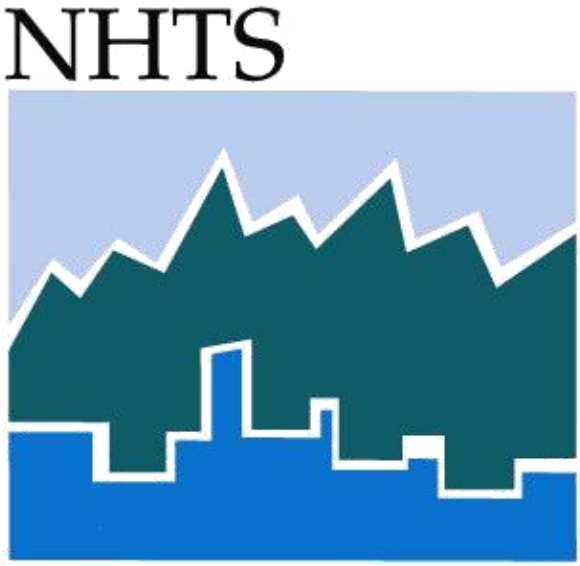

National Household Travel Survey

Compendium of Uses

January 2022–December 2022

Foreword

This compendium contains various uses and applications of the National Household Travel Survey (NHTS) data referenced in transportation planning and research from January 2022 through December 2022. The articles and reports in this compendium cover a diverse range of topics in the areas of transportation, health, safety, environment, and engineering and were published in various journals including, but not limited to, the *Transportation Research Record*, the *Journal of Transport Geography*, and the *Journal of Transport & Health*. Several papers were also submitted by researchers and graduate students for presentation and publication to the Transportation Research Board's (TRB's) 101st Annual Meeting and can be found in the *2022 TRB Annual Meeting Compendium of Papers*. Source material was also identified through Google Scholar™ and Google Alerts™ using "National Household Travel Survey" and "NHTS" keyword and search engine terms.

These selected articles and reports were grouped into 12 categories using the subject areas and index terms identified in each abstract as well as category titles used in previous NHTS compendium databases. The following categories, broken out by report chapter, were used in this version of the compendium:

1. Bicycle and pedestrian studies.
2. Energy consumption.
3. Environment.
4. Health.
5. Policy and mobility.
6. Special population groups.
7. Survey, data synthesis, and other applications.
8. Traffic safety.
9. Transit planning.
10. Travel behavior.
11. Trend analysis and market segmentation.
12. Emerging travel modes.
13. Passive OD data product usage.

This compendium includes a short description of each article and report along with the title, author(s), abstract, subject areas, and availability.

Please note that the 2022 compendium consists of 420 research articles and reports. It is updated on an ongoing basis with newly published papers that cite NHTS data. For information about adding a research paper to the NHTS compendium, please contact Daniel Jenkins at Daniel.Jenkins@dot.gov.

Search and documentation support was provided by Layla Sun (MacroSys), who also categorized the paper abstracts.

Table of Contents

Chapter 1. Bicycle and Pedestrian Studies

1.1 Title: Who Travels Where: Behavior of Pedestrians and Micromobility Users on Transportation Infrastructure

Author(s): Lanza, K., Burford, K., and Ganzar, L.A.

Abstract: Cities are investing in active transportation networks, yet little is known about travel behavior of different nonvehicle modes in the presence of multiple types of transportation infrastructure. At two sites in Austin, Texas, USA, with a cycle track, sidewalk, and street in parallel, we determined where different modes traveled and the likelihood of crossing from one infrastructure to another and of using "recommended" infrastructure—defined as sidewalk for walkers, dog walkers, and runners and bike lane with traffic for cyclists, e-scooter riders, and other wheeled micromobility users. We created the Mobility Behavior Tool to conduct observations of travelers on 50-m-long, straight segments of the parallel infrastructure at sites for 1-hour sampling periods (n = 16 periods) in April–May 2021. In our sample (n = 2245 individuals), we observed that 20 percent of travelers crossed into other infrastructure and 35.8 percent used not recommended infrastructure. Using binomial logistic regression, we found statistically significant odds ratios for dog walkers (3.17), cyclists (0.56), e-scooter riders (1.85), and other micromobility users (3.06) crossing into other infrastructure compared to walkers ($p < 0.001$), and no significant differences between runners (0.50) and walkers ($p > 0.05$). A second model predicted statistically significant odds ratios for dog walkers (1.74), runners (3.88), e-scooter riders (1.38), and other micromobility users (2.74) using not recommended infrastructure compared to walkers ($p < 0.001$), and no significant differences between cyclists (0.86) and walkers ($p > 0.05$). Potential reasons for differences in travel behavior by mode include levels of understanding of local regulations and situational awareness, infrastructure preferences, frequency of passing, and propensity for weaving, swerving, and subversive behavior. Municipalities should consider how infrastructure design influences travel behavior and the travel efficiency, comfort, and safety of all modes.

Subject Areas: Active travel; Mobility; Pedestrian; Cyclist; E-scooter; Safe design

Availability: Lanza, K., Burford, K., and Ganzar, L.A. (2022). "Who Travels Where: Behavior of Pedestrians and Micromobility Users on Transportation Infrastructure." *Journal of Transport Geography*, *98*. https://doi.org/10.1016/j.jtrangeo.2021.103269

1.2 Title: Transit Access and Egress Travel as Hidden Sources of Walking and Biking: An Analysis of the Georgia Subsample of the 2017 National Household Travel Survey

Author(s): Kash, G. and Mokhtarian, P.

Abstract: In this paper, we use travel diary data from the 2017 National Household Travel Survey (NHTS) Georgia subsample to identify, examine, and propose resolution to some critical definitional and measurement issues associated with measuring access/egress travel, intermodal travel, and nonmotorized travel (NMT) in general. We begin by reviewing the challenges of accurately measuring walking and biking. We next provide an overview of how access/egress and intermodal travel are measured in the 2017 NHTS. We then describe our methods for extracting and analyzing instances of walking and biking that are stored in the data as access/egress travel and formatted differently than independent trips. We present estimates of nonmotorized travel based on (A) separate trips alone and (B) a combination of separate trips and access/egress legs. We find that including access/egress travel increases the number of instances of walking and biking by 27.7 percent compared to using separate trips alone and increases the estimated amount of time people spend walking and biking by 12.9 percent compared to trips alone. We examine access/egress travel within the context of the larger transit trip and describe measurement difficulties in analyzing this relationship. We discuss the importance of documenting access/egress travel for obtaining a robust estimate of nonmotorized travel, while recognizing the tradeoffs of subdividing transit trips into smaller pieces.

Subject Areas: Access/egress travel; Intermodal travel; Nonmotorized travel

Availability: Kash, G. and Mokhtarian, P. (2022). *Transit Access and Egress Travel as Hidden Sources of Walking and Biking: An Analysis of the Georgia Subsample of the 2017 National Household Travel Survey.* Transportation Research Board 101st Annual Meeting, Washington, DC. https://annualmeeting.mytrb.org/OnlineProgram/Details/17346

1.3 Title: Regional Trail Network Creates New Recreation and Active Transportation Access for Millions of Bay Area Residents, With Potential Statewide Economic Impact of $6.6 Billion Annually

Author(s): Rails-to-Trails Conservancy.

Abstract: Blog.

Subject Areas: Regional trail network; Recreation and transportation access; Bay Area; Statewide economic impact

Availability: Rails-to-Trails Conservancy. (2022). "Regional Trail Network Creates New Recreation and Active Transportation Access for Millions of Bay Area Residents, With Potential Statewide Economic Impact of $6.6 Billion Annually." *PR Newswire*. https://www.prnewswire.com/news-releases/regional-trail-network-creates-new-recreation-and-active-transportation-access-for-millions-of-bay-area-residents-with-potential-statewide-economic-impact-of-6-6-billion-annually-301459137.html

1.4 Title: Are Our Suburbs Walkable for The Elderly? - Focus On Walking for Transport

Author(s): Pemberton, D.

Abstract: Research has found that walkability supports physical and social health by increasing physical activity and social interaction, thus reducing obesity, high blood pressure, type two diabetes, and social isolation among other things. Additionally, connective pedestrian network, rich proximate services and sufficient density support walkability including the vital social interaction. Safe and accessible pedestrian environment with open, interactive building frontages, greenery balancing the density and interesting public open spaces complement the structural neighborhood level walkability features, supported by frequent public transport. On the other hand, suburban sprawl has been shown to decrease walkability by increasing walking distances, decreasing local diversity and destination availability, and lowering public transport availability. And lack of walkability decreases the independent mobility and social interaction of suburban elderly over 65 years old, who generally share the same features affecting walkability and the benefits of it as any of us but in the course of decreasing mobility require shorter distances and thus require closer proximity of essential amenities than the younger ones. Walking for transport is in focus here, as it is an especially relevant form of walking for those not having active mobility habits or preferences of active transport, thus helping them to stay closer to the health sustaining minimum level of physical activity to avoid increasing dependency and premature hospitalization.

Subject Areas: Walkability; Suburban elderly; Independent mobility; Social interaction

Availability: Pemberton, D. (2022). *Are Our Suburbs Walkable for The Elderly? - Focus On Walking for Transport*. Master's Thesis, University of Eastern Finland, Kuopio, Finland. https://erepo.uef.fi/handle/123456789/26731

1.5 Title: Study: More Bike Lanes Needed to Reduce Traffic Congestion

Author(s): Descant, S.

Abstract: Blog.

Subject Areas: Micromobility; Transportation; Urban planning; Climate change; Structure

Availability: Descant, S. (2022). "Study: More Bike Lanes Needed to Reduce Traffic Congestion." *Government Technology*. https://www.govtech.com/fs/study-more-bike-lanes-needed-to-reduce-traffic-congestion

1.6 Title: What Travel Modes Do Shared E-Scooters Displace? A Review of Recent Research Findings

Author(s): Wang, K., Qian, X., Fitch, D.T., Lee, Y., Malik, J., and Circella, G.

Abstract: The impacts of shared e-scooters on modal shifts have received increased attention in recent years. This study provides a review of the literature for modal shifts in the U.S. and other countries. The profile of shared e-scooter users is rather similar to that of station-based and free-floating bikeshare programs. The empirical data reveal that people use shared e-scooters in place of cars at substantial rates, especially in many U.S. cities, which suggests that in many locations shared e-scooters may be a good strategy for reducing car dependence. The use of shared e-scooters as a complement to public transit varies highly by city, highlighting how technology, regulations, and incentives may be needed in some cities to ensure modal integration and harvest the potential societal benefits from the introduction of shared e-scooters.

Subject Areas: E-scooters; Micromobility; Mode substitution; Car use; Transportation planning

Availability: Wang, K., Qian, X., Fitch, D.T., Lee, Y., Malik, J., and Circella, G. (2022). "What Travel Modes Do Shared E-Scooters Displace? A Review of Recent Research Findings." *Transport Reviews*, *43*(1), pp. 5–31. https://doi.org/10.1080/01441647.2021.2015639

1.7 Title: The Mode Is Not the Methods: Assessing Changes in Biking, Walking and Transit in California Using the 2012 CHTS and 2017 NHTS

Author(s): Pike, S. and Handy, S.

Abstract: Data from the 2012 California Household Travel Survey (CHTS) and the 2017 National Household Travel Survey (NHTS) suggest that biking, walking, and transit use in California decreased over this five-year period. In light of the California Department of Transportation (Caltrans) and State Transportation Agency (CalSTA)'s goal of tripling walking and doubling biking and transit use in their most recent strategic plan, these unanticipated results raised concerns about whether these decreases stem from methodological differences and choices about analysis between the two surveys. In this study, we evaluate numerous differences between the two surveys to assess whether the changes are likely to be real, or the result of methodological differences between the CHTS and the NHTS. We find that overall, the use of biking, walking and transit decreased over this time period, and these results are generally consistent across methodological differences and analysis choices.

Subject Areas: Active travel; Survey methods; Weighting; Travel trends

Availability: Pike, S. and Handy, S. (2022). "The Mode Is Not the Methods: Assessing Changes in Biking, Walking and Transit in California Using the 2012 CHTS and 2017 NHTS." *Transport Findings*. https://doi.org/10.32866/001c.37777

1.8 Title: Over 100 Michigan Schools Participate in National Walk and Roll to School Day

Author(s): Jones, K.

Abstract: Blog.

Subject Areas: Active travel; Safe routes; National Walk and Roll to School Day

Availability: Jones, K. (2022). "Over 100 Michigan Schools Participate in National Walk and Roll to School Day." *WILX*. https://www.wilx.com/2022/10/12/over-100-michigan-schools-participate-national-walk-roll-school-day/

1.9 Title: Walker School Gets Moving on Walk to School Day

Author(s): Randhava, H.

Abstract: Blog.

Subject Areas: Active travel; Walk to School Day; Active commuting

Availability: Randhava, H. (2022). "Walker School Gets Moving on Walk to School Day." *Evanston RoundTable Media NFP*. https://evanstonroundtable.com/2022/10/15/evanston-walk-to-school-day-walker-elementary/

1.10 Title: Exploration of the Contributing Factors to the Walking and Biking Travel Frequency Using Multi-Level Joint Models with Endogeneity

Author(s): Singh, M., Cheng, W., Gopalakrishnan, R., Li, Y., and Cao, M.

Abstract: The enormous advantages of active transportation lead the transportation research focus towards enhancing the walking and biking trips. The present study explored the influential factors to the walking and biking travel frequency based on data obtained from the National Household Travel Survey California add-on survey. The study features some highlights. First, bivariate models were used to account for the common unobserved heterogeneity shared at both household and personal levels. Second, endogeneity was explicitly considered. Third, both variable importance ranking and correlation analysis are employed to determine the different features to be fed into each of the joint models. The results illustrated that the models developed with endogeneity performed better than the models without endogeneity. Four influential variables which include mode to work by bicycle, public transit usage, count of household members, and multiple race responses, tend to have statistically significant impacts on walking and biking trips.

Subject Areas: Active transportation; Household and personal levels; Bivariate models; Endogeneity

Availability: Singh, M., Cheng, W., Gopalakrishnan, R., Li, Y., and Cao, M. (2022). "Exploration of the Contributing Factors to the Walking and Biking Travel Frequency Using Multi-Level Joint Models with Endogeneity." *Journal of Traffic and Transportation Engineering (English Edition)*, *9*(6), pp. 1044–1054. https://doi.org/10.1016/j.jtte.2021.10.004

Chapter 2. Energy Consumption

2.1. Title: A Frequency and Voltage Coordinated Control Strategy of Island Microgrid including Electric Vehicles

Author(s): Fan, P., Ke, S., Kamel, S., Yang, J., Li, Y., Xiao, J., Xu, B., and Rashed, G.I.

Abstract: Frequency and voltage deviation are important standards for measuring energy indicators. It is important for microgrids to maintain the stability of voltage and frequency (VF). Aiming at the VF regulation of microgrid caused by wind disturbance and load fluctuation, a comprehensive VF control strategy for an islanded microgrid with electric vehicles (EVs) based on Deep Deterministic Policy Gradient (DDPG) is proposed in this paper. First of all, the SOC constraints of EVs are added to construct a cluster-EV charging model, by considering the randomness of users' travel demand and charging behavior. In addition, a four-quadrant two-way charger capacity model is introduced to build a microgrid VF control model including load, micro gas turbine (MT), EVs, and their random power increment constraints. Secondly, according to the two control goals of microgrid frequency and voltage, the structure of DDPG controller is designed. Then, the definition of space, the design of global and local reward functions, and the selection of optimal hyperparameters are completed. Finally, different scenarios are set up in an islanded microgrid with EVs, and the simulation results are compared with traditional PI control and R(λ) control. The simulation results show that the proposed DDPG controller can quickly and efficiently suppress the VF fluctuations caused by wind disturbance and load fluctuations at the same time.

Subject Areas: Islanded microgrid; Electric vehicles; Charger capacity model; Voltage and frequency control; Deep Deterministic Policy Gradient

Availability: Fan, P., Ke, S., Kamel, S., Yang, J., Li, Y., Xiao, J., Xu, B., and Rashed, G.I. (2022). "A Frequency and Voltage Coordinated Control Strategy of Island Microgrid including Electric Vehicles." *Electronics*, *11*(1). https://doi.org/10.3390/electronics11010017

2.2. Title: Optimal Planning of Intra-City Public Charging Stations

Author(s): Lin, H., Bian, C., Wang, Y., Li, H., Sun, Q., and Wallin, F.

Abstract: Intra-city Public Charging Stations (PCSs) play a crucial role in promoting the mass deployment of Electric Vehicles (EVs). To motivate the investment on PCSs, this work proposes a novel framework to find the optimal location and size of PCSs, which can maximize the benefit of the investment. The impacts of charging behaviors and urban land uses on the income of PCSs are taken into account. An agent-based trip chain model is used to represent the travel and charging patterns of EV owners. A cell-based geographic partition method based on Geographic Information System is employed to reflect the influence of land use on the dynamic and stochastic nature of EV charging behaviors. Based on the distributed charging demand, the optimal location and size of PCSs are determined by mixed-integer linear programming. Västerås, a Swedish city, is used as a case study to demonstrate the model's effectiveness. It is found that the charging demand served by a PCS is critical to its profitability, which is greatly affected by the charging behavior of drivers, the location and the service range of PCS. Moreover, charging price is another significant factor impacting profitability, and consequently the competitiveness of slow and fast PCSs.

Subject Areas: Electric vehicle; Public charging stations; Geographic information system; Agent-based model; Optimal planning

Availability: Lin, H., Bian, C., Wang, Y., Li, H., Sun, Q., and Wallin, F. (2022). "Optimal Planning of Intra-City Public Charging Stations." *Energy*, *238* (Part C). https://doi.org/10.1016/j.energy.2021.121948

2.3. Title: Data-Driven Adjustable Robust Day-Ahead Economic Dispatch Strategy Considering Uncertainties of Wind Power Generation and Electric Vehicles

Author(s): Wu, J., Liu, Y., Chen, X., Wang, C., and Li, W.

Abstract: Considering the intermittent features of wind power generation and electric vehicles, it is important for microgrid to formulate available dispatch strategy while ensuring the system economy. A two-stage data-driven adjustable robust optimization (ARO) model is presented in this paper to realize an optimal day-ahead economic dispatch strategy for the microgrid considering the uncertainties of wind power generation and electric vehicles. In the optimization model, an imprecise-Dirichlet-model-based nonparametric ambiguity set is constructed without any presumption about the probability distributions of the uncertainties. Further, a polyhedron uncertainty set obtained from the ambiguity set is driven by historical data, and this becomes narrower with an increase in the amount of the historical data used to construct the ambiguity set. The data-driven ARO problem is converted into a traditional two-stage ARO model with the obtained polyhedron uncertainty set. Further, this can be decomposed into a mixed integer linear programming (MILP) master problem and a sub problem with a max–min structure. Then, duality theory, Big-M method, and column and constraint generation (C&CG) algorithm are applied to achieve the optimized day-ahead economic dispatch strategy for the microgrid. Case studies illustrate the solution robustness, economic benefit, flexible adjustment capability and uncertainty depiction ability of the presented method.

