *Journal of Choice Modelling*, 29, 2018, 47-62.

"Transport Policy in the Era of Shared Mobility and Other Disruptive Transportation Technologies", by G. Circella and F. Alemi, in *Advances in Transport Policy and Planning*, Vol. 1, eds. Y. Shiftan and M. Kamargianni, Ch. 5, 2018, 119-144, Elsevier.

"What Influences Travelers to Use Uber? Exploring the Factors Affecting the Adoption of On-Demand Ride Services", by F. Alemi, G. Circella, S. L. Handy and P. L. Mokhtarian, *Travel Behaviour and Society*, 13, 2018, 88-104.

"Exploring the Self-reported Long-distance Travel Frequency of Millennials and Generation X in California", by R. Berliner, L. Aultman-Hall and G. Circella, *Transp. Research Record*, 2672(47), 2018, 208-2018.

PATRICIA L. MOKHTARIAN, PhD
Susan G. and Christopher D. Pappas Professor
Georgia Institute of Technology, School of Civil and Environmental Engineering
CURRICULUM VITAE

EARNED DEGREES

- Northwestern University, Ph.D. in Industrial Engineering/Management Science (1981)
- Northwestern University, M.S. in Industrial Engineering/Management Science (1977)
- Florida State University, B.A. (summa cum laude) in Mathematics (1975)

EMPLOYMENT (selected)

1. **2013 – present - *Georgia Institute of Technology****: School of Civil & Environmental Engineering, Susan G. and Christopher D. Pappas Professor; Transportation Group Coordinator*
2. **1990 - 2013 - *University of California, Davis***
   a. *Department of Civil & Environmental Engineering, Assistant Professor (1990-96), Associate Professor (1996-1999), and Professor (1999-2013);*
   b. *Graduate Group in Transportation Technology and Policy, Chair and Graduate Adviser (1997-2013);*
   c. *Institute of Transportation Studies, Acting Director (1999-2000), Associate Director for Education (2001-2013)*
3. **1982 - 1988 - *Southern California Association of Governments:*** *Transportation Planner (1982-1985); Senior Planner (1985-1988)*

CURRENT/RECENT GRANTS AND CONTRACTS

1. Teaching Old Models NEW Tricks (TOMNET), Tier 1 University Transportation Center
U. S. Department of Transportation, subcontract to Arizona State University
$6.25 million total (Georgia Tech share about 1/3), 2017 – 2022
(Georgia Tech) Collaborators: Prof. Kari Watkins, Dr. Giovanni Circella (senior personnel)

2. The Impact of Emerging Technologies and Trends on Travel Demand in Georgia
Georgia Department of Transportation, $380,000, August 2016 - October 2019
Collaborator: Dr. Giovanni Circella (senior personnel)

PROFESSIONAL CONTRIBUTIONS

Editorial Board Memberships

1. Editorial Board, *Travel Behaviour and Society* (2013 – present).
2. Editorial Board, *Transportation* (2018 – present; Associate Editor 2008 – 2018).
3. Editorial Advisory Board, *Transportation Research A* (2004 – present).
4. Editorial Board, *Transport Policy* (2008 - present).
5. Editorial Board, *Transportation Letters: The International Journal of Transportation Research* (2008 – present).
6. Editorial Board, *International Journal of Sustainable Transportation* (2010 – present).
7. Editorial Advisory Board, *European Journal of Transport and Infrastructure Research* (2011 – present).

Society Offices, Activities, and Membership (selected)

1. **Transportation Research Board:**
   a. Founding chair, Effects of Information and Communication Technologies (ICT) on Travel Choices (ADB20, formerly A1C08) (1993-2000) and Subcommittee (A1C04(3)) (1988-1993); member (2000- 2006); emeritus member (2007-present)
   b. Emeritus member (2009-present), Travel Behavior and Values (ADB10)
2. **Chair of International Association for Travel Behaviour Research (2016-2017)**

HONORS (selected)

1. **Thomas B. Deen Distinguished Lecture**, 97th Annual Meeting of the **Transportation Research Board**, Washington, DC, January 8, 2018. "The lectureship recognizes the career contributions and achievements of an individual in one of the areas covered by the TRB's Technical Activities Division."
2. Opening **keynote speaker,** 17th **Swiss Transport Research Conference**, Monte Verita, Switzerland, May 17-19, 2017.
3. **Eminent Professor Lecture,** Department of Civil Engineering, **Monash University, Melbourne, Australia,** May 23, 2016.
4. **Keynote speaker**, **14th Conference of the International Association for Travel Behaviour Research**, Windsor, UK, July 23, 2015.
5. **Keynote speaker, 14th International Conference on Traffic and Transportation Engineering**, Tehran, Iran, February 24, 2015.
6. Eighth Annual **Martin Wachs Distinguished Lecture in Transportation**, University of California, Los Angeles, October 9, 2014.
7. **PROFILES,** ***TR News*** (the bimonthly magazine of the Transportation Research Board), September/October 2014. "The PROFILES honor and highlight the professional achievements and contributions of select TRB leaders."
8. **Keynote speaker, World Symposium on Transport and Land Use Research (WSTLUR)**, Delft, the Netherlands, June 24, 2014.
9. University-wide endowed lecture series: **Burack Lecture, University of Vermont**, Burlington, April 14, 2014.
10. Invited speaker, **Distinguished Transport Lecture Series. University of Hong Kong Institute of Transport Studies**, December 12, 2013.