Subject Areas: Microgrid; Uncertainty; Day-ahead economic dispatch; Data-driven; Adjustable robust optimization

Availability: Wu, J., Liu, Y., Chen, X., Wang, C., and Li, W. (2022). “Data-Driven Adjustable Robust Day-Ahead Economic Dispatch Strategy Considering Uncertainties of Wind Power Generation and Electric Vehicles.” *International Journal of Electrical Power & Energy Systems*, *138*. https://doi.org/10.1016/j.ijepes.2021.107898

2.4. Title: Research on Charging-Discharging Operation Strategy for Electric Vehicles Based on Different Trip Patterns for Various City Types in China

Author(s): Qi, S., Lin, Z., Song, J., Lin, X., Liu, Y., Ni, M., and Wang, B.

Abstract: Connecting large numbers of electric vehicles to the power grid creates challenges for the operation of the power distribution network, but also provides a new method for supporting grid operation. This paper considers the trip patterns of electric vehicle users in China, including their trip starting time, traffic congestion, vehicle energy consumption, and other factors. We develop a charging–discharging operation strategy for electric vehicles in different functional areas with the goal of minimizing the cost of distribution network, which considers the distribution patterns of electric vehicles in different functional areas. As different types of cities in China have different proportions of electric vehicle users who follow different travel chains, we provide multiple examples showing the effectiveness of our proposed V2G method in different cities.

Subject Areas: Electric vehicles; Distribution network; Travel chains; Time and space distribution model

Availability: Qi, S., Lin, Z., Song, J., Lin, X., Liu, Y., Ni, M., and Wang, B. (2022). "Research on Charging-Discharging Operation Strategy for Electric Vehicles Based on Different Trip Patterns for Various City Types in China." *World Electric Vehicle Journal*, *13*(1). https://doi.org/10.3390/wevj13010007

2.5. Title: Online Battery-Protective Vehicle to Grid Behavior Management

Author(s): Li, S., Zhao, P., Gu, C., Huo, D., Zeng, X., Pei, X., Cheng, S., and Li, J.

Abstract: With the popularization of electric vehicles, vehicle-to-grid (V2G) has become an indispensable technology to improve grid economy and reliability. However, battery aging should be mitigated while providing V2G services so as to protect customer benefits and mobilize their positivity. Conventional battery anti-aging V2G scheduling methods mainly offline operates and can hardly be deployed online in hardware equipment. This paper proposes a novel online battery anti-aging V2G scheduling method based on a novel two-stage parameter calibration framework. In the first stage, the V2G scheduling is modeled as an optimization problem, where the objective is to reduce grid peak–valley difference and mitigate battery aging. The online deployment of the developed optimization-based V2G scheduling is realized by a rule-based V2G coordinator in the second stage, and a novel parameter calibration method is developed to adjust controller hyper-parameters. With the parameter calibration process, the global optimality and real-time performance of V2G strategies can be simultaneously realized. The effectiveness of the proposed methodologies is verified on a practical UK distribution network. Simulation results indicate that it can effectively mitigate battery aging in providing V2G services while guaranteeing algorithm real-time performance.

Subject Areas: Battery degradation; Battery protective strategy; Electric vehicle; Energy management; Energy storage system; Transportation electrification; Vehicle to grid

Availability: Li, S., Zhao, P., Gu, C., Huo, D., Zeng, X., Pei, X., Cheng, S., and Li, J. (2022). "Online Battery-Protective Vehicle to Grid Behavior Management." *Energy*, *243*. https://doi.org/10.1016/j.energy.2021.123083

2.6. Title: U.S. Has a Blueprint to Electrify Its Country Roads

Author(s): Denning, L.

Abstract: Blog.

Subject Areas: Rural America; Rural electrification; Travel behavior; Electric vehicle ownership; Charging stations

Availability: Denning, L. (2022). "U.S. Has a Blueprint to Electrify Its Country Roads." *Bloomberg Opinion*. https://www.bloomberg.com/opinion/articles/2022-01-22/u-s-has-a-blueprint-to-electrify-its-country-roads-for-evs

2.7. Title: Are Connecticut Consumers Ready for Electric Vehicles?

Author(s): Gallaher, A.

Abstract: Blog.

Subject Areas: Electric vehicles; Barrier to adoption; Range anxiety

Availability: Gallaher, A. (2022). "Are Connecticut Consumers Ready for Electric Vehicles?" *Hartford Courant*. https://www.courant.com/opinion/op-ed/hc-op-electric-vehicle-industry-01152022-20220118-ci42u6hklnephnmux6tuvvbmqa-story.html

2.8. Title: Econometric Frameworks for Energy Prediction

Author(s): Iraganaboina, N.C.

Abstract: Global warming and associated role of energy consumption across various sectors is a well-researched topic in recent years. Understanding current urban energy consumption patterns will allow us to understand how future energy consumption patterns will evolve. With electrification of vehicles and potentially altering culture of work from home, the energy usage at regional level would see a significant change in the future. The current PhD dissertation contributes to energy consumption analysis of a region by analyzing residential energy consumption, commercial energy consumption and transportation energy use by households. The aggregation of these energy consumption within a region contributes to the total energy consumption of a region. As the share of electric vehicles increases, the proposed modeling frameworks provides the current consumption that serves as a baseline estimate. Specifically, for the energy consumption, we examine the choice of energy sources and the energy consumption by source. The share of electrical vehicles is currently increasing. As the share of electric vehicles increases within our transportation infrastructure, the spatiotemporal nature of current electricity demand is likely to alter with increased household electricity consumption for vehicle charging. To develop a future estimate of urban demand with electric vehicles, a model system of current consumption serves as a baseline estimate. The analysis of energy use in residential buildings and commercial buildings is conducted using Residential Energy Consumption Survey (RECS) and Commercial Building Energy Consumption (CBECS) datasets. The transportation energy use is analyzed using National Household Travel Survey (NHTS) and MPG of the vehicles taken from Vehicle Fuel Economy Estimates. Multiple Discrete Continuous Extreme Value (MDCEV) model and Joint Binary Logit - Fractional Split Model (Joint BLFSM) are used to analyze residential energy consumption, while bi-level MDCEV is used for commercial energy use and spatial weighted regression models are used to analyze transportation energy use.

Subject Areas: Urban energy consumption; Electricity demand; Transportation energy consumption; Commercial energy consumption; Residential energy consumption

Availability: Iraganaboina, N.C. (2022). *Econometric Frameworks for Energy Prediction*. Doctoral Dissertation, University of Central Florida, Orlando, FL.
https://stars.library.ucf.edu/etd2020/955

2.9. Title: Modeling and Optimization of Smart Building Energy Management System Considering Both Electrical and Thermal Load

Author(s): Khan, M.H., Asar, A.U., Ullah, N., Albogamy, F.R., and Rafique, M.K.

Abstract: Energy consumption in buildings is expected to increase by 40 percent over the next 20 years. Electricity remains the largest source of energy used by buildings, and the demand for it is growing. Building energy improvement strategies is needed to mitigate the impact of growing energy demand. Introducing a smart energy management system in buildings is an ambitious yet increasingly achievable goal that is gaining momentum across geographic regions and corporate markets in the world due to its potential in saving energy costs consumed by the buildings. This paper presents a Smart Building Energy Management system (SBEMS), which is connected to a bidirectional power network. The smart building has both thermal and electrical power loops. Renewable energy from wind and photo-voltaic, battery storage system, auxiliary boiler, a fuel cell-based combined heat and power system, heat sharing from neighboring buildings, and heat storage tank are among the main components of the smart building. A constraint optimization model has been developed for the proposed SBEMS and the state-of-the-art real coded genetic algorithm is used to solve the optimization problem. The main characteristics of the proposed SBEMS are emphasized through eight simulation cases, taking into account the various configurations of the smart building components. In addition, EV charging is also scheduled and the outcomes are compared to the unscheduled mode of charging which shows that scheduling of Electric Vehicle charging further enhances the cost-effectiveness of smart building operation.

Subject Areas: Battery storage system; Combined heat and power system; Electric vehicle; Real coded genetic algorithm; Renewable energy system; Smart building energy management system

Availability: Khan, M.H., Asar, A.U., Ullah, N., Albogamy, F.R., and Rafique, M.K. (2022). "Modeling and Optimization of Smart Building Energy Management System Considering Both Electrical and Thermal Load." *Energies*, *15*(2). https://doi.org/10.3390/en15020574

2.10. Title: Reliability-as-a-Service Usage of Electric Vehicles: Suitability Analysis for Different Types of Buildings

Author(s): Hussain, A. and Musilek, P.

Abstract: The use of electric vehicles (EVs) to provide different grid services is becoming possible due to the increased penetration levels, mileage efficiencies, and useable battery sizes of EVs. One such application is providing reliability-as-a-service (RaaS) during short-term power outages. Instead of using a dedicated backup power source, EVs can be contracted to provide RaaS, which is an environmentally friendly solution with benefits for both building owners and EV owners. However, the presence of EVs at a particular location during different hours of the day and the availability of energy from EVs is uncertain. Therefore, in this study, a suitability analysis is performed concerning the use of EVs to provide RaaS for different types of buildings. First, the National Household Travel Survey (NHTS) survey data are used to estimate driver behavior, such as arrival/departure times, daily mileage, and traveling duration. Then, the usable battery size and mileage efficiency of EVs is extracted from the database of commercially available EVs. Based on these parameters, the daily energy consumption and available energy of EVs to provide RaaS are estimated. A suitability analysis is conducted for residential, commercial/industrial, and mixed buildings for both weekdays and holidays. The participation ratio of EV owners is varied between 10 and 90 percent, and nine cases are simulated for commercial/industrial buildings and multiunit residential buildings. Similarly, the ratio of home-based EVs is varied between 5 and 50 percent, and 10 cases are tested for mixed buildings. The analysis shows that mixed buildings are the most suitable, while commercial/industrial buildings are the least suitable for using EVs to provide RaaS. To this end, an index is proposed to analyze and determine the desired ratio of EVs to be contracted from homes and workplaces for mixed buildings. Finally, the impact of EV fleet size on the available energy for RaaS is also analyzed.

Subject Areas: Backup power; Electric vehicle; Home and workplace; Power outage; Reliability-as-a-service; Suitability analysis; Vehicle-to-grid

Availability: Hussain, A. and Musilek, P. (2022). “Reliability-as-a-Service Usage of Electric Vehicles: Suitability Analysis for Different Types of Buildings.” *Energies*, *15*(2). https://doi.org/10.3390/en15020665

2.11. Title: Economical Planning of Fuel Cell Vehicle-To-Grid Integrated Green Buildings with A New Hybrid Optimization Algorithm

Author(s): Li, H., Sun, B., Hao, J., Zhao, J., Li, J., and Khakichi, A.

Abstract: Popularity of fuel cell electric vehicles (FCVs) is an important criterion for solving the global problem of reducing CO_2 emissions. However, the overall cost of FCVs and hydrogen fuel production is relatively high, so FCV promotion is slow. Considering that FCVs have near-zero CO_2 emissions and high endurance, which is suitable for vehicle-to-grid (V2G) systems, this study aims to analyze the economic potential of the fuel cell vehicle-to-grid (FCV2G) systems to promote FCVs to the highest level. For this purpose, a large-scale green building was first selected as the research target and an agent to provide V2G services for the power grid. Then, the Monte Carlo method was used to simulate the vehicle visiting time. A discharge model was also developed. Considering CO_2 emission price and self-elasticity coefficient of discharge price, an overall economic optimization model was presented. Then, the hybrid algorithm of competitive swarm optimization (CSO) and imperialist competitive algorithm (ICA) was applied to optimize the model, which not only led to definite results and reduced standard deviation, but also eliminated the weakness of the CSO, i.e., convergence speed and poor performance in some benchmark functions. The simulation results indicated the proposed algorithm had faster convergence and more accuracy in finding the optimal solution than other optimization algorithms. Moreover, the overall economic profit improved in the presence of FCVs. Finally, sensitivity analysis was performed on six parameters, including daily electricity price, battery cost, fuel cell cost, CO_2 emission price, power grid carbon emission, and hydrogen cost. The results showed FCV2G system had high development potential as well as great economic profit increasing over time.

Subject Areas: Economic potential analysis; Fuel cell; Hybrid optimization algorithm; Electric vehicles (EVs)

Availability: Li, H., Sun, B., Hao, J., Zhao, J., Li, J., and Khakichi, A. (2022). "Economical Planning of Fuel Cell Vehicle-To-Grid Integrated Green Buildings with A New Hybrid Optimization Algorithm." *International Journal of Hydrogen Energy*, *47*(13), pp. 8514–8531. https://doi.org/10.1016/j.ijhydene.2021.12.156

2.12. Title: DSO+T: Integrated System Simulation

Author(s): Reeve, H.M. et al.

Abstract: This report summarizes an integrated co-simulation model used by the Distribution System Operator with Transactive (DSO+T) study to represent an electrical generation, delivery, and end-load systems for the purposes of assessing the viability and value proposition of transactive energy coordination of flexible assets versus a business-as-usual case. The integrated co-simulation model includes the bulk generation and transmission system, including the day-ahead and real-time scheduling and dispatch of thermal generators. Forty distribution system operators were modeled in detail, including tens of thousands of residential and commercial buildings and their flexible end loads. These included heating, ventilation, and cooling systems; residential water heaters; electric vehicles; and stationary behind-the-meter batteries. Both wholesale market and end-load results for the business-as-usual case are presented and compared to actual ERCOT system data to assess the accuracy and representativeness of the resulting model.

Subject Areas: Distribution System Operator with Transactive (DSO+T); Co-simulation model; Transactive energy coordination; Bulk generation; Transmission system; Scheduling; Thermal generators

Availability: Reeve, H.M. et al. (2022). *DSO+T: Integrated System Simulation*. Pacific Northwest National Laboratory, Richland, WA. https://www.osti.gov/servlets/purl/1842488

2.13. Title: 12 – Optimal Operation Strategy of Virtual Power Plant Considering EVs and ESSs

Author(s): Kabirifar, M., Pourghaderi, N., and Moeini-Aghtaie, M.

Abstract: The growing utilization rate of electric vehicles (EVs) because of their advantages, like environmental pollutant reduction, may bring challenges to power systems for the reason of considerable charging load and random nature of their net load consumption. However, aggregation and coordination of EVs (especially EVs with vehicle-to-grid (V2G) capability) offer new opportunities to grid operators by providing the possibility of charging/discharging cycle control of their batteries. On the other hand, energy storage systems (ESSs) are one of the most applicable distributed energy resources (DERs) with growing penetration level in the last decades. The optimal coordination and schedule of ESSs, along with other DERs, can accommodate the uncertain and intermittent renewable energy sources (RESs) in the network, as well as improve service reliability and power quality. Virtual power plant (VPP) aggregates the capacity of DERs around the network and effectively manages them to obtain single operating profile in order to improve its operation and increase profit by participating in electricity markets. Thus, VPP is able to aggregate and coordinate EVs and ESSs around the network and effectively schedule them in order to fulfill its objectives. In this regard, VPP not only addresses the upcoming challenges of DERs but also optimally utilizes them to improve network operation and increase its profit through participating in electricity markets. By considering these explanations, in this chapter detailed models of EVs and ESSs are presented and then the optimal operation strategy of VPP by considering EVs and ESSs is investigated.

Subject Areas: Electric vehicles; Electricity market; Energy storage systems; Operation strategy; Virtual power plant

Availability: Kabirifar, M., Pourghaderi, N., and Moeini-Aghtaie, M. (2022). "12 – Optimal Operation Strategy of Virtual Power Plant Considering EVs and ESSs." *Scheduling and Operation of Virtual Power Plants*, pp. 257–297. https://doi.org/10.1016/B978-0-32-385267-8.00017-2

2.14. Title: Optimal Sizing of City Photovoltaic-Storage-Charging System Based on Coalitional Game Theory

Author(s): Cheng, M., Huang, S., Li, B., and Yang, Z.

Abstract: With more and more electric vehicles (EV), distributed photovoltaic (PV) generations, and energy storage (ES) equipment infiltrating into the urban power distribution network (DN), this paper studies the optimal sizing problem of city photovoltaic-storage-charging system. The distribution system operator sets rules for energy trading in the urban power market, expecting its local load to be as smooth as possible. The three participants, i.e., the constructors of EV charging piles, PV, and ES, influence each other on their strategies for optimal sizing and their profits. We study this multiagent optimization problem from the perspective of coalitional game theory. A particle swarm optimization algorithm is used to solve the Nash equilibrium under each coalitional structure, and the results show that the grand coalition can always obtain the highest return. Furthermore, to ensure the coalition is stable and the payment imputation is fair, this paper adopts two methods, Sharpley value and equal disruptive propensity, to redistribute the profits of the grand coalition. Through a case study in the future DN of Beijing, the effectiveness of the coalitional game model, solution method, and imputation are verified.

Subject Areas: Photovoltaic-storage-charging system; Optimal sizing; Coalitional game; Particle swarm optimization; Payment imputation; Sensitivity analysis; Urban areas; Games; Nash equilibrium; Electric vehicle charging; Power markets

Availability: Cheng, M., Huang, S., Li, B., and Yang, Z. (2021). "Optimal Sizing of City Photovoltaic-Storage-Charging System Based on Coalitional Game Theory." *2021 International Conference on Power System Technology (POWERCON)*, pp. 388–394. https://doi.org/10.1109/POWERCON53785.2021.9697851

2.15. Title: Novel Flexibility Indices of Controllable Loads in Relation to EV and Rooftop PV

Author(s): Alyami, S., Almutairi, A., and Alrumayh, O.

Abstract: In order to analyze the flexibility of controllable loads in smart homes, two flexibility indices are proposed in this study. The first index, the electric vehicle (EV) flexibility index, determines the ability of any particular controllable load to avoid the EV charging intervals during its operation. The second index, the photovoltaic (PV) flexibility index, evaluates the ability of any controllable load to absorb PV power during its operation. Both these indices can be utilized by homeowners or policymakers in installing/updating PVs and controllable home appliances. Higher index values imply more flexibility and thus those devices are more beneficial for the homeowners. In order to capture different consumption patterns in different homes, five home clusters are considered in this study. In each cluster, the controllable loads are grouped into three groups based on their flexibility level and utilization purpose. The performance of the proposed method is analyzed for the two commonly used charging levels in the residential sector, i.e., level 1 and level 2. In addition, sensitivity analysis of different uncertain factors such as PV power, the arrival time of EVs, and daily mileage of EVs is also carried out. Simulation results have shown the effectiveness of the proposed method in determining the flexibility of different controllable loads with respect to EVs and PV.

Subject Areas: Controllable load; Electric vehicles; Flexibility; Machine learning; Photovoltaics; Smart homes; Load modeling; Indexes; Costs; Electric vehicle charging; Demand side management; Water heating

Availability: Alyami, S., Almutairi, A., and Alrumayh, O. (2022). "Novel Flexibility Indices of Controllable Loads in Relation to EV and Rooftop PV." *IEEE Transactions on Intelligent Transportation Systems*, pp. 1–9. https://doi.org/10.1109/TITS.2022.3146237

2.16. Title: The Long Road to Electric Cars

Author(s): Cage, F.

Abstract: Blog.

Subject Areas: Sales forecast; Electric vehicle; Alternative fuel vehicle; Projection estimate

Availability: Cage, F. (2022). "The Long Road to Electric Cars." *Reuter Graphics*. https://graphics.reuters.com/AUTOS-ELECTRIC/USA/mopanyqxwva/

2.17. Title: Optimal Energy Scheduling Based on Jaya Algorithm for Integration of Vehicle-to-Home and Energy Storage System with Photovoltaic Generation in Smart Home

Author(s): Wang, M. and Abdalla, M.A.A.

Abstract: With the emerging of the smart grid, it has become easier for consumers to control their consumption. The efficient use of the integration of renewable energy sources with electric vehicle (EV) and energy storage systems (ESSs) in the smart home is a popular choice to reduce electricity costs and improve the stability of the grid. Therefore, this study presents optimal energy management based on the Jaya algorithm for controlling energy flow in the smart home that contains photovoltaic generation (PV), integrated with ESS and EV. The objective of the proposed energy management is to reduce electricity cost while meeting the household load demand and energy requirement for the EV trip distance. By using the Jaya algorithm, the modes of home-to-vehicle (H2V) and vehicle-to-home (V2H) are controlled, in addition to controlling the purchase of energy from the grid and sale of the energy to the grid from surplus PV generation and ESS. Before EV participation in the V2H process, the amount of energy stored in the electric vehicle battery will be verified to be more than the energy amount required for the remaining EV trip to ensure that the required energy for the remaining EV trip is satisfied. Simulation results highlight the performance of the optimal energy scheduling to achieve the reduction of the daily electricity cost and meeting of load demand and EV energy required. The simulation results prove that optimal energy management solutions can be found with significant electricity cost savings. In addition, Jaya is compared with the particle swarm optimization (PSO) algorithm in order to evaluate its performance. Jaya outperforms PSO in terms of achieving optimal energy management objectives.

Subject Areas: Smart home; Electric vehicle; Energy storage system; Photovoltaic generation; Vehicle-to-home; Jaya algorithm

Availability: Wang, M. and Abdalla, M.A.A. (2022). “Optimal Energy Scheduling Based on Jaya Algorithm for Integration of Vehicle-to-Home and Energy Storage System with Photovoltaic Generation in Smart Home.” *Sensors*, *22*(4). https://doi.org/10.3390/s22041306

2.18. Title: A Cooperative Charging Control Strategy for Electric Vehicles Based on Multi-Agent Deep Reinforcement Learning

Author(s): Yan, L., Chen, X., Chen, Y., and Wen, J.

Abstract: The growth of electric vehicles (EVs) significantly increases the residential electricity demand and potentially leads to the overload of the transformer in the distribution grid. Aiming to coordinate the charging control of EVs, this paper formulates the EVs charging problem as a Markov game with an unknown transition function and proposes a cooperative charging control strategy based on the multiagent deep reinforcement learning (MADRL). The uncertainties from the dynamic electricity price, non-EV residential load consumption and driver's individual behaviors are considered to construct the dynamic charging environment. Each agent contains a collective-policy model and an independent learner. The collective-policy model is introduced to model other agent's behaviors by approximating their power consumption. The independent learner is used to learn the optimal charging strategy by interacting with the environment. The soft-actor-critic (SAC) framework is adopted to train the independent learner, enabling the proposed method to address the continuous state and action. Agents are trained with only the local observation and approximation, indicating that the proposed approach is fully decentralized and scalable to the problem with multiple agents. Finally, several numerical studies constructed on the real-world data demonstrate the effectiveness and scalability of the proposed approach.

Subject Areas: Electric vehicles; Multiagent deep reinforcement learning; Soft actor-critic; Collective-policy approximation; Transformers; Electric vehicle charging; Batteries; Load modeling; Markov processes; Costs; Real-time systems

Availability: Yan, L., Chen, X., Chen, Y., and Wen, J. (2022). "A Cooperative Charging Control Strategy for Electric Vehicles Based on Multi-Agent Deep Reinforcement Learning." *IEEE Transactions on Industrial Informatics*, *18*(12), pp. 8765–8775. https://doi.org/10.1109/TII.2022.3152218

2.19. Title: Impacts of EV Residential Charging and Charging Stations on Quasi-Static Time-Series PV Hosting Capacity

Author(s): Henrique, L.F., Bitencourt, L.A., Borba, B.S.M.C., and Dias, B.H.

Abstract: The increasing adoption of distributed energy resources, such as rooftop photovoltaic (PV) systems and electric vehicles (EVs), can cause adverse impacts in distribution systems, including the growth in PV hosting capacity (PVHC) and the depreciation of on-load tap changers (OLTC) lifetime. To analyze the impacts of these technologies in the network over the day, the quasi-static time series (QSTS) can be used with a resolution capable of performing the start and end times of the EVs charging and PV generation profile to observe the role of the OLTC in the grid. This work investigates the QSTS PVHC from the integration of EVs residential charging and in a public charging station (PCS) considering an unbalanced medium voltage (MV) network with and without OLCT. For this, a set of random variables for EV behavior are used, such as home and PCS arrival and departure times. The model is developed in Python and OpenDSS in a Monte Carlo simulation. In addition, the results show that the PCSs along the grid can increase the QSTS PVHC in MV networks that do not have OLTC. However, when the distribution system presents OLTC, the number of tap changes increases significantly if many EVs use the PCS. This result can drive actions by the distribution network operator to consider the distance between PCSs and OLTCs.

Subject Areas: PV hosting capacity; EV residential charging; EV public charging station; On-load tap changer

Availability: Henrique, L.F., Bitencourt, L.A., Borba, B.S.M.C., and Dias, B.H. (2022). "Impacts of EV Residential Charging and Charging Stations on Quasi-Static Time-Series PV Hosting Capacity." *Electrical Engineering*, *104*, pp. 2717–2728. https://doi.org/10.1007/s00202-022-01513-8

2.20. Title: Integrating Plug-In Electric Vehicles (PEVs) Into Household Fleets- Factors Influencing Miles Traveled by PEV Owners in California

Author(s): Chakraborty, D., Hardman, S., and Tal, G.

Abstract: Household vehicle miles traveled (VMT) has traditionally been studied in the context of gasoline vehicles. In this study, we analyze VMT of Plug-in Electric Vehicles (PEVs) to understand PEV use and the factors that influence their use in a household. We use data from a unique repeat survey of PEV owners in California who were originally surveyed when they first bought their vehicle. Having two survey responses per household allows us to obtain more reliable VMT data and analyze the change in VMT over the vehicle ownership period. The results show that PEV VMT is correlated with traditional factors like population density, built environment, attitudes towards technology, and lifestyle preferences. Specific to PEVs, electric driving range and access to infrastructure, have a major influence on PEV VMT. Moreover, while lower electricity price at home may lead to a higher share of PEV VMT in total household VMT, we do not identify the presence of "rebound effect". Overall, we observe that factors influencing PEV VMT are like those observed for conventional gasoline vehicles. We find that PEVs drive a similar amount as conventional vehicles, not less (due to range anxiety) as some have suggested. The results have implications for emissions impact assessments and travel demand models that depend on assumptions of average annual VMT for policymaking.

Subject Areas: Vehicle miles traveled; Plug-in electric vehicles; Multivariate analysis

Availability: Chakraborty, D., Hardman, S., and Tal, G. (2022). "Integrating Plug-In Electric Vehicles (PEVs) Into Household Fleets- Factors Influencing Miles Traveled by PEV Owners in California." *Travel Behaviour and Society*, *26*, pp. 67–83.
https://doi.org/10.1016/j.tbs.2021.09.004

2.21. Title: Resilience Enhancement Strategies For and Through Electric Vehicles

Author(s): Hussain, A. and Musilek, P.

Abstract: Electric vehicles (EVs) have the potential to reduce emissions from the transportation sector and are also capable of providing several services to the power system including resilience during power outages. However, transportation electrification has increased the interdependence of transport and power networks, which could become challenging during periods of extended outages. Consequently, the analysis of the existing literature on the resilience of power systems and EVs is carried out in two parts in this study. In the first part, the use of EVs as a resilience resource for buildings, microgrids, and power systems is discussed. In addition, the use of exhausted EV batteries (second life) for resilience enhancement purposes and collective resilience of power and transport networks are also discussed. In the second part, strategies used for enhancing the resilience of EVs are discussed, which comprise onsite storage deployment, integration of renewable energy sources, design of off-grid charging stations, energy allocation to EVs during outages, and the use of EVs for evacuation during emergencies. Especially, the need to include EVs in making public policies on disaster management is emphasized. Then, the prevailing challenges for realizing these services are discussed along with the research gaps in the existing literature. Finally, several potential research directions are presented to carry out future research based on the existing studies.

Subject Areas: Backup resource; Electric vehicles; Evacuation; Natural disasters; Power outages; Power system resiliency; Resilience enhancement; Survivability

Availability: Hussain, A. and Musilek, P. (2022). “Resilience Enhancement Strategies For and Through Electric Vehicles.” *Sustainable Cities and Society*, *80*. https://doi.org/10.1016/j.scs.2022.103788

2.22. Title: Energy-Cost Minimization with Dynamic Smart Charging of Electric Vehicles and The Analysis of Its Impact on Distribution-System Operation

Author(s): Visakh, A. and Manickavasagam Parvathy, S.

Abstract: Widespread recharging of electric vehicle (EV) batteries could lead to frequent overloads, excessive power loss, and severe voltage fluctuations, especially at the distribution-system level. These challenges can be mitigated with smart charging initiatives, in which the system operator regulates EV charging with certain technical or economic objectives, provided that the EV owners are prepared to relinquish the charging control of their vehicles. Amidst concerns regarding the potential hike in electricity bills due to domestic EV charging, cost-minimizing objectives have been identified as compelling motivation for EV owners to participate in centralized charging programs. This paper presents a dynamic strategy for smart charging that can account for the uncertainties associated with vehicle mobility. The charging scheme aims to minimize energy costs with respect to a real-time pricing tariff while fulfilling the charge requirement of all EV users. The benefits of smart charging under both grid-to-vehicle (G2V) and vehicle-to-grid (V2G) modes are analyzed. Furthermore, the impact of smart charging on the distribution system is assessed in terms of system demand, distribution efficiency, and load voltage. Results indicate that the proposed technique can reduce the consumers' energy bill by roughly one third. Although the smart V2G method leads to maximum saving, the inclusion of battery degradation cost tips the balance in smart G2V's favor. Moreover, the pair of smart charging solutions improves distribution-system operation, with all the monitored metrics of power distribution showing significant improvement.

Subject Areas: Electric vehicle; Smart charging; Cost minimization; Grid-to-vehicle; Vehicle-to-grid

Availability: Visakh, A. and Manickavasagam Parvathy, S. (2022). "Energy-Cost Minimization with Dynamic Smart Charging of Electric Vehicles and The Analysis of Its Impact on Distribution-System Operation." *Electrical Engineering*, *104*, pp. 2805–2817. https://doi.org/10.1007/s00202-022-01511-w

2.23. Title: Trip Chain Information Model Based Stochastic Energy Management System for Microgrid

Author(s): Rathor, S.K. and Saxena, D.

Abstract: Forecasting the demand-supply and achieving a balance between the two is challenging for power engineers to integrate intermittent renewable energy resources, energy storage systems, and plug-in electric vehicles in the emerging grid. Plug-in electric vehicles with bidirectional capacity and an effective energy management system can solve numerous power quality problems and cost-related issues. The most challenging part faced by the decision-makers is the stochastic behavior of plug-in electric vehicles and renewable energy sources. This paper utilizes the vehicle-to-grid capacity of a plug-in electric vehicle to minimize the operating cost of microgrid and plug-in electric vehicles (PEV) charging cost. To tackle the uncertain behavior of PEV, the concept of trip chain information base modeling has been applied. An additional benefit of stochastic modeling has been achieved by the day-ahead and real-time scheduling of PEV in intra-hour periods. The results are compared for four cases: benchmark model, deterministic framework, stochastic framework without trip chain modeling of PEV, and stochastic framework with trip chain modeling of PEV.

Subject Areas: Plug-in electric vehicles; Renewable energy sources; Vehicle-to-grid; Costs; Stochastic processes; Microgrids; Benchmark testing; K-means clustering method; stochastic modeling; Energy management system (EMS); Monte Carlo simulation (MCS)

Availability: Rathor, S.K. and Saxena, D. (2021). "Trip Chain Information Model Based Stochastic Energy Management System for Microgrid." *IEEE 2nd International Conference on Smart Technologies for Power, Energy and Control (STPEC)*, pp. 1–6. https://doi.org/10.1109/STPEC52385.2021.9718748

2.24. Title: A Vehicle-To-Grid Framework for Power System Unit Commitment

Author(s): Egbue, O. and Aldubaisi, A.

Abstract: The projected growth of plug-in electric vehicles on roads has the potential to produce challenges to the operational stability of power systems, particularly when a significant number of these vehicles charge and discharge concurrently. However, if plug-in electric vehicles in a vehicle-to-grid system are properly managed, they can be transformed from potential problems for the electrical grid to benefits. Some benefits from smart management of plug-in electric vehicles integration into the power grid include cost reduction and load leveling. This study describes a preliminary unit commitment framework for a vehicle-to-grid system. The methodology incorporates controlled charging and discharging as well as battery degradation into the unit commitment problem. The framework described in this study is useful to engineering managers because it enables smart control of plug-in electric vehicle integration into the power grid which can lead to reduction in generation cost and leveling of the load profile.

Subject Areas: Unit commitment; Vehicle-to-grid; Battery degradation; Plug-in electric vehicles

Availability: Egbue, O. and Aldubaisi, A. (2021). *A Vehicle-To-Grid Framework for Power System Unit Commitment*. Proceedings of the American Society for Engineering Management 2021 International Annual Conference, Huntsville, AL.
https://www.proquest.com/docview/2635269976

2.25. Title: False Data Injection Attack on Electric Vehicle-Assisted Voltage Regulation

Author(s): Liu, Y., Ardakanian, O., Nikolaidis, I., and Liang, H.

Abstract: With the large scale penetration of electric vehicles (EVs) and the advent of bidirectional chargers, EV aggregators will become a major player in the voltage regulation market. This paper proposes a novel false data injection attack (FDIA) against the voltage regulation capacity estimation of EV charging stations, the process that underpins voltage regulation in a distribution system. The proposed FDIA takes into account the uncertainty in EV mobility and network conditions. The attack vector with the largest expected adverse impact is the solution of a stochastic optimization problem subject to a constraint that ensures it can bypass bad data detection. We show that this attack vector can be determined by solving a sequence of convex quadratically constrained linear programs. The case studies examined in a co-simulation platform, based on two standard test feeders, reveal the vulnerability of the voltage regulation capacity estimation.

Subject Areas: Cyber-attacks; Distribution system state estimation; Electric vehicles; Stochastic optimization

Availability: Liu, Y., Ardakanian, O., Nikolaidis, I., and Liang, H. (2022). *False Data Injection Attack on Electric Vehicle-Assisted Voltage Regulation*. arXiv preprint, arXiv:2203.05087 [eess.SY]. https://arxiv.org/abs/2203.05087

2.26. Title: Optimal Scheduling Strategy of EVs Considering the Limitation of Battery State Switching Times

Author(s): Luo, L., He, P., Zhou, S., Lou, G., Fang, B., and Wang, P.

Abstract: In recent years, with environmental problems being increasingly outstanding, the clean transport represented by electric vehicles (EVs) has replaced traditional fossil fuel vehicles in an inevitable way. Taking advantage of the bidirectional charging power of EVs is an effective measure to avoid the grid shock caused by the large-scale EV penetration. However, the frequent charging and discharging of EVs will bring unnecessary damage to the batteries. In order to solve this problem, the paper proposes an optimal scheduling strategy of EVs considering the limitation of battery state switching times. Besides the traditional constraints relevant with EVs' scheduling, the limitation of battery state switching times is properly involved in the proposed strategy. Numerical results show that the charging schemes obtained from the proposed scheduling model can protect EV batteries at an almost negligible loss in users' charging cost.

Subject Areas: Electric vehicle; Vehicle-to-grid; Optimal scheduling; Battery state switching times; Regular dodecagonal relaxation

Availability: Luo, L., He, P., Zhou, S., Lou, G., Fang, B., and Wang, P. (2022). "Optimal Scheduling Strategy of EVs Considering the Limitation of Battery State Switching Times." *Energy Reports*, *8*(5), pp. 918–927. https://doi.org/10.1016/j.egyr.2022.02.199

2.27. Title: Charge Scheduling Optimization of Plug-In Electric Vehicle in a PV Powered Grid-Connected Charging Station Based on Day-Ahead Solar Energy Forecasting in Australia

Author(s): S., S.M., Titus, F., Thanikanti, S.B., M., S.S., Deb, S., and Kumar, N.M.

Abstract: Optimal charge scheduling of electric vehicles in solar-powered charging stations based on day-ahead forecasting of solar power generation is proposed in this paper. The proposed algorithm's major objective is to schedule EV charging based on the availability of solar PV power to minimize the total charging costs. The efficacy of the proposed algorithm is validated for a small-scale system with a capacity of 3.45 kW and a single charging point, and the annual cost analysis is carried out by modelling a 65 kWp solar-powered EV charging station The reliability and cost saving of the proposed optimal scheduling algorithm along with the integration and the solar PV system is validated for a charging station with a 65-kW solar PV system having charging points with different charging powers. A comprehensive comparison of uncontrolled charging, optimal charging without solar PV system, and optimal charging with solar PV system for different vehicles and different time slots are presented and discussed. From the results, it can be realized that the proposed charging algorithm reduces the overall charging cost from 10 to 20 percent without a PV system, and while integrating a solar PV system with the proposed charging method, a cost saving of 50 to 100 percent can be achieved. Based on the selected location, system size, and charging points, it is realized that the annual charging cost under an uncontrolled approach is AUS $28,131. On the other hand, vehicle charging becomes completely sustainable with net-zero energy consumption from the grid and net annual revenue of AUS $28,134.445 can be generated by the operator. New South Wales (NSW), Australia is selected as the location for the study. For the analysis Time-Of-Use pricing (ToUP) scheme and solar feed-in tariff of New South Wales (NSW), Australia is adopted, and the daily power generation of the PV system is computed using the real-time data on an hourly basis for the selected location. The power forecasting is carried out using an ANN-based forecast model and is developed using MATLAB and trained using the Levenberg–Marquardt algorithm. Overall, a prediction accuracy of 99.61 percent was achieved using the selected algorithm.