PUBLISHED JOURNAL ARTICLES (selected)

1. "How Much Does the Method Matter? An Empirical Comparison of Ways to Quantify the Influence of Residential Self-Selection", by David van Herick and Patricia L. Mokhtarian. *Travel Behaviour and Society* **18**, 2020, 68-82.
2. "How Do Activities Conducted while Commuting Influence Mode Choice? Using Revealed Preference Models to Inform Public Transportation Advantage and Autonomous Vehicle Scenarios", by Aliaksandr Malokin, Giovanni Circella, and Patricia L. Mokhtarian. *Transportation Research A* **124**, 2019, 82-114.
3. "Subjective Well-Being and Travel: Retrospect and Prospect", by Patricia L. Mokhtarian. *Transportation* **46(2)**, 2019, 493-513.
4. "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", by Gouri Shankar Mishra, Patricia L. Mokhtarian, Regina R. Clewlow, and Keith F. Widaman. *Transportation* **46**, 2019, 95-123.
5. "What Drives the Use of Ridehailing in California? Ordered Probit Models of the Usage Frequency of Uber and Lyft", by Farzad Alemi, Giovanni Circella, Patricia Mokhtarian, and Susan Handy. *Transportation Research C* **102**, 2019, 233-248.
6. "The Times They are A-changin': What Do the Expanding Uses of Travel Time Portend for Policy, Planning, and Life?", by Patricia L. Mokhtarian. *Transportation Research Record* **2672(47)**, 2018, 1-11.
7. "Face to Facebook: The Relationship between Social Media and Social Travel", by Alexa Delbosc and Patricia L. Mokhtarian. *Transport Policy* **68**, 2018, 20-27.
8. "Taste Heterogeneity as an Alternative Form of Endogeneity Bias: Investigating the Attitude-Moderated Effects of Built Environment and Socio-demographics on Vehicle Ownership using Latent Class Modeling", by Sung Hoo Kim and Patricia L. Mokhtarian. *Transportation Research Part A* **116**, 2018, 130-150.

13. Budget Including Non-Federal Matching Funds

Institution: Georgia Institute of Technology
Project Title: Attitudes towards Emerging Mobility Options and Technologies – Phase 3: Data Collection
Principal Investigator: Dr. Giovanni Circella, Senior Research Engineer

Budget Period: 8/1/2020 to 7/31/2021

CATEGORY	Budgeted Amount from Federal Share	Budgeted Amount from Matching Funds	Explanatory Notes; Identify Source of Matching Funds
Faculty Salaries	18,000	40,000	Dr. Mokhtarian salary as match = $40,000
Other Staff Salaries			
Student Salaries (includes data entry costs)	12,600		
Fringe Benefits	22,016	11,520	Faculty: 28.8% of salaries Grad RA: 14.73% of salaries
Total Salaries & Benefits	104,616	51,520	
Student Tuition Remission	8,934		a semester tuition
Operating Services and Supplies (data storage)		500	Dr. Mokhtarian Startup Funds
Domestic Travel		1,000	Dr. Mokhtarian Startup Funds
Other Direct Costs (specify):			
Total Direct Costs	113,550	53,020	
F&A (Indirect) Costs: 57.8% of MTDC (excludes tuition)	60,468	30,646	
TOTAL COSTS	174,018	83,666	Total Project Cost: $257,684

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 3: Data Analysis
University	Georgia Institute of Technology
Principal Investigator	Giovanni Circella
PI Contact Information	Address: 790 Atlantic Dr, Atlanta GA 30302 Email: Giovanni.Circella@ce.gatech.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	US Department of Transportation (Federal UTC): $166,519 Georgia Institute of Technology (Cost Share): $83,666
Total Project Cost	$257,684
Agency ID or Contract Number	
Start and End Dates	8/1/2019 - 07/31/2020
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 penetrtion 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 and analyze survey data from a sample of 1000 residents in the Atlanta region, GA 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 finalize survey administration and data collection, focus heavily on data analysis and complex model estimation, and produce research reports and technical documentation. Thus, the focus of this phase-3 effort is to prepare a cleaned 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. (270 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 data 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 and merged dataset is then analyzed to shed light on questions regarding users' responses to new transport choices.
Impacts/Benefits of Implementation (actual, not anticipated)	Eventually, the collected valuable dataset and complex behavior modeling 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 • Reports • Project Website	https://www.tomnet-utc.org/gt-av-survey-project.html