Subject Areas: Electric vehicles; Plug-in electric vehicle; Charge scheduling; Time-of-use pricing; Electric vehicle charging infrastructure; Solar charging; Solar forecasting; Electric vehicles in Australia

Availability: S., S.M., Titus, F., Thanikanti, S.B., M., S.S., Deb, S., and Kumar, N.M. (2022). "Charge Scheduling Optimization of Plug-In Electric Vehicle in a PV Powered Grid-Connected Charging Station Based on Day-Ahead Solar Energy Forecasting in Australia." *Sustainability*, *14*(6). https://doi.org/10.3390/su14063498

2.28. Title: Quantifying Transportation Energy Vulnerability and Its Spatial Patterns in the United States

Author(s): Liu, S. and Kontou, E.

Abstract: Transportation provides access to economic opportunities, empowers individuals and adds value to their communities. However, the average household in the United States spends 17percent of their income on transportation expenditures and almost 4 percent on fuel costs. In response to both budgetary and social implications of facing burdens to meet transportation energy needs, we propose a new data-driven framework to quantify transportation energy vulnerability. We measure exposure, sensitivity, and adaptive capacity to transportation energy burdens and present spatial patterns of transportation energy vulnerability across the United States census tracts. We examine the sensitivity of the vulnerability outcomes to the composite score's functional form and evaluate the impact of electric vehicle adoption on transportation fuel and electricity consumption. Generating the composite vulnerability score as an additive index is robust when estimating the impact of adaptive capacity interventions, but the multiplicative index performs better when exposure and sensitivity metrics are priorities. The market growth of electric vehicles reduces spatial disparities in energy vulnerability but has diminishing returns over time. We present the geography of vulnerability in Los Angeles, Chicago, and New York and find that populations in urban areas in Chicago and New York experience less transportation energy vulnerability. On the other hand, city center and rural regions' populations face a greater transportation energy burden in Los Angeles.

Subject Areas: Transport energy; Vulnerability; Fuel costs; Electric vehicles

Availability: Liu, S. and Kontou, E. (2022). "Quantifying Transportation Energy Vulnerability and Its Spatial Patterns in the United States." *Sustainable Cities and Society*, 82. https://doi.org/10.1016/j.scs.2022.103805

2.29. Title: Designing a Transactive Electric Vehicle Agent with Customer's Participation Preference

Author(s): Singhal, A., Hanif, S., Bhattarai, B., dos Reis, F.B., Reeve, H., and Pratt, R.

Abstract: The proliferation of electric vehicles (EVs) and their inherent flexibility in charging timings make them an asset to improve grid performance. In contrast to direct control by a utility or autonomous price-based charging, the transactive control framework not only provides benefits to both grid and customers but also ensures customer autonomy. In this work, we design a transactive electric vehicle (TEV) agent that incorporates the EV owner's willingness to trade-off between savings and amenity in form of a slider, where the EV owner's amenity is characterized as vehicle readiness. Further, a privacy-preserving bidding formulation is proposed that also represents the customer's transactive preference. A transactive market mechanism is discussed that integrates the TEV Agents into the local retail market and reconciles with the current day-ahead and real-time market structure. It is demonstrated that the proposed slider is able to provide a preferred trade-off between savings and amenity to individual customers. At the same time, the market mechanism is shown to successfully reduce both peak prices and peak demand. A comparative investigation of V1G and V2G technologies with respect to the battery prices is also discussed.

Subject Areas: Electric vehicle; Smart charging; Electricity market; Flexible bidding; Transactive agent

Availability: Singhal, A., Hanif, S., Bhattarai, B., dos Reis, F.B., Reeve, H., and Pratt, R. (2022). *Designing a Transactive Electric Vehicle Agent with Customer's Participation Preference*. arXiv preprint, arXiv:2203.16516 [eess.SY]. https://arxiv.org/abs/2203.16516

2.30. Title: Country Roads, Charge at Home

Author(s): King, P.

Abstract: Blog.

Subject Areas: Clean transportation; Electric vehicles; Energy justice; Rural communities; Charging station

Availability: King, P. (2022). "Country Roads, Charge at Home." *cleanenergy.org*. https://cleanenergy.org/blog/rural-mobility/

2.31. Title: Which Cities Have the Most Gas ‘Superusers’ and How Seattle Ranks

Author(s): Balk, G.

Abstract: Blog.

Subject Areas: Gasoline superusers; Pattern of gas consumption; Electric vehicles

Availability: Balk, G. (2022). “Which Cities Have the Most Gas ‘Superusers’ and How Seattle Ranks.” *The Seattle Times*. https://www.seattletimes.com/seattle-news/data/which-cities-have-the-most-gas-superusers-and-how-seattle-ranks/

2.32. Title: Washington State to Spend $450,000 Studying 'Gasoline Superusers'

Author(s): Ramsey, J.

Abstract: Blog.

Subject Areas: Gasoline superusers; Washington state; Ford F-150; Rural communities

Availability: Ramsey, J. (2022). "Washington State to Spend $450,000 Studying 'Gasoline Superusers.'" *Yahoo.com*. https://autos.yahoo.com/washington-state-spend-450-000-160000641.html

2.33. Title: California Joins Washington with Gasoline Superuser Study

Author(s): Ramsey, J.

Abstract: Blog.

Subject Areas: Gasoline superusers; California state; Electric vehicle incentives; Low-income communities

Availability: Ramsey, J. (2022). "California Joins Washington with Gasoline Superuser Study." *Autoblog*. https://www.autoblog.com/2022/05/05/california-gas-superusers-study-carb/

2.34. Title: Consumers Most Highly Influenced by the U.S. Federal Tax Credit

Author(s): Williams, B.D.H.

Abstract: This brief summarizes and provides additional context for findings of a paper published by the 33rd Annual Electric Vehicle Symposium. It analysed survey responses from 3,452 recipients of California's state-wide EV rebate (CVRP) who purchased a plug-in hybrid EV (PHEV) from November 2016 through December 2018. The beginning of the date range marks a major CVRP program change (introduction of income-based eligibility) and the end marks the most recent data available at the time of analysis—i.e., the data constituted the most recent "current-program" era. Data weights were used to make the survey more representative of all program participants, and the program constituted roughly half of the California EV market at the time.

The analysis evaluated a wide range of factors (demographic, household, regional, motivational, and transactional) to identify and rank-order those found statistically associated with increased odds of being a consumer that rated the FTC "Extremely Important" to making their PHEV purchase possible. As such, these "FTC Extremes" were the most highly influenced and might not have been able to adopt their EV without the FTC. Respondents who selected "Not at all important," "Slightly important," or "Moderately important" were grouped to form the nonextreme status. Further details are in the paper.

Subject Areas: Federal tax credit; California state; Plug-in electric vehicles; Demographics; Clean Vehicle Rebate Project

Availability: Williams, B.D.H. (2022). *Consumers Most Highly Influenced by the U.S. Federal Tax Credit*. Brief, Center for Sustainable Energy, San Diego, CA. https://cleanvehiclerebate.org/sites/default/files/attachments/PHEV-FTC-Extremes-Research-Summary-2022-01-12.pdf

2.35. Title: Modeling Integrated Power and Transportation Systems: Impacts of Power-to-Gas on the Deep Decarbonization

Author(s): Li, B., Chen, M., Ma, Z., He, G., Dai, W., Liu, D., Zhang, C., and Zhong, H.

Abstract: The deployment of renewable energy sources, power-to-gas (P2G) systems, and zero-emission vehicles provide a synergistic opportunity to accelerate the decarbonization of both power and transportation system. This article investigates the prospects of implementing hydrogen P2G technology in coupling the power system and the transportation system. A novel coordinated long-term planning model of integrated power and transportation system (IPTS) at the regional scale is proposed to simulate the power system balance and travel demand balance simultaneously, while subject to a series of constraints, such as CO2 emission constraints. IPTS of Texas was investigated considering various CO2 emission cap scenarios. Results show unique decarbonization trajectories of the proposed coordinated planning model, in which IPTS prefers to decarbonizing the power sector firstly. When the power system reaches ultralow carbon intensity, the IPTS then focuses on the road transportation system decarbonization. The results show that with the P2G system, IPTS of Texas could achieve 100% CO2 emission reductions (relative 2018 emissions level) by adding a combination of approximately 143.5 GW of wind, 50 GW of solar PV, and 40 GW of P2G systems with 2.5% renewables curtailment. The integration of the P2G system can produce hydrogen by use of surplus RES generation to meet hydrogen demand of fuel cell electric vehicles (FCEVs) and to meet multiday electricity supply imbalances.

Subject Areas: Capacity expansion; Fuel cell electric vehicle; Integrated power and transportation system; Power-to-gas technology; Smart charging

Availability: Li, B., Chen, M., Ma, Z., He, G., Dai, W., Liu, D., Zhang, C., and Zhong, H. (2022). "Modeling Integrated Power and Transportation Systems: Impacts of Power-to-Gas on the Deep Decarbonization." *IEEE Transactions on Industry Applications*, *58*(2), pp. 2677–2693. https://doi.org/10.1109/TIA.2021.3116916

2.36. Title: Slow/Fast Charging Pile Configuration in Multi-Areas Based on Time-Space Transfer Characteristics of EV

Author(s): Xu, Y., Shu, W., Chen, J., Sang, L., Hu, Q., and Han, R.

Abstract: This paper proposes a charging model to determine the charging load demand of EVs (Electric Vehicles) based on their time–space transfer characteristics in different typical travel days and analyzes the configuration requirements of different charging piles in multi-type urban areas. By dividing travel destinations into five area types, this paper analyzes the probability characteristics of users' travel purpose, travel time, driving and parking time distribution, and constructs the time–space transfer travel chain of EVs in different typical days. Then, we establish a charging decision model with two charging modes to calculate charging demands and different charging pile requirements of EVs in different functional areas on different typical days by Monte Carlo simulation and SUMO (Simulation of Urban Mobility). The results may provide suggestions for the planning and configuration of charging piles in different functional areas.

Subject Areas: Time–space characteristics; Charging demand; Charging pile configuration; Simulation of urban mobility; Monte Carlo simulation

Availability: Xu, Y., Shu, W., Chen, J., Sang, L., Hu, Q., and Han, R. (2022). "Slow/Fast Charging Pile Configuration in Multi-Areas Based on Time–Space Transfer Characteristics of EV." The proceedings of the 16th Annual Conference of China Electrotechnical Society. *Lecture Notes in Electrical Engineering*, *890*. Springer, Singapore. https://doi.org/10.1007/978-981-19-1870-4_74

2.37. Title: A Unit Commitment Model for Optimal Vehicle-To-Grid Operation in a Power System

Author(s): Egbue, O., Uko, C., Aldubaisi, A., and Santi, E.

Abstract: Integrating plug-in electric vehicles (PEVs) into a smart grid can pose some challenges, particularly when a significant number of these vehicles are simultaneously charged and discharged. However, smart management of PEVs in a vehicle-to-grid (V2G) system can result in benefits to the grid such as load leveling, and cost reduction. This paper proposes a unit commitment model for a V2G system connected to a smart power grid. The model considers different penetration levels of PEVs and investigates the economic and technical effects of using PEVs to support the grid. The proposed methodology incorporates controlled charging and discharging as well as accounting for battery degradation in the unit commitment problem. The model is tested using an IEEE 24 bus network to determine the impact of high PEV penetration on generation cost. A comparison between a system without V2G and a system with V2G is presented to highlight the benefits of the proposed approach. The results show that the optimal scheduling of PEVs leads to reduction in generation cost and is effective in leveling the load profile through valley filling and peak load reduction.

Subject Areas: Economic dispatch; Plug-in electric vehicles; Power systems; Unit commitment; Vehicle-to-grid

Availability: Egbue, O., Uko, C., Aldubaisi, A., and Santi, E. (2022). "A Unit Commitment Model for Optimal Vehicle-To-Grid Operation in a Power System." *International Journal of Electrical Power & Energy Systems*, *141*. https://doi.org/10.1016/j.ijepes.2022.108094

2.38. Title: Toward Human-Centric Transportation and Energy Metrics: Influence of Mode, Vehicle Occupancy, Trip Distance, and Fuel Economy

Author(s): Henao, A., Sperling, J., Weigl, D., Atnoorkar, S., Wilson, A., Nobler, E., Shankari, K., and Smith, S.

Abstract: Traditional metrics measuring transportation and energy outcomes can be augmented to better represent impacts on people's lives and systems-level performance. This study introduces, analyzes, and tests two novel metrics: human-centered road capacity (road capacity for people) and energy intensity (energy use for people's transportation) using empirical cumulative distribution functions of associated parameters for scenario development. Current national-level distributions of available data in the United States for factors contributing to the two new integrated metrics are used as context to evaluate potential outcomes. These factors include vehicle occupancy, mode share, fuel economy, and trip distance. Variations in input values provide insights on how these factors shape efficiencies in road capacity and energy intensity. Parametric sensitivity analysis indicates that the impact of each input depends on the metric being evaluated. For the human-centered road capacity mobility metric, increasing vehicle occupancy has the largest effect—twice that of increasing mode share for bike, walk, and transit. For the energy intensity mobility metric, the effect of improving fuel economy is the largest. Additionally, a novel interactive tool to visualize the results for various parameter combinations is designed to allow researchers and decision makers to test the metrics. The findings show deficiencies in continuing to use traditional vehicle-centric metrics and suggest that the diffusion of new human-centric metrics that benchmark outcomes associated with road capacity and energy may be significant in motivating new sustainable transportation investments and efficient utilization of infrastructure, mobility assets, and services.

Subject Areas: Data and data science; Multimodal information systems; Multimodal analysis; Analytic data visualization; Pedestrians; Bicycles; Human factors; Accessibility; Planning and analysis; Access/accessibility; Sustainability and resilience; Transportation and sustainability; Accessibility and mobility

Availability: Henao, A., Sperling, J., Weigl, D., Atnoorkar, S., Wilson, A., Nobler, E., Shankari, K., and Smith, S. (2022). "Toward Human-Centric Transportation and Energy Metrics: Influence of Mode, Vehicle Occupancy, Trip Distance, and Fuel Economy."
Transportation Research Record: Journal of the Transportation Research Board, *2676*(9), pp. 467–478. https://doi.org/10.1177%2F03611981221086932

2.39. Title: Models and Optimal Controls for Smart Homes and their Integration into the Electric Power Grid

Author(s): Gong, H.

Abstract: Smart homes can operate as a distributed energy resource (DER), when equipped with controllable high-efficiency appliances, solar photovoltaic (PV) generators, electric vehicles (EV) and energy storage systems (ESS). The high penetration of such buildings changes the typical electric power load profile, which, without appropriate controls, may become a "duck curve" when the surplus PV generation is high, or a "dragon curve" when the EV charging load is high. A smart home may contribute to an optimal solution of such problems through the energy storage capacity, provided by its by battery energy storage system (BESS), heating, ventilation, and air conditioning (HVAC) system, and electric water heater (EWH), and the advanced controls of a home energy management (HEM). The integrated modeling of home energy usage and electric power distribution system, developed as part of this dissertation research, provides a testbed for HEM control methods and prediction of long-term scenarios.

The main original contributions of this dissertation include the comprehensive simulation of the total building energy usage and the development of the co-simulation framework incorporating building and power system simulators. Another contribution of the dissertation is the quantification of building resilience based on the building energy usage model. The dissertation also contributes to the concept of GES which regards the HVAC and EWH as virtual energy storage and their unified controls with BESS. The GES facilitates the employment of industrial standards, e.g., CTA-2045, and the hybrid ESS reduces required BESS capacity.

This dissertation contributes to the modeling of aggregated load for EWH, HVAC, and EV using different methods and long term forecasting of power profile at the system level. The aggregated generic load for EWH was calculated based on large amount of field data, the aggregated EV charging load was estimated based on national survey results, and the aggregated HVAC load was simulated based on the modeling of every residence, where the model parameters were populated according to special distributions. The methods based LSTM for the identification of HVAC power from the aggregated load was developed.

Subject Areas: Smart home; Distributed energy resource; Hybrid energy storage system; Home energy management; Electric vehicles charging; Co-simulation framework; Long term forecasting

Availability: Gong, H. (2022). *Models and Optimal Controls for Smart Homes and their Integration into the Electric Power Grid*. Doctoral Dissertation, University of Kentucky, Lexington, KY. https://doi.org/10.13023/etd.2022.053

2.40. Title: Sizing Considerations for EV Dynamic Wireless Charging Systems with Integrated Energy Storage

Author(s): Lewis, D.D., Gong, H., Erhardt, G., Zeng, R., Onar, O., Galigekere, V.P., Ozpineci, B., and Ionel, D.M.

Abstract: Roadways with dynamic wireless charging systems (DWCS) enable charge-sustaining in-motion EV charging, which can reduce charging idle time while increasing range capabilities. Spatially distributed transmitter coils are controlled in response to traffic load that varies significantly minute to minute with high power levels, very short charging time, and low system utilization like wind turbine power. Traffic load estimation and localized analysis may guide effective sizing and topology adoption for feasible and scalable DWCS deployment. DWCS traffic load approximation is reviewed with measured Automated Traffic Recorder (ATR) data and statistical distributions being used to create a synthetic load analyzed using proposed metrics quantifying system utilization over time. Lumped coil section segmentation is compared between second-based distance and spatial density analysis methods, offering 17 to 27 percent greater system utilization. A peak load shifting method is proposed for traffic redirection across two tracks with optional BESS integration increasing system utilization by 50 to 60 percent depending on time-based and power reserve-based sizing and control.

Subject Areas: Electric vehicle (EV); Dynamic wireless charging; Transportation electrification; Wireless power transfer; Energy storage

Availability: Lewis, D.D., Gong, H., Erhardt, G., Zeng, R., Onar, O., Galigekere, V.P., Ozpineci, B., and Ionel, D.M. (2022). *Sizing Considerations for EV Dynamic Wireless Charging Systems with Integrated Energy Storage*. Authors' Manuscript, 2022 IEEE Transportation Electrification Conference & Expo (ITEC 2022).
https://sparklab.engr.uky.edu/sites/sparklab/files/2022%20IEEE%20ITEC%20UKORNL%20DWCS%20Authors%20Manuscript.pdf

2.41. Title: EV Response Capability Assessment Considering User Travel Demand and Cyber System Reliability

Author(s): Liu, Y., Liu, K., and Sun, X.

Abstract: With the increasing penetration rate of electric vehicles (EVs), EV demand response holds great significance for promoting the optimal and secure operation of the power system. This paper proposes an EV response capability assessment method that considers EV users' travel demands and the reliability of the cyber systems integrated into both the power grid and the transportation network. A novel framework for an integrated cyber-power-transportation system is proposed for the first time, and a reliability model for the cyber system is provided. A method is further proposed to calculate the state of an EV when it is plugged in, considering the reliability of traffic guidance information and the reliability of the release of such information. The degree of relaxation in the EV charging demand is proposed to reflect the user's travel demand, based on which the EV response capability can be assessed. Extensive test results on a cyber-power-transportation system containing RBTS BUS6 and the Beijing transportation network are conducted to show the efficiency of the proposed method. The impact of cyber reliability on the EV trip and response capability is analyzed.

Subject Areas: Cyber system; Demand response; Electric vehicle

Availability: Liu, Y., Liu, K., and Sun, X. (2022). "EV Response Capability Assessment Considering User Travel Demand and Cyber System Reliability." *Engineering*, *15*, pp. 186–195. https://doi.org/10.1016/j.eng.2021.08.031

2.42. Title: Electric Vehicle Deployment and Integration in the Saudi Electric Power System

Author(s): Almohaimeed, S.A.

Abstract: The demand for electricity in Saudi Arabia has grown in the last few years due to the growth in the economy and the population. The country has invested in many solutions such as promoting renewable energy and shifting to generation mix to respond to this growing demand. However, Electric Vehicles (EVs) are used as an important factor in achieving the Saudi Vision 2030 in its environmental and economical parts. This work gives an overview on the Saudi electrical energy system and then investigates the impact EVs technology in the electricity sector in Saudi Arabia and its relevant consequences. A statistical analysis is used to quantify the number of EVs, travelled distance and traffic congestions, and State of Charge (SOC). The data were used to implement a daily load profile for EVs for a large population of vehicles. The obtained results show that the EVs peak loads occur during the late evening and early morning at different means. Interestingly, the work shows that the peak periods of EVs occur during the off-peak times of the daily load curve. This means that a large population of EVs can offer more flexibility and improvement to the electric grid, and the summative EV load of a large population of vehicles has a smooth pattern and will not affect the national electric system.

Subject Areas: Daily curve load; Electric vehicle; Grid; Saudi Arabia; Normal distribution

Availability: Almohaimeed, S.A. (2022). "Electric Vehicle Deployment and Integration in the Saudi Electric Power System." *World Electric Vehicle Journal*, *13*(5). https://doi.org/10.3390/wevj13050084

2.43. Title: Transition of Electric Vehicles from a Niche to a Regime: Analyzing the Impact of Consumers' Internal Factors on Purchasing Behavior in the U.S. and Finland

Author(s): Nuutinen, J.

Abstract: Objectives: The main objective of the study was to understand why the transition to electric vehicles has been slower in the U.S. compared to other developed countries. Supporting objectives to achieving the main one includes comparing the electric vehicle incentives and barriers present.

Summary: A study was conducted to analyze and compare the effect internal factors on buying behavior have on intent to purchase electric vehicles between the U.S. and Finland. To gather the necessary data, consumers reported their knowledge on electric vehicles, perceptions of barriers and incentives to their purchase, attitudes towards electric vehicle features and intent to purchase and own electric vehicles. The results would suggest if the U.S. consumers internal factors are the cause of their low adoption of electric vehicles

Conclusions: Secondary research indicated that Finland had more incentives and less barriers to the purchase of electric vehicles than the U.S., and the primary research indicated that Finland was further ahead in the transition of electric vehicles from niche to regime. Consumers attitudes were concluded as the most influential factor to intent to purchase.

Subject Areas: Electric vehicles; Sustainability; Government intervention; Macroeconomic policies; Multi-level perspective; Buying behavior; Consumer perceptions; United States; Finland

Availability: Nuutinen, J. (2022). *Transition of Electric Vehicles from a Niche to a Regime: Analyzing the Impact of Consumers' Internal Factors on Purchasing Behavior in the U.S. and Finland*. Bachelor's Thesis, Aalto University, Espoo, Finland. https://aaltodoc.aalto.fi/bitstream/handle/123456789/114289/bachelor_Nuutinen_Jonatan_2022.pdf?sequence=1&isAllowed=y

2.44. Title: Hierarchical Management Strategy for Electric Vehicles Charging Schedule Considering the Scarcity of Charging Resources

Author(s): Zhu, X., Sun, Y., Yang, J., Zhan, X., Wu, F., Fan, H., and Liang, J.

Abstract: Charging resources are scarce due to the limited capacity of charging stations and the congestion of distribution networks. Here, a hierarchical scheduling framework that considers the privacy of participants is established to optimize the charging power with a fair payment mechanism. The charging resource allocation model is established considering the scarcity of charging resources. Furthermore, the model is divided into three sub problems, including the congestion management problem of distribution network operator, the energy management problem of charging station and the charging mode problem of electric vehicle. Then the collaborative optimization algorithms are proposed to ensure the privacy of participants. Finally, a hierarchical payment mechanism based on the opportunity cost theory is proposed. The performance of the proposed hierarchical scheduling framework is evaluated using the Roy Billiton Test System with 2000 EVs. On the premise of ensuring distribution network economic operation, the proposed hierarchical scheduling strategy can satisfy the requirement for privacy protection and eliminate the overload problem caused by electric vehicle charging. The simulation results have shown that the additional capacity cost has an obvious levelling effect. With the application of the payment mechanism, charging resources is equitably allocated. Also, the equilibrium of a market and the stable operation of power system can be guaranteed.

Subject Areas: Cyber system; Demand response; Electric vehicle

Availability: Zhu, X., Sun, Y., Yang, J., Zhan, X., Wu, F., Fan, H., and Liang, J. (2022). "Hierarchical Management Strategy for Electric Vehicles Charging Schedule Considering the Scarcity of Charging Resources." *IET Generation, Transmission & Distribution*, *16*(15), pp. 3092–3108. https://doi.org/10.1049/gtd2.12503

2.45. Title: An Improved Charging Navigation Strategy of Electric Vehicles via Optimal Time-of-Use Pricing

Author(s): Huang, J., Wang, X., Shao, C., Song, Z., Wang, Y., and Shuai, X.

Abstract: Electric vehicles (EVs) have attracted worldwide attention and have been vigorously promoted by the government. However, users' mileage anxiety and the intermittent charging load are still great challenges to the popularization of EVs. To tackle these problems, this paper proposes an improved charging navigation model, aiming at maximizing the benefits of multiple parties by setting time-of-use (TOU) price of fast charging stations (FCSs) to attract EVs to charge at off-peak hours and saving the costs of EVs with real-time navigation. It is modeled as a Stackelberg game, in which the FCSs operator and EVs are the leader and followers respectively. First, a rigorous and dedicated traffic simulation model, air conditioner energy consumption model and queuing model of EVs are established. Then, by researching the impact of prices on charging choices, an EV strategy including the selection of charging time, charging energy, charging station and routes is proposed to minimize EV's cost. Based on EV charging response behavior, the optimal TOU pricing strategy for FCSs is formulated to maximize FCSs' revenue. The simulation results confirm that the proposed approach is beneficial to EVs and FCSs and can effectively reduce the peak-to-average ratio and the peak–valley difference of the power system.

Subject Areas: EV charging navigation; Time-of-use charging price; Fast charging station; Traffic simulation; Peak shaving

Availability: Huang, J., Wang, X., Shao, C., Song, Z., Wang, Y., and Shuai, X. (2022). "An Improved Charging Navigation Strategy of Electric Vehicles via Optimal Time-of-Use Pricing." *Electric Power Systems Research*, *210*. https://doi.org/10.1016/j.epsr.2022.108077

2.46. Title: Prediction of Charging Requirements for Electric Vehicles Based on Multiagent Intelligence

Author(s): Ling, S., Zhu, X., Wang, Q., and Schonfeld, P.

Abstract: This study investigates the spatiotemporal distribution of electric vehicle (EV) charging demands and operating efficiency of the charging system. The travel behavior of EV drivers is analyzed by considering the heterogeneity of range anxiety and bound rationality. Building on existing charging choice models, our more holistic perspective of charging demand distribution is obtained through multiagent system (MAS) modeling. In our study, the charging demand distribution in different areas is compared by considering two charging price schemes. The performance of the charging system is then evaluated based on three indicators, the charging request rejection rate, charging pile utilization rate, and charging load deviation, thereby verifying the effectiveness of our charging demand prediction model. This is done using multiagent-based simulations applied to the National Household Travel Survey (NHTS) 2017 dataset. The results are analyzed according to different key indicators, mainly indicating (a) the limitations of the time-of-use (TOU) pricing strategy in reducing the peak–valley difference, (b) the transferability of charging demand among different functional areas, and (c) that there is less demand for charging piles in the workplace, as users mainly rely on home charging. These results facilitate further analyses to help the design and operation of the EV charging infrastructure.

Subject Areas: Electric vehicle; Charging demands; Operating efficiency; Multiagent system (MAS) modeling

Availability: Ling, S., Zhu, X., Wang, Q., and Schonfeld, P. (2022). "Prediction of Charging Requirements for Electric Vehicles Based on Multiagent Intelligence." *Journal of Advanced Transportation*, *2022*. https://doi.org/10.1155/2022/2309376

2.47. Title: Estimation of Charging Demand for Electric Vehicles by Discrete Choice Models and Numerical Simulations: Application to a Case Study in Turin

Author(s): Sica, L.

Abstract: The electrification of vehicles is one of the recent trends of development for our society to mitigate the problem of air pollution, the critical issues related to climate change and meet the new user needs. Many fields of study and research are involved in this theme, ranging from technological areas to statistical and modelling of transport systems for the management of electric vehicles (EV) and their operations.

This study is focused on modelling and simulation of EVs user behaviour to forecast possible electric charging scenarios in cities and understand potential management problems, as well as the room for improvements of EVs and related infrastructures systems. Indeed, many factors may prevent a wide diffusion of electric vehicles. In order to analyse these issues, the case study of conurbation of Turin was selected, to reproduce realistic scenarios applying discrete choice modelling based on socioeconomic and transport system data. One of the specific objectives of the study is to identify user's charging behaviour from a spatial point of view to model where users prefer to charge in the study area according to the variables that may affect decisions. On the other hand, the estimation of electric vehicles in cities and the characteristics of their user is helpful to complete the picture on electric mobility. Analysing these behavioural issues in a modelling framework can provide a set of tools to realise which are the improvements and the modifications to pursue and facilitate the diffusion of electric vehicles providing an adequate charging infrastructure to users.

To perform the analysis, two available models were considered from the scientific literature: (1) to predict the charging demand and applied in Amsterdam districts and (2) to estimate the EVs penetration rate, as considered in a test applied in USA. The first model works using the methodology of Discrete Choice Modelling based on Random Utility Theory and in particular the multinomial logit and nested logit. The independent variables considered includes households dataset and vehicle-related dataset aggregated at zonal level. Its main output is the estimation of the charging demand distribution in the study area. The second model works by using the linear regression technique and requires a disaggregate dataset for individuals to estimate the penetration rate of EVs for the area. Since zonal datasets were available, for the penetration rate model, a Monte Carlo simulation was performed to manage individual data from a zone-aggregated dataset. The two models are applied in an integrated framework to Turin study area and various scenarios are generated. Results show the zones in which higher electric charging demand is expected and the zones where the penetration rate of EVs is important. Also, some experimental scenarios are presented to understand which are the most influencing factors on the results and the impact of their changes on the charging demand in the various zones of the conurbation. Observing the model results, the estimated demand is concentrated in those zones presenting adequate charging infrastructures supply, a significative number of attraction poles and a particular combination of sociodemographic characteristics. The EVs penetration rates estimated exhibit a tendency to be higher in urban zones of the study area and is considerably influenced by the education level of inhabitants, which is correlated to the positive perception of electric mobility diffusion.

Subject Areas: Electric vehicle; Charging infrastructure; Charging strategy; Electric vehicle penetration rate; User behavior

Availability: Sica, L. (2022). *Estimation of Charging Demand for Electric Vehicles by Discrete Choice Models and Numerical Simulations: Application to a Case Study in Turin*. Master's Thesis, Polytechnic University of Turin, Turin, Italy.
https://webthesis.biblio.polito.it/22249/1/tesi.pdf

2.48. Title: Optimal Planning of Flood-Resilient Electric Vehicle Charging Stations

Author(s): Zhang, Q., Yu, H., Zhang, G., and Ma, T.

Abstract: This study is the first attempt to integrate flood resilience into the electric vehicle (EV) charging station planning process. Instead of fully avoiding flood-prone areas, an optimized placement considering the magnitude of flood inundations can minimize the impact of flood hazards and simultaneously maximize the socioeconomic benefit of EV charging station networks. In this study, an integrated framework of the non-dominated sorting genetic algorithm-III (NSGA-III) and the technique for order of preference by similarity to ideal solution (TOPSIS) is proposed to optimize the charging station locations by maximizing the charging convenience, minimizing the impact of flood hazards, and minimizing the impact of existing charging stations. The NSGA-III is applied to solve the multi-objective location optimization of charging stations. TOPSIS is subsequently used to determine the best solution from the feasible candidates generated by the NSGA-III. A case study conducted in the Waikiki area demonstrates that the proposed optimization framework can effectively deal with the trade-off between the impact of flood hazards and the charging service of a charging station network. This study provides new insights into best practices for dealing with multiple conflicting objectives in EV charging station planning under climate change.

Subject Areas: Electric vehicles; Charging station planning; Flood resilience; Optimization framework; Non-dominated sorting genetic algorithm-III (NSGA-III)

Availability: Zhang, Q., Yu, H., Zhang, G., and Ma, T. (2022). "Optimal Planning of Flood-Resilient Electric Vehicle Charging Stations." *Computer-Aided Civil and Infrastructure Engineering*, pp.1–19. https://doi.org/10.1111/mice.12853

2.49. Title: A Multiple Linear Regression (MLR) Model for the Application of Electrical Vehicles in the United States

Author(s): Navarro, L. and Bathaei, B.

Abstract: This study focuses on the assessment of the factors affecting the adaptation of Hybrid/Electric Vehicles. The problem that arises when using conventional vehicles has some negative impacts on the environment (Greenhouse Gas emission), society (health issues), and economics (energy demand). There is a need to mitigate these effects by inducing a transportation mode with a fuel source of electricity and progressively reducing the use of gasoline. To find the socioeconomic and environmental impacts of the application of Hybrid/Electric Vehicles, the current research aims to explore potential factors that can be attributed to purchasing H/EVs to estimate their penetration in the U.S. Several multiple linear regression (MLR) models were applied to find the significant factors that impact the use of several types of Hybrid/Electric vehicles compared to conventional ones. The types of Hybrid/Electric Vehicles assessed are Plug-in Hybrid Vehicles (PHEV), Electric Vehicles (EV), Hybrid Vehicles (HEV). The models use data from the National Household Travel Survey website. R Studio software is applied to conduct statistical analysis. The results identify that the variables that have statistical significance are Fuel Expenditures and Household Income. The factors that impact the use of conventional vehicles compared to hybrid ones are MSA, Model Toyota Vehicles, Vehicles Driven in the Weekdays, Weekends, Zero Workers and One to Three Workers per Household. Furthermore, people with PHEVs, EVs, and HEVs tend to have more fuel expenditures and higher household income than conventional vehicles. Therefore, it is determined that "adults with and without children" are not significant among the models.

Subject Areas: Electric vehicles; Socioeconomic and environmental impacts; Multiple linear regression; Adaptation

Availability: Navarro, L. and Bathaei, B. (2022). "A Multiple Linear Regression (MLR) Model for the Application of Electrical Vehicles in the United States." *Proceedings of the Canadian Society of Civil Engineering Annual Conference 2021*. *Lecture Notes in Civil Engineering*, *250*, pp. 223–238. https://doi.org/10.1007/978-981-19-1065-4_19

2.50. Title: Assessing the Potential and Pathways for Renewable Energy Transformations in Orleans, California

Author(s): Moncheur de Rieudotte, M.P.

Abstract: In what is now known as the state of California in the United States, the Karuk Tribe is interested in deploying a renewable-powered microgrid in the rural community of Orleans to improve electricity system reliability and resilience to address a wide range of challenges, including extreme events such as wildfires. This study assesses the potential of local distributed renewable energy and battery storage to meet Orleans' energy needs today and in the increasingly electrified future using an energy model. It also identifies existing cultural and social priorities for energy technology along with structural barriers to renewable energy adoption and the decarbonization of transportation and water heating from interviews with community members.

Many, but not all community members we interviewed find their electric service unreliable, do not trust PG&E or their bills, and are interested in alternative sources of energy. However, the high upfront costs of renewables and lack of local contractors can lower the priority of adoption. Keeping food from expiring during blackouts is a key concern for study participants, in part because the lack of nearby affordable grocery stores means households own several fridges / freezers to store groceries and culturally important foods.

Given existing demand, solar resource, land area, and available funding, the community of Orleans is well suited for renewable-powered microgrid development. Depending on the extent of electrification, a renewable-powered microgrid in Orleans with implementation costs ranging from $12 million to $15 million could provide up to 21 days of autonomy when islanded and reduce community-wide greenhouse gas emissions by up to 90 percent.

Subject Areas: Renewable energy; Microgrid; Rural community; Electricity system reliability and resilience; Decarbonization

Availability: Moncheur de Rieudotte, M.P. (2022). *Assessing the Potential and Pathways for Renewable Energy Transformations in Orleans, California*. Master's Thesis, California State Polytechnic University, Humboldt, Arcata, CA.
https://digitalcommons.humboldt.edu/cgi/viewcontent.cgi?article=1605&context=etd

2.51. Title: High-Frequency Ripple Injection Signals for the Effective Utilization of Residential EV Storage in Future Power Grids with Rooftop PV System

Author(s): Muttaqi, K.M., Rahman, O., Sutanto, D., Lipu, M.S.H., Abdolrasol, M.G.M., and Hannan, M.A.

Abstract: The electrification of the transport industry is expected to have a major impact on the operation of future distribution grids which includes overloading of components, voltage unbalance and power quality issues. This paper proposes a novel approach to utilize the ripple injection load control signals for the control of EV charging load, considering a large integration of PV systems in the grid. Currently, ripple injection signals are widely used by distribution network service providers (DNSPs) around the world for control of loads such as streetlights and hot water systems. Ripple Injection Signals or Audio Frequency Injection Control (AFIC) signals are the applications of a high-frequency signal superimposed on the 50/60 Hz supply. The proposed control will make use of the existing infrastructure and offers a viable solution where a smart grid solution is not available. AFIC signals can be encoded in binary to carry different information which can be used to set the maximum allowable charging rate of future charging stations or activate the Vehicle-to-Grid (V2G) mode when necessary. This provides a method to control the EV load depending on the stochastic nature of a future grid. A multimode energy management algorithm has been proposed depending on the load consumption of a particular substation. A power flow simulation study has been used to demonstrate the efficacy of the proposed method.

Subject Areas: Ripple injection signals; Audio frequency injection control signals; Load control; Electric vehicle; Vehicle-to-grid; Load modeling; Electric vehicle charging; Batteries; Voltage control; Costs; Substations

Availability: Muttaqi, K.M., Rahman, O., Sutanto, D., Lipu, M.S.H., Abdolrasol, M.G.M., and Hannan, M.A. (2022). "High-Frequency Ripple Injection Signals for the Effective Utilization of Residential EV Storage in Future Power Grids with Rooftop PV System." *IEEE Transactions on Industry Applications*, *58*(5), pp. 6655–6665. https://doi.org/10.1109/TIA.2022.3180985

2.52. Title: Data-Driven Energy Management in Residential Areas Leveraging Demand Response

Author(s): Wang, P., Ma, Z., Shao, M., Zhao, J., Srinivasan, D., Zou, S., and Wang, G.

Abstract: A distributed data-driven coordinated design is proposed to achieve efficient energy management of a residential grid, where controllable distributed resources such as electric vehicles (EVs) and thermostatically controlled loads (TCLs) are adjusted by balancing the end-use electricity cost, charging preference, and thermal comfort. The motivation for the control pattern is to minimize the total system cost by directly utilizing the measured input–output data instead of intractable model identification and state estimation. Firstly, we formulate a data based optimization problem with persistently exciting data sets and show the equivalence with the model-based problem. To protect the privacy of each consumer, we design a distributed pattern by the gradient of the augmented Lagrangian such that TCLs and EVs implement demand response individually. Moreover, the proposed algorithm is enhanced by a receding control scheme to tackle the uncertainties in the predictions. Standard test systems are used to illustrate the proposed design and demonstrate its effectiveness and benefits in the residential community.

Subject Areas: Energy management; Data-driven approach; Distributed control; Residential area; Demand response

Availability: Wang, P., Ma, Z., Shao, M., Zhao, J., Srinivasan, D., Zou, S., and Wang, G. (2022). "Data-Driven Energy Management in Residential Areas Leveraging Demand Response." *Energy and Buildings*, *269*. https://doi.org/10.1016/j.enbuild.2022.112235

2.53. Title: Reliability and Stability Assessment of Renewable Energy and Energy Storage Integrated Systems

Author(s): Pandit, D.

Abstract: The integration of renewable energy resources into power systems is increasing globally because of the inherent advantages of unlimited supply and negligible emissions. Decreasing capital costs and increasing efficiency have been the major drivers in the growing integration of renewable energy resources (RERs). With the projected increase in RER integration and the associated displacement of high-inertia conventional generators, there are concerns over their negative effects on the reliability and stability of power grids. The displacement of conventional sources by RERs must be limited to ensure frequency stability, which in turn affects the system reliability. Hence, with the growing integration of RERs, accurate reliability models are essential that consider limited integration of RERs along with the generation intermittency and variable component availability associated with RERs. The energy storage systems (ESS) and electric vehicles (EVs) have emerged as mitigation measures to the reliability and stability problems due to RER integration. Their growing integration dictates their inclusion in the reliability and frequency stability assessment problem.

This research proposes analytical and Monte Carlo simulation (MCS) based reliability assessment techniques for RER integrated systems, with an emphasis on the photovoltaic (PV) and wind systems. A discrete convolution-based analytical model is proposed that incorporates a thermal power loss model to account for the varying availability of PV array components. Also, the model incorporates a PV power integration limit to account for frequency stability. Improvement in system reliability using wind power, ESS, and EVs is illustrated using MCS-based reliability models for these components. The operation strategy for ESS and EVs includes a dynamic PV integration level assessment technique where the maximum PV power penetration is determined with changing system states and included in the reliability assessment problem. In regard to ESS sizing, an analytical model for the inertia response and primary frequency reserve is proposed based on system frequency nadir, rate of change of frequency (RoCoF), and steady-state frequency with varying RER integration. A mixed-timing MCS-based ESS sizing algorithm is also proposed that incorporates frequency stability and wind power aggregation in the estimation of ESS size.

Subject Areas: Renewable energy resources; Electric vehicles; Energy storage systems; Rate of change of frequency; Monte Carlo simulation

Availability: Pandit, D. (2022). *Reliability and Stability Assessment of Renewable Energy and Energy Storage Integrated Systems*. Master's Thesis, University of Wyoming, Laramie, WY. https://www.proquest.com/openview/5af6ea5c653db2a351033b558fa281c3/1?pq-origsite=gscholar&cbl=18750&diss=y

2.54. Title: Energy Superabundance: How Cheap, Abundant Energy Will Shape Our Future

Author(s): Vernon, A. and Dourado, E.

Abstract: In this policy paper, authors Austin Vernon and Eli Dourado explore what life would be like with endless energy. Coining the term "energy superabundance," they look at energy policy, not in the usual sense of trying to restrict energy consumption, but as a way to promote energy abundance—a future in which energy is so clean and plentiful, limiting consumption would be entirely unnecessary.

Though energy may never be "too cheap to meter," Vernon and Dourado explain that higher energy consumption directly increases economic growth. Achieving energy superabundance would radically improve the US economy as well as the quality of life for all Americans. They show us a vision of the future that includes flying cars, hyperloop, sub-orbital point-to-point travel, electric autonomous trucking, vertical farming, water-from-air condensation, water desalination, and so much more.

In this research-based vision, cities are no longer limited by access to ground transportation. Plastics and cement are made from air, water, and electricity. Vernon and Dourado even predict a carbon shortage.

This future is only possible if we remove the many obstacles standing in the way of building new infrastructure. New power plants, transmission lines, transportation infrastructure, and better energy technology are all being held back by red tape that stops us from building a better future. This paper will help us show policymakers and thought leaders what is possible if we are able to reform our policies and reclaim a future of superabundant energy and prosperity.

Subject Areas: Energy superabundance; Energy consumption; Economic growth; Carbon shortage; Energy technology; Infrastructure

Availability: Vernon, A. and Dourado, E. (2022). *Energy Superabundance: How Cheap, Abundant Energy Will Shape Our Future*. Policy Paper, The Center for Growth and Opportunity, Utah State University, Logan, UT. https://www.thecgo.org/wp-content/uploads/2022/06/Energy-Superabundance.pdf

2.55. Title: On Optimal Charging Scheduling for Electric Vehicles with Wind Power Generation

Author(s): Wu, J. and Jia, Q.-S.

Abstract: We consider the scheduling of battery charging of electric vehicles (EVs) integrated with renewable power generation. The increasing adoption of EVs and the development of renewable energies contribute importance to this research. The optimization of charging scheduling is challenging because of the large action space, the multi-stage decision making, and the high uncertainty. To solve this problem is time-consuming when the scale of the system is large. It is urgent to develop a practical and efficient method to properly schedule the charging of EVs. The contribution of this work is threefold. First, we provide a sufficient condition on which the charging of EVs can be completely self-sustained by distributed generation. An algorithm is proposed to obtain the optimal charging policy when the sufficient condition holds. Second, the scenario when the supply of the renewable power generation is deficient is investigated. We prove that when the renewable generation is deterministic there exists an optimal policy which follows the modified least laxity and longer remaining processing time first (mLLLP) rule. Third, we provide an adaptive rule-based algorithm which obtains a near-optimal charging policy efficiently in general situations. We test the proposed algorithm by numerical experiments. The results show that it performs better than the other existing rule-based methods.

Subject Areas: Electric vehicle; Charging scheduling; Wind power; Optimal policy; Renewable energy

Availability: Wu, J. and Jia, Q.-S. (2022). "On Optimal Charging Scheduling for Electric Vehicles with Wind Power Generation." *Fundamental Research*. https://doi.org/10.1016/j.fmre.2022.04.023

2.56. Title: EVI-Equity: Electric Vehicle Infrastructure for Equity Model

Author(s): Lee, D.-Y.

Abstract: NREL's Electric Vehicle Infrastructure for Equity (EVI-Equity) model evaluates the environmental justice, energy justice, and energy equity of the nationwide electric vehicle (EV) charging infrastructure using comprehensive, high-resolution analysis.

Subject Areas: Electric vehicle charging; Charging infrastructure; Electric vehicle adoption; Equity

Availability: Lee, D.-Y. (2022). *EVI-Equity: Electric Vehicle Infrastructure for Equity Model*. Presentation, Transportation and Mobility Research, National Renewable Energy Laboratory, Washington, D.C. https://www.nrel.gov/transportation/evi-equity.html

2.57. Title: Coordinated Multi-Objective Scheduling of a Multi-Energy Virtual Power Plant Considering Storages and Demand Response

Author(s): Olanlari, F.G., Amraee, T., Moradi-Sepahvand, M., and Ahmadian, A.

Abstract: A virtual power plant (VPP) is a solution that brings distributed generation (DG) resources together and allows them to be optimally utilized to meet load demands in the presence of technical and pollution constraints. Electricity, heat, and natural gas are interdependent at the levels of generation, transmission, and consumption, and the interactions of these energy sources need to be considered. This paper presents an optimal model for daily operation of a multi-energy virtual power plant (MEVPP), including electric, thermal, and natural gas sectors. MEVPP includes small-scale gas-fired and non-gas-fired DGs, combined heat and power (CHP), power to gas (P2G), boilers, electrical storage, electric vehicles (EV), and thermal storage. Renewable energy resources (RES), including wind turbines (WT), photovoltaic (PV), and PV-thermal (PVT), also supply P2G technology. Smart grid technologies such as price-based demand response (PBDR) and incentive-based demand response (IBDR) are employed for electric loads. The proposed MEVPP model is eligible to participate in day-ahead electricity, natural gas, heat markets, and electrical spinning reserve market. The scheduling model is multi-objective to maximize MEVPP profit and minimize carbon dioxide emissions. The Epsilon constraint method is utilized to solve the problem, and the best Pareto point is chosen using the fuzzy satisfying approach.

Subject Areas: Virtual power plant; Distributed generation; Multi-energy virtual power plant; Electric vehicles; Renewable energy resources; Price-based demand response; Incentive-based demand response

Availability: Olanlari, F.G., Amraee, T., Moradi-Sepahvand, M., and Ahmadian, A. (2022). "Coordinated Multi-Objective Scheduling of a Multi-Energy Virtual Power Plant Considering Storages and Demand Response." *IET Generation, Transmission & Distribution*, *16*(17), pp. 3539–3562. https://doi.org/10.1049/gtd2.12543

2.58. Title: Stochastic Battery SOC Model of EV Community for V2G Operations Using CTA-2045 Standards

Author(s): Gong, H., Alden, R.E., and Ionel, D.M.

Abstract: An electric vehicle (EV) battery has large energy storage capacity in the context of residential total usage, and the potential to provide large energy reserves for Home energy Management (HEM) systems. In an electric distribution system, groups of EVs could provide vehicle-to-grid (V2G) service in response to control signals and enable virtual power plant (VPP) operation of the car batteries. The CTA-2045 standards were considered for integration of the EV controls into the HEM system for maximal interoperability with other appliances, such as residential battery, electric water heater, and heating, ventilation, and air conditioning (HVAC) system. The power distribution system under study was modeled based on a modified IEEE 123-bus feeder test case in OpenDSS software. The availability and state of charge (SOC) of EVs were calculated based on the national household travel survey (NHTS) data following a new procedure to create synthetic communities following experimental probability density functions (PDFs). Example case studies for long- and short-term V2G services were completed in this paper from the perspective of the distribution system. The power flow for the distribution system, the voltages on the buses, as well as the SOCs and available energies of the EVs were calculated following the control signals on an example day.

Subject Areas: Electrical vehicle; Virtual power plant; Vehicle-to-Grid; CTA-2045; Stochastic; IEEE 123-bus; Electric power distribution; Home energy management; OpenDSS

Availability: Gong, H., Alden, R.E., and Ionel, D.M. (2022). "Stochastic Battery SOC Model of EV Community for V2G Operations Using CTA-2045 Standards." *2022 IEEE Transportation Electrification Conference & Expo (ITEC)*, pp. 1144–1147. https://doi.org/10.1109/ITEC53557.2022.9813889

2.59. Title: EV Penetration Impact Analysis on Transmission System Using Co-Simulation

Author(s): Yusuf, J., Hasan, A.S.M.J., and Ula, S.

Abstract: The recent advancement of Distributed Energy Resources (DERs) has escalated their integrations behind the meter and into the power system. The impacts of DERs on the transmission system while coupled with the distribution system are required to be investigated to assess their roles thoroughly. Electric Vehicles (EVs) being one of the widely adopted DERs at the customer end has been making the task of maintaining the regular peak demand in a distribution feeder more challenging and affecting the transmission system as well. This paper utilizes the Transmission and Distribution (T&D) co-simulation approach to analyze the EV integration impacts on the transmission system. An iterative co-simulation approach is deployed and the EPRI distribution feeder ckt-24 is integrated with the IEEE 9-bus transmission system to study the EV integration impacts on the transmission system. The analysis is carried out for uncoordinated EV charging activities and different levels of EV penetration in the distribution feeder. Later on, distributed solar photovoltaic (PV) resources are also integrated to investigate their combined impacts. The results show that the voltage at the Point of Common Coupling (PCC) stays within the limit despite having maximum EV and PV penetration.

Subject Areas: Photovoltaic systems; Meters; Couplings; Voltage; Electric vehicle charging; Power systems; Distributed power generation

Availability: Yusuf, J., Hasan, A.S.M.J., and Ula, S. (2022). "EV Penetration Impact Analysis on Transmission System Using Co-Simulation." *2022 IEEE Transportation Electrification Conference & Expo (ITEC)*, pp. 1154–1158. https://doi.org/10.1109/ITEC53557.2022.9814058

2.60. Title: Frequently Asked Questions: Electric Vehicles (EVs)

Author(s): Folger, M.

Abstract: Blog.

Subject Areas: Electric vehicles; Plug-in hybrid vehicles; Hybrid vehicles; Costs; Range; Charging; Environmental impact; Hydrogen fuel cells

Availability: Folger, M. (2022). "Frequently Asked Questions: Electric Vehicles (EVs)." *Environment America*. https://environmentamerica.org/resources/frequently-asked-questions-electric-vehicles-evs/

2.61. Title: How Much Are High Gas Prices Affecting the Upper Midwest?

Author(s): Montgomery, D.H.

Abstract: Blog.

Subject Areas: Gasoline prices; Gasoline usage; Upper Midwest; Household income

Availability: Montgomery, D.H. (2022). "How Much Are High Gas Prices Affecting the Upper Midwest?" *Federal Reserve Bank of Minneapolis*. https://www.minneapolisfed.org/article/2022/how-much-are-high-gas-prices-affecting-the-upper-midwest

2.62. Title: Coupled Dispatching of Regional Integrated Energy System Under an Electric-Traffic Environment Considering User Equilibrium Theory

Author(s): Wei, W., Xu, L., Xu, J., Liu, C., Jiang, X., and Liao, K.

Abstract: With large-scale electric vehicles (EVs) connected to the distribution network, the charging demand of EVs aggravates the peak-to-valley difference, which brings massive pressure to the power system. How to environmentally optimize the system considering the features of EVs' charging demand has become a mainstream issue. To tackle this challenge, a low carbon economic dispatch model for the integrated energy system is proposed under an electric-traffic environment based on user equilibrium (UE) theory. This model considers carbon emission and multiple energy demand responses. First, to optimize the spatio-temporal distribution of the EV charging demand, a semi-dynamic traffic assignment (SDTA) model is constructed. This model considers vehicle travel, road congestion, and the influence of traffic flow in one interval to guide EVs to select an optimal route. Then, for reducing the carbon emission and promoting the reliability of the integrated energy system, a ladder carbon trading model and a demand response model for three different types of loads are proposed. Finally, a co-optimization system of traffic network, distribution network, and natural gas network is employed to illustrate the validity of the proposed model. The proposed model is demonstrated on the regional integrated energy system (RIES). The simulation results show that the peak-to-valley difference can be obviously relieved by introducing the SDTA model. In the meantime, via reasonable dispatching of the carbon trading, demand response, and vehicle-to-grid (V2G) service, the multiple energy demands can be alleviated, ensuring the low carbon and economical operation of the RIES.

Subject Areas: Integrated energy system; EV; Low carbon economic dispatch; User equilibrium

Availability: Wei, W., Xu, L., Xu, J., Liu, C., Jiang, X., and Liao, K. (2022). "Coupled Dispatching of Regional Integrated Energy System Under an Electric-Traffic Environment Considering User Equilibrium Theory." *Energy Reports*, *8*, pp. 8939–8952. https://doi.org/10.1016/j.egyr.2022.07.008

2.63. Title: Review of Load Modelling and Scheduling Strategy for Orderly Charging of Electric Vehicles

Author(s): Huang, J. and Zhou, B.

Abstract: With the vigorous promotion of electric vehicles, the burden brought by the irregular charging of large-scale loads to the power grid is becoming increasingly prominent. Therefore, it is necessary to study the orderly charging strategy of electric vehicles. This paper briefly describes the advantages of orderly charging of electric vehicles, introduces several types of calculation methods of charging loads, summarizes different scheduling strategies and their advantages and disadvantages, and finally puts forward some suggestions for further research.

Subject Areas: Electric vehicles; Charging strategies; Charging loads

Availability: Huang, J. and Zhou, B. (2022). "Review of Load Modelling and Scheduling Strategy for Orderly Charging of Electric Vehicles." *Journal of Physics: Conference Series*, *2301*. https://iopscience.iop.org/article/10.1088/1742-6596/2301/1/012016

2.64. Title: Power Exchanging of a VPP with Its Neighboring VPPs and Participating in Day-Ahead and Spinning Reserve Markets

Author(s): Dehghanniri, M.F., Golkar, M.A., and Olanlari, F.G.

Abstract: The virtual power plant (VPP) is a concept that aggregates various distributed energy resources (DERs) and allows them to participate in different wholesale markets. This article presents an optimal operation of two VPPs connected by transmission lines. The VPPs consist of combined heat and power (CHP), renewable units such as wind turbines, photovoltaic (PV) power plants, diesel generators, electrical and thermal storages, electric vehicles, and controllable and uncontrollable loads. In addition to exchanging power with each other, the mentioned VPPs can also participate in electricity markets such as day-ahead (DA) and spinning reserve markets. Optimization is carried out using a mixed-integer linear programming (MILP) problem, considering network, generation units, electric vehicles, and demand responsive constraints all taken into account. The proposed method, also simulated on the IEEE 21-bus and 33-bus test network.

Subject Areas: Cogeneration; Virtual power plants; Electric vehicles; Behavioral sciences; Wind turbines; Smart grids; Spinning

Availability: Dehghanniri, M.F., Golkar, M.A., and Olanlari, F.G. (2022). "Power Exchanging of a VPP with Its Neighboring VPPs and Participating in Day-Ahead and Spinning Reserve Markets." *30th International Conference on Electrical Engineering (ICEE)*, pp. 336–340. https://doi.org/10.1109/ICEE55646.2022.9827339

2.65. Title: Event-Triggered Model Predictive Control for Dynamic Energy Management of Electric Vehicles in Microgrids

Author(s): Wu, C., Jiang, S., Gao, S., Liu, Y., and Han, H.

Abstract: The rapidly increasing charging demand of electric vehicles (EVs) represents a significant new load with myriad uncertainties. This paper proposes an event-triggered model predictive control (ET-MPC) method for dynamic energy management of EVs in microgrids (MGs). The study novelties lie in the forecasting models of EV status in an environment of MGs and the event-triggered mechanism for dynamic energy management of EVs. Firstly, the characteristics of EVs from different types of MGs are analysed by fitting the EV states with different probability distributions to improve the accuracy of forecasting of their status. Secondly, an ET-MPC method focusing on the energy management of EVs is first proposed to achieve coordination between the computational efficiency and optimisation impact of EVs. The event-triggered mechanism is achieved by monitoring the errors between the real EV states and their forecast values, which is only required to carry out optimisation when the forecast error of the EV states meet a set trigger level. Numerical simulations show that unlike time-triggered MPC methods—with long calculation times and fixed mechanisms—the ET-MPC method proposed achieves nearly the same energy management impact with a significantly shorter calculation overhead.

Subject Areas: Electric vehicle; Uncertainty; Event-triggered; Model predictive control; Microgrid

Availability: Wu, C., Jiang, S., Gao, S., Liu, Y., and Han, H. (2022). "Event-Triggered Model Predictive Control for Dynamic Energy Management of Electric Vehicles in Microgrids." *Journal of Cleaner Production*, *368*. https://doi.org/10.1016/j.jclepro.2022.133175

2.66. Title: A Three-Level Framework for Strategic Participation of Aggregated Electric Vehicle-Owning Households in Local Electricity and Thermal Energy Markets

Author(s): Zeynali, S., Nasiri, N., Ravadanegh, S.N., and Marzband, M.

Abstract: The impact of electric vehicles (EV) charging strategy will not be limited to power systems as integrated electricity, natural gas and thermal energy systems have become increasingly interconnected. We introduce a three-level framework for the aggregated electric vehicle-owning households (AEVH) to strategically participate in local electricity and thermal energy markets as a price-maker, while considering the strategic behavior of the integrated energy service provider (IESP) in the wholesale electricity market (WEM) also as a price-maker. The AEVH operator forms the first level, while IESP and WEM operators are integrated at the second and third levels, respectively. To solve the three-level problem, the second and third levels are modified as a single-level problem through the Karush–Kuhn–Tucker (KKT) conditions, and then the equilibrium point of the resulting single-level problem and the first level is achieved through two-step iterative method. At the first level, the arrival/departure time and daily traveled miles of EV fleets are modeled via stochastic scenarios, while renewable energy production at the second level is dealt with by information gap decision theory (IGDT). Ultimately, different case studies verify that AEVHs can deploy their thermal flexibility together with the smart charging strategy of the EVs to influence the local electricity, thermal energy and even WEM prices. Using the proposed three-level optimization framework reaches the best point of equilibrium between different market players. The outcomes prove the effectiveness of the proposed model. Based on the results, the AEVH can deploy the proposed model to diminish the WEM price by 2.1%, while the local electricity price was dropped by 18.85%. Furthermore, the thermal energy price was reduced by 5.82%, which illustrates that EVs can influence the thermal energy market through the combined heat and power units.

Subject Areas: Electric vehicles; Thermal energy market; Strategic scheduling; Three-level optimization; Wholesale electricity market; Local electricity market

Availability: Zeynali, S., Nasiri, N., Ravadanegh, S.N., and Marzband, M. (2022). "A Three-Level Framework for Strategic Participation of Aggregated Electric Vehicle-Owning Households in Local Electricity and Thermal Energy Markets." *Applied Energy*, *324*. https://doi.org/10.1016/j.apenergy.2022.119749

2.67. Title: Incentivizing Alternative Fuel Vehicle Transactions: Analysis of Cash-for-Clunkers Transactions for New Alternative Fuel Vehicles

Author(s): Zolnik, E.

Abstract: Monetary incentives to accelerate the transition of private vehicle fleets to zero emissions promote sustainability in the transportation sector. Clean Cars for America to incentivize transactions for new battery power vehicles is a program in furtherance of sustainable transportation goals in the United States. Unfortunately, data on transactions for new alternative fuel vehicles (AFVs) are scarce so empirical research to explore the costs and/or the benefits of such programs is also scarce. Analysis of transactions for new AFVs from a past, national vehicle retirement program known as Cash for Clunkers provides a rare glimpse into the economic costs and into the environmental benefits of monetary incentives. Analysis of transactions for new AFVs also provides an empirical context for a future, national retirement program such as Clean Cars for America. To that end, the analysis estimates Greenhouse Gas (GHG) emission reduction from a subsample of Cash-for-Clunkers transactions for new AFVs. Overall, incentivizing AFV transactions effectively decreases GHG emissions though regional differences may necessitate dynamic, rather than static, voucher amounts so as to harmonize such differences.

Subject Areas: Private vehicle retirement; Alternative fuel vehicles; Greenhouse gas emissions; Private vehicle usage; Rebound effect; Multilevel model

Availability: Zolnik, E. (2022). "Incentivizing Alternative Fuel Vehicle Transactions: Analysis of Cash-for-Clunkers Transactions for New Alternative Fuel Vehicles." *Journal of Energy and Power Technology*, *4*(3). http://dx.doi.org/10.21926/jept.2203026

2.68. Title: Multi-Objective Economic Emission Dispatch of Thermal Power-Electric Vehicles Considering User's Revenue

Author(s): Qiao, B., Liu, J., and Huan, J.

Abstract: In recent years, the rapid development of electric vehicles has increased the load power system and brought new challenges to the safe and stable operation of the gird. Although the vehicle-to-grid technology can reduce the load that electric vehicles put on the grid, without any incentives, electric vehicle owners are more inclined not to use vehicle-to-grid services. In this paper, therefore, a new dynamic economic emission model based on electric vehicles (DEED_EV) is proposed to maximize the electric vehicle user's revenue, as well as minimize the fuel cost and emission of the thermal power unit. In the DEED_EV model, the stochastic of electric vehicles' users' travel and wear of the battery, as well as some constraints such as electric vehicles' charging/discharging rate and status, electric vehicles remain power, electric vehicles travel power capacity, ramp limits, up and down reserves, and the system balance are considered. To solve the DEED_EV model, a multi-objective evolutionary algorithm based on decomposition with a step-by-step constraint handling strategy is developed. Different test cases based on the 10-unit are simulated to verify the proposed model and method. The results show that the DEED_EV model not only encourages more electric vehicles to plug into the grid but also reduces the fuel cost and emission of the thermal power unit. Besides, the electric vehicles in the DEED_EV completely realize the peak shaving and valley filling of the load.

Subject Areas: Dynamic power system dispatching; Electric vehicles; Multi-objective optimization; User's revenue

Availability: Qiao, B., Liu, J., and Huan, J. (2022). "Multi-Objective Economic Emission Dispatch of Thermal Power-Electric Vehicles Considering User's Revenue." *Soft Computing*, *26*, pp. 12833–12849. https://doi.org/10.1007/s00500-022-07297-0

2.69. Title: Improving the Effectiveness and Equity of Fuel Economy Regulations with Sales Adjustment Factors

Author(s): Ou, S. et al.

Abstract: Larger vehicles, such as sports utility vehicles, consume more energy than cars. Their increasing popularity runs contrary to the goal of fuel economy regulations to reduce fossil fuel consumption and greenhouse gas emissions and can be explained by consumer preference and lower regulation stringency, which is due to footprint, truck classification, and the omission of heterogenous lifetime vehicle distance traveled among vehicle classes. This study shows that, for both the US and China, large vehicles travel more, last longer, and are owned by higher income consumers. This means large vehicles and their high-income owners use more fuel and emit more pollutants than represented by current policy and thus raise both policy effectiveness and energy equity concerns. We propose and estimate Sales Adjustment Factors that weigh fuel economy standards based on vehicle lifetime usage and demonstrate the resultant significant improvements in the effectiveness and equity of fuel economy regulations.

Subject Areas: Energy resources; Energy policy; Energy management; Energy modeling; Energy transportation

Availability: Ou, S. et al. (2022). "Improving the Effectiveness and Equity of Fuel Economy Regulations with Sales Adjustment Factors." *iScience*, *25*(9). https://doi.org/10.1016/j.isci.2022.104902

2.70. Title: Mapping Electric Vehicle Impacts: Greenhouse Gas Emissions, Fuel Costs, and Energy Justice in the United States

Author(s): Vega-Perkins, J.

Abstract: The impact of the electric vehicle (EV) transition on household transportation energy burdens (i.e., percentage of income spent on vehicle fuels) in the U.S. is not well known. This study addresses this gap by comparing EVs to internal combustion engine vehicles (ICEVs) in terms of greenhouse gas emissions (GHGs), fuel costs, and transportation energy burden. The results indicate that over 90% of U.S. households (measured by census tract) would see some savings in both GHGs and energy burden by adopting an EV and for 60% of U.S. households these savings would be moderate to high. Savings are especially pronounced in the American West (e.g., California, Washington) and parts of the Northeast (e.g., New York) primarily due to a varying combination of cleaner electricity grids, lower electricity prices (relative to gas prices), and smaller drive-cycle and temperature-related impacts on fuel efficiency. Moreover, adopting an EV would more than double the percentage of households that have low transportation energy burdens (less than 2% of income spent on fuel annually) which equates to 80% of all U.S. households. Despite significant reductions of energy burdens in most cases, over half of the lowest income households would have high EV energy burdens (greater than 4% income spent on fuel annually), and over three quarters would have high EV energy burdens if at-home charging is unavailable. Addressing this requires targeted policies to promote energy justice in lower-income communities, including subsidizing charging infrastructure, strategies to reduce electricity costs, and increasing the availability of low-carbon transport modes (e.g., public transit, biking, and car sharing).

Subject Areas: Electric vehicles; Decarbonization; Greenhouse gas emissions; Energy justice; Transportation energy burden

Availability: Vega-Perkins, J. (2022). *Mapping Electric Vehicle Impacts: Greenhouse Gas Emissions, Fuel Costs, and Energy Justice in the United States*. Master's Thesis, University of Michigan, Ann Arbor, Michigan. https://dx.doi.org/10.7302/5835

2.71. Title: Multi-Time Scale Electric Vehicle Charging Load Forecasting Considering Constant Current Charging and Parallel Computing

Author(s): Bian, H., Guo, Z., Zhou, C., and Peng, S.

Abstract: At present, the concept of ecological civilization has been widely recognized by the whole world, and a series of policies that guarantees the evolution of the electric vehicle (EV) industry has been implemented by multiple countries. Therefore, it is significant to predict the charging load of EVs to solve the challenges of power system planning and operation. The Monte Carlo (MC) method is preferred by many scholars in EV charging load prediction because it is very suitable for describing random characteristics with a good prediction effect. To obtain more reliable and efficient prediction results, this paper analyzes the application of parallel computing technology in MC simulation. Firstly, EVs in the region are classified according to their battery capacity. Based on the voltage change curve of lithium-ion power batteries in the process of constant current charging under different capacities, the charging power, charging time, and state of charge (SOC) of EVs are investigated. Secondly, the behavior characteristics of users and the driving parameter characteristics of EVs are studied respectively, and the probability distribution model of multi-source information is established. Thirdly, parallel computing technology in the computer field is introduced, and an improved MC method is proposed based on the multi-core CPU architecture. After fully considering the complex constant current charging process after fitting, the charging load of EVs in a region of East China is simulated. Finally, the time cost and the load forecasting results of serial and parallel methods are compared and analyzed, and the progressiveness and effectiveness of the parallel method are verified. Results show that the charging load has four peaks in a day, taxis are the main source of the peak load of the power grid, the charging load of buses fluctuates the most, and private cars are the main backup capacity to participate in V2G dispatching in the future. In addition, under the experimental conditions set in this paper, compared with the traditional serial MC method, the improved MC method based on parallel computing shows good performance with the acceleration effect improved by 7 to 12 times.

Subject Areas: Load forecasting; Constant current charging process; Electric vehicle; Monte Carlo method; Parallel computing

Availability: Bian, H., Guo, Z., Zhou, C., and Peng, S. (2022). “Multi-Time Scale Electric Vehicle Charging Load Forecasting Considering Constant Current Charging and Parallel Computing.” *Energy Reports*, *8*(13), pp. 722–732. https://doi.org/10.1016/j.egyr.2022.08.034

2.72. Title: Clean Energy Transition for Transportation Systems: Modeling Implications

Author(s): Muratori, M.

Abstract: Transportation is currently the least-diversified energy demand sector, with over 90% of energy use coming from petroleum. As a result, transportation recently became the largest source of GHG emissions in the U.S. and mobility needs for passengers and freight are growing rapidly. However, after over a century of petroleum dominance, new disruptive technologies and business models offer a pathway to decarbonize the sector. Transportation is at a turning point. On the horizon lies a future where affordable and abundant renewable electricity can be used to power cost-competitive battery electric vehicles (EVs) and produce energy-dense low-carbon fuels enabling to fully decarbonize transportation systems across all modes. Exploring the clean energy transition for the multitude of different transportation systems requires new analytical modeling and approaches. This talk reviewed current work at the National Renewable Energy Laboratory (NREL) to develop and use innovative tools and analytics approaches to inform the transformation to a sustainable mobility future and the integration of transportation systems with the broader energy sector.

Subject Areas: Clean energy transition; Decarbonization; Sustainability; Energy use; Vehicle electrification

Availability: Muratori, M. (2022). *Clean Energy Transition for Transportation Systems: Modeling Implications*. Conference Presentation, National Renewable Energy Laboratory, Golden, CO. https://www.osti.gov/servlets/purl/1882674

2.73. Title: Increasing the Penetration of Electric Vehicles in Distribution Networks Using Optimal Charging/Discharging Control and Reactive Power Support in the Presence of Nonlinear Loads

Author(s): Partovi, M., Esmaeili, S., and Aein, M.

Abstract: Electrical vehicles (EVs) are among the fastest-growing electrical loads that change both temporally and spatially on distribution networks. The large-scale integration of EVs equipped with power electronic-based chargers into distribution networks, to meet new electrical load demands, can cause instability and power quality issues. Moreover, the absence of control strategies for the smart charging and discharging of EVs at their plug-in intervals poses serious challenges to them. Accordingly, the implementation of controlled charging/discharging scheduling of EV batteries along with the use of charger capabilities, such as reactive power support, is a must. Against this background, this paper introduces an integrated model to solve the problem of simultaneous active and reactive power management in distribution networks subject to network operation constraints imposed by EV batteries and chargers. To this end, this problem is modeled as an optimization problem. In this respect, minimization of the costs associated with power generation and losses and improvement of the total harmonic distortion of voltage (THDv) on network buses are two terms of the objective function. The problem is solved by a hybrid technique named the "PSO-GA algorithm" that takes advantage of both the genetic algorithm (GA) and the particle swarm optimization (PSO) method. Accordingly, the effectiveness of the proposed model is examined in a standard IEEE 33-bus distribution network populated with EVs and non-linear devices (NLDs). The results obtained show that the maximum possible penetration rate of EVs into the network is facilitated, while technical and financial goals of the network and parking lots are ensured.

Subject Areas: Electrical vehicles; Distribution networks; Optimization; Genetic algorithm; Particle swarm optimization; Charging/Discharging Control; Reactive power support; Nonlinear devices

Availability: Partovi, M., Esmaeili, S., and Aein, M. (2022). "Increasing the Penetration of Electric Vehicles in Distribution Networks Using Optimal Charging/Discharging Control and Reactive Power Support in the Presence of Nonlinear Loads." *International Transactions on Electrical Energy Systems*, *2022*. https://doi.org/10.1155/2022/3838113

2.74. Title: Coordinated Scheduling for Multi-Microgrid Systems Considering Mobile Energy Storage Characteristics of Electric Vehicles

Author(s): Wu, C., Han, H., Gao, S., and Liu, Y.

Abstract: Because of the rapid development of electric vehicles (EVs), the energy management of multi-microgrid (MMG) systems has attracted considerable research attention. The objective of this study is to coordinate scheduling performance for MMG systems under large-scale EV operations. To address the problem that the calculation time increases exponentially with the scale of EVs, a clustering algorithm was proposed to speed up the solving efficiency of the coordinated scheduling of MMG systems. To address the problem of the departure and arrival times of clustering EV crossover among various MGs, the proposed clustering algorithm set the boundary of the parking period of clustering EVs by maximizing their controllable time in various MGs. The coordinated scheduling strategy of MMG systems was executed considering the charging cost of EVs, the optimization of transmission power curves, and the absorption of renewable energy. The simulation results revealed that by fully utilizing the mobile energy storage characteristics of EVs, the performance of MMG systems can be maximized. Meanwhile, the computing efficiency of coordinated scheduling can be considerably improved in the case of large-scale EVs integrated into MMG systems by using the proposed clustering algorithm.

Subject Areas: Coordinated scheduling; Electric vehicles; Energy management; Mobile energy storage; Multi-microgrid systems; Clustering algorithms; State of charge; Costs; Renewable energy sources; Optimization

Availability: Wu, C., Han, H., Gao, S., and Liu, Y. (2022). "Coordinated Scheduling for Multi-Microgrid Systems Considering Mobile Energy Storage Characteristics of Electric Vehicles." *IEEE Transactions on Transportation Electrification (Early Access)*. https://doi.org/10.1109/TTE.2022.3201033

2.75. Title: Charging Infrastructure Access and Operation to Reduce the Grid Impacts of Deep Electric Vehicle Adoption

Author(s): Powell, S., Cezar, G.V., Min, L., Azevedo, I.M.L., and Rajagopal, R.

Abstract: Electric vehicles will contribute to emissions reductions in the United States, but their charging may challenge electricity grid operations. We present a data-driven, realistic model of charging demand that captures the diverse charging behaviours of future adopters in the US Western Interconnection. We study charging control and infrastructure build-out as critical factors shaping charging load and evaluate grid impact under rapid electric vehicle adoption with a detailed economic dispatch model of 2035 generation. We find that peak net electricity demand increases by up to 25% with forecast adoption and by 50% in a stress test with full electrification. Locally optimized controls and high home charging can strain the grid. Shifting instead to uncontrolled, daytime charging can reduce storage requirements, excess non-fossil fuel generation, ramping, and emissions. Our results urge policymakers to reflect generation-level impacts in utility rates and deploy charging infrastructure that promotes a shift from home to daytime charging.

Subject Areas: Charging demand; Charging behavior; Power grid; Future adoption

Availability: Powell, S., Cezar, G.V., Min, L., Azevedo, I.M.L., and Rajagopal, R. (2022). "Charging Infrastructure Access and Operation to Reduce the Grid Impacts of Deep Electric Vehicle Adoption." *Nature Energy*, *7*, pp. 932–945. https://doi.org/10.1038/s41560-022-01105-7

2.76. Title: Electric Vehicles and Smart Grid Integration: Analysis of Battery Degradation Cost

Author(s): Egbue, O., Naidu, D.S., and Uko, C.

Abstract: Batteries of plug-in electric vehicles (PEVs) can be used in vehicle-to-grid (V2G) systems for controlled bidirectional power flow between the vehicles and the power grid. Some benefits of V2G include the use of PEVs to provide ancillary services to the grid. However, there are concerns about PEV use for these services, particularly about the degradation of vehicle batteries due to frequent charging and discharging. In this study, a model is used to calculate the total cost of battery degradation for a significant number of vehicles as a result of V2G. Battery degradation is considered to be caused by cycling aging because this type of aging occurs during the V2G process. Simulation is conducted to determine how the battery degradation cost changes based on competing objectives. This study demonstrates the importance of considering PEV battery health during V2G operation and shows how battery degradation can be affected by the different objectives of the aggregator and PEV owners.

Subject Areas: Vehicle-to-grid; Electric vehicles; Battery degradation; Smart grid; Optimization; Costs; Bidirectional power flow; Aging; Control systems

Availability: Egbue, O., Naidu, D.S., and Uko, C. (2022). "Electric Vehicles and Smart Grid Integration: Analysis of Battery Degradation Cost." *2022 7th International Conference on Smart and Sustainable Technologies (SpliTech)*, pp. 1–4. https://doi.org/10.23919/SpliTech55088.2022.9854357

2.77. Title: A Joint Planning Method of Charging Piles and Charging-Battery Swapping Stations Considering Spatial-Temporal Distribution of Electric Vehicles

Author(s): Zhang, L., Huo, R., Cai, G., Hai, K.L., Lyu, L., and Wang, P.

Abstract: With the rapid popularization of electric vehicles (EVs), more charging and swapping facilities are needed to provide services. However, a single type of charging and battery swapping facilities cannot conveniently and rapidly meet the power supply demands of different types of vehicles at the same time. In order to solve this problem, a joint planning method of charging piles and charging-battery swapping stations (CBSSs) is proposed in this paper. In this method, the influence of geospatial constraints on the layout scale of charging piles is considered, and the Monte Carlo simulation method is used to predict the spatial-temporal distribution of charging and battery swapping demands of private electric vehicles (PEVs) and the battery swapping demands of taxi electric vehicles (TEVs), respectively. On this basis, the layout scale of charging piles of each functional area is determined during the maximum charging demand period in a day to meet the demands of PEVs for charging convenience. Then, an operating state model of CBSSs is established for calculation of the objective function. At the same time, a planning model of CBSSs is established to minimize the annual social comprehensive cost, which takes into account the economy of CBSSs and the battery swapping convenience of EVs. The planning of CBSSs can meet the demands of TEVs and some PEVs for a rapid power supply. Finally, taking an urban transportation network of Changchun and IEEE 33-node system as a case, the planning of charging piles and CCBSs in direct charging mode and peak shifting mode are simulated and analyzed. The simulation results show that the proposed method can make PEVs and TEVs obtain convenient and rapid power supply, and the planning result of CBSSs in direct charging mode is more economical, while peak shifting mode is more conducive to the safe operation of distribution network.

Subject Areas: Electric vehicle; Charging piles; Charging-battery swapping station; Joint planning; Spatial-temporal distribution of the charging; Battery swapping demands

Availability: Zhang, L., Huo, R., Cai, G., Hai, K.L., Lyu, L., and Wang, P. (2022). "A Joint Planning Method of Charging Piles and Charging-Battery Swapping Stations Considering Spatial-Temporal Distribution of Electric Vehicles." *CSEE Journal of Power and Energy Systems*, pp. 1–16. https://ieeexplore.ieee.org/document/9862567

2.78. Title: Probabilistic Optimal Management of Active and Reactive Power in Distribution Networks Using Electric Vehicles with Harmonic Compensation Capability

Author(s): Partovi, M., Esmaeili, S., and Aein, M.

Abstract: Electrical vehicles (EVs) are among the fastest-growing electrical loads that change both temporally and spatially at distribution networks. Moreover, the existence of uncertain parameters, such as EVs as well as domestic loads in power networks, poses serious operational challenges for them. Accordingly, stochastic studies of system performance are a must. Against this background, this paper aims to present a stochastic multi-objective method for the problem of simultaneous active and reactive power management as well as harmonic compensation in distribution networks in the presence of EVs and non-linear devices (NLDs). This method minimizes costs associated with power generation and losses. Besides, it improves the total harmonic distortion of voltage (THDv) at network buses subject to network and EV constraints. In the proposed method, to strike a balance between exploration and exploitation abilities, a hybrid technique named the "PSO-GA optimization algorithm" was used to take advantage of both the genetic algorithm (GA) and the particle swarm optimization (PSO) method. Accordingly, the effectiveness of the proposed method was examined on a standard IEEE 33-bus distribution network populated with EVs equipped with on-board bidirectional chargers. The results obtained showed that the proposed model improved network power quality indices as well as economic and technical issues of EVs in parking lots.

Subject Areas: Electric vehicle; Charging piles; Charging-battery swapping station; Joint planning; Spatial-temporal distribution of the charging; Battery swapping demands

Availability: Partovi, M., Esmaeili, S., and Aein, M. (2022). "Probabilistic Optimal Management of Active and Reactive Power in Distribution Networks Using Electric Vehicles with Harmonic Compensation Capability." *IET Generation, Transmission & Distribution*, *16*(21), pp. 4304–4320. https://doi.org/10.1049/gtd2.12599

2.79. Title: An Octopus Charger-Based Smart Protocol for Battery Electric Vehicle Charging at a Workplace Parking Structure

Author(s): Muñoz, E.R. and Jabbari, F.

Abstract: The transportation sector produces a large portion of greenhouse gas emissions in the United States. Meeting ambitious reductions in greenhouse gasses requires large-scale adoption of battery electric vehicles and has led to several policies and laws aimed at incentivizing their sales. While electric vehicles comprise a small percentage of the overall fleets of vehicles, the expected production of electric vehicles is soon expected to be in the millions. This will create challenges in providing an adequate charging infrastructure, as well as the ensuing management of the overall electricity demand at the grid level. In this work, a novel smart-charging protocol for battery electric vehicle charging at workplace parking structures is proposed. The Octopus Charger-based Mixed Integer Linear Programming protocol allows octopus chargers (i.e., charging stations with multiple cables) to independently schedule charging periods for their assigned vehicles. The proposed protocols can manage a parking structure demand load while reducing the number of installed charging stations. Driving patterns from the National Household Travel Survey were used to perform simulations, to verify and quantify the effectiveness of the proposed protocol. The proposed protocol resulted in improved peak load reductions for all simulated smart-charging scenarios when compared with uncontrolled charging. Critically, the assignment algorithm resulted in a number of required chargers close to the theoretical minimum.

Subject Areas: Battery electric vehicle; Octopus charger; Plug-in electric vehicle; Smart charging; Utility cost; Demand charge

Availability: Muñoz, E.R. and Jabbari, F. (2022). "An Octopus Charger-Based Smart Protocol for Battery Electric Vehicle Charging at a Workplace Parking Structure." *Energies*, *15*(17). https://doi.org/10.3390/en15176459

2.80. Title: Novel Battery Module Design for Increased Resource Efficiency

Author(s): Schmidt, S., Clausen, J., van der Auwera, R., Klapp, O., Schmerler, R., Löffler, D., Werner, M.J., and Block, L.

Abstract: The work presented focuses on a material efficient, modular design of a battery module for vehicle applications. Furthermore, the possibility of disassembly of individual components was considered. The constructive design focused on the combination of cast aluminum components, lightweight composites panels, and aluminum-foam phase-change material (PCM) composites. This led to an innovative battery module, which was finally implemented on a demonstrator level. The required cooling power of the module could be reduced by approx 20% compared to conventional battery module setups. Furthermore, the constructive design of the module and the use of a "debonding-on-demand" technology enabled significantly faster disassembly. Due to the combination of these advantages and the possibility to give individual parts of the module a second life for new modules, the module shows a high resource efficiency as well as high CO_2 savings potential.

Subject Areas: Design for recycling; Scalable modular design; Casting technology; Thermal management; Adhesive bonding

Availability: Schmidt, S., Clausen, J., van der Auwera, R., Klapp, O., Schmerler, R., Löffler, D., Werner, M.J., and Block, L. (2022). "Novel Battery Module Design for Increased Resource Efficiency." *World Electric Vehicle Journal*, *13*(10). https://doi.org/10.3390/wevj13100177

2.81. Title: Optimal Scheduling of Aggregated Electric Vehicle Charging with a Smart Coordination Approach

Author(s): Akil, M., Dokur, E., and Bayindir, R.

Abstract: Conventional internal combustion engine vehicles are one of the main reasons for the increase in carbon emissions. The Electric Vehicles (EVs) in the transportation sector to significantly reduce these emissions can be expanded collectively instead of these vehicles. While EVs are still hindered from adoption due to their battery life, cost, and a few other challenges, the global fuel crisis around the world and sanctions and incentives in government policies are helping large-scale EVs adoption. The increase in EVs' penetration adds an indefinite amount of electricity to the grid and is likely to pose a very complex operating problem for distribution grid operators. Since EV users want to leave with maximum battery energy capacity, uncoordinated charging can damage grid equipment in the distribution system. Accurate charge scheduling of EVs is essential for seamless integration of EVs into the grid. However, in this charging scheduling, it is necessary to consider the battery energy capacities of the EVs as well as the charging costs. In this paper, the optimal charging scheduling of EVs under the proposed smart coordination was performed according to the battery capacity. In this way, uncoordinated charging was prevented, which led to an increase in the peak power of the distribution system. Data for EV charging time, waiting time and battery energy-capacity were obtained by Monte Carlo Simulations (MCSs) based on statistical data. The Mixed Integer Linear programming (MILP) technique was used for charging scheduling of EVs. The results show that the proposed approach is a systematic reference, as it both reduces the charging cost of the users when charging the EVs and efficiently uses the load smoothing and load-shifting strategies in the distribution network.

Subject Areas: Charging schedule; Monte Carlo simulation; Smart coordination; Load curtailment; Load shifting

Availability: Akil, M., Dokur, E., and Bayindir, R. (2022). "Optimal Scheduling of Aggregated Electric Vehicle Charging with a Smart Coordination Approach." *2022 11th International Conference on Renewable Energy Research and Application (ICRERA)*, pp. 546–551. https://doi.org/10.1109/ICRERA55966.2022.9922739

2.82. Title: On Inferred Real-World Fuel Consumption of Past Decade Plug-In Hybrid Electric Vehicles in the U.S.

Author(s): Hamza, K., Laberteaux, K.P., and Chu, K.-C.

Abstract: Plug-in hybrid electric vehicles (PHEVs) have powertrain architectures that seek to combine the best features of two well-known powertrains: the environmental and other benefits of electric driving of battery electric vehicles and the fuel efficiency and, due to widely available fueling infrastructure and quick refueling times, limitless practical range of hybrid electric vehicles (HEVs). Different regulatory organizations around the world have different standard testing procedures, and accordingly, different predictions for the degree of efficacy of PHEVs at reducing greenhouse gas (GHG) emissions. However, there is somewhat of a consensus that PHEVs have the capacity for significant GHG reduction compared to conventional internal combustion engine vehicles, yet some recent studies have claimed the real-world fuel consumption of PHEVs to be more than twice their standard ratings. A key factor to the efficacy of GHG reduction via PHEVs is the fraction of miles traveled in electric mode, also known as the utility factor (UF). In this work, we reinvestigate the data sources cited in previous studies for PHEVs in the US for the inferred real-world UF and fuel consumption via the same estimation approaches as a previous study. We then compare with UF from SAE J2841 standard and fuel consumption ratings from the US environmental protection agency. While noting that it is difficult if not impossible to discern the exact reason for observed deviations given the available information in the cited data sources, we find the real-world fuel consumption of PHEVs in the US to be within 62% better to 21% worse than their standard ratings in the US, and generally, significantly better than a comparable HEV. Contrasted with reported results for other parts of the world, the results are viewed as a testimony to the importance of proper procedures for evaluation of PHEVs to reflect their correct environmental benefit value.

Subject Areas: Plug-in hybrid electric vehicles; Real-world fuel consumption; Utility factor; Greenhouse gas emissions

Availability: Hamza, K., Laberteaux, K.P., and Chu, K.-C. (2022). “On Inferred Real-World Fuel Consumption of Past Decade Plug-In Hybrid Electric Vehicles in the U.S.” *Environmental Research Letters*, *17*(10). https://iopscience.iop.org/article/10.1088/1748-9326/ac94e8

2.83. Title: Aging Mitigation for Battery Energy Storage System in Electric Vehicles

Author(s): Li, S., Zhao, P., Gu, C., Li, J., Huo, D., and Cheng, S.

Abstract: Battery energy storage systems (BESS) have been extensively investigated to improve the efficiency, economy, and stability of modern power systems and electric vehicles (EVs). However, it is still challenging to widely deploy BESS in commercial and industrial applications due to the concerns of battery aging. This paper proposes an integrated battery life loss modeling and anti-aging energy management (IBLEM) method for improving the total economy of BESS in EVs. The quantification of BESS aging cost is realized by a multifactorial battery life loss quantification model established by capturing aging characteristics from cell acceleration aging tests. Meanwhile, a charging event analysis method is proposed to deploy the built life loss model in vehicle BESS management. Two BESS active anti-aging vehicle energy management models, vehicle-to-grid (V2G) scheduling and plug-in hybrid electric vehicle (PHEV) power distribution, are further designed, where the battery life loss quantification model is used to generate the aging cost feedback signals. The performance of the developed method is validated on a V2G peak-shaving simulation system and a hybrid electric vehicle. The work in this paper presents a practical solution to quantify and mitigate battery aging costs by optimizing energy management strategies and thus can further promote transportation electrification.

Subject Areas: Battery energy storage system; Electric vehicle; Battery aging assessment; Battery aging mitigation; Energy management; Vehicle power distribution; Vehicle to grid

Availability: Li, S., Zhao, P., Gu, C., Li, J., Huo, D., and Cheng, S. (2022). "Aging Mitigation for Battery Energy Storage System in Electric Vehicles." *IEEE Transactions on Smart Grid*. https://doi.org/10.1109/TSG.2022.3210041

2.84. Title: A Coordinated EV Charging Scheduling Containing PV System

Author(s): Akil, M., Dokur, E., and Bayindir, R.

Abstract: The two main reasons for the increase in carbon emissions are the use of fossil fuel resources in the transportation and energy sector. It is possible to reduce these emissions significantly by expanding Electric Vehicles (EVs) in the transportation sector and renewable energy sources (RES) in electric power generation. While the adoption of EVs is still struggling for various reasons, such as battery costs and reduced range, rising fuel prices combined with government policy sanctions and incentives are increasing the need for EVs. The increased penetration of EVs on the grid is likely to pose a very complex operational problem. Therefore, this penetration can result in overloading of the infrastructure equipment in the distribution system and a power outage. This study focuses on the coordinated charge scheduling for EVs with a photovoltaic (PV) system as one of the renewable energy sources for seamless integration of EVs into the grid. In this paper, charge scheduling of EVs has been made by considering the EV battery state of energy (SoE) value. Mixed Integer Linear Programming (MILP) technique is used for the charge scheduling model of EVs. Thus, the charge scheduling of EVs is made within the allowable limits in the grid. It is also a systematic reference work in the proposed approach because of the load balancing of the EVs with the power supplied from the PV system.

Subject Areas: Scheduling; Monte Carlo simulation; PV system; Coordinated charging; Load balancing

Availability: Akil, M., Dokur, E., and Bayindir, R. (2022). "A Coordinated EV Charging Scheduling Containing PV System." *International Journal of Smart Grid*, *6*(3). https://www.ijsmartgrid.org/index.php/ijsmartgridnew/article/view/252

2.85. Title: Electric Vehicle Managed Charging: Forward-Looking Estimates of Bulk Power System Value

Author(s): Hale, E., Lavin, L., Yip, A., Cowiestoll, B., Zhang, J., Jadun, P., and Muratori, M.

Abstract: When and where electric vehicle charging occurs has significant implications for power systems supporting widespread electric vehicle deployment with high shares of wind and solar generation. Numerous studies have estimated the value of scheduling or otherwise managing electric vehicle charging in such power systems. This study improves on those earlier works by leveraging detailed simulation models for electric vehicle adoption, electric vehicle use, electric vehicle charging, and bulk power system operations and linking them with methods for describing charging flexibility at both the individual vehicle and aggregate levels. This study closely analyzes electric vehicle managed charging (EVMC) performance along the dimensions of flexibility type (within-charging session or within-week scheduling), dispatch mechanism (direct load control or one of several price-based mechanisms), and participation rate, under the assumptions of ubiquitous chargers and all trips completed on time. The study is located in a passenger light-duty vehicle adoption scenario with 100% electric vehicle sales by 2035 and in an envisioned 2038 New England power system for which within-region generation is 84% clean.

Subject Areas: Battery energy storage system; Electric vehicle; Battery aging assessment; Battery aging mitigation; Energy management; Vehicle power distribution; Vehicle to grid

Availability: Hale, E., Lavin, L., Yip, A., Cowiestoll, B., Zhang, J., Jadun, P., and Muratori, M. (2022). *Electric Vehicle Managed Charging: Forward-Looking Estimates of Bulk Power System Value*. Technical Report, National Renewable Energy Laboratory, Golden, CO. https://doi.org/10.2172/1890139

2.86. Title: Integrated DR and V2G Framework of EV Aggregator Under Low Carbon Paradigm

Author(s): Sharma, S. and Jain, P.

Abstract: Emerging ambitious and viable scheduling business models for scheduling of electric vehicles aggregator (EVA) ensures smart electrification of transportation with renewables through coordinated and efficiently deployed V2G driving the transformation of energy services. Proposed work models an integrated DR framework for vehicle-to-grid (V2G) energy management by EVA for efficient use of photovoltaic (PV) generation by smart harmonization among involved entities EV users, grid/system operator (SO) and EVA. EVA regulates V2G (charge/discharge) strategy for dropping vehicle-to-grid (V2G) operational cost and maximizing its revenue through regulation services and modulating charging/discharging rates according to real-time monitored data of self PV generation unit. Battery ageing cost is modelled to compensate EV users against V2G regulation. Different integrated frameworks considered for V2G scheduling case studies are RTP-DR, electricity company TOU DR and Designed TOU DR. Simulation results confirm the effectiveness of anticipated business model from the perspective of V2G operational cost reduction and PV generation utilization.

Subject Areas: Demand response (DR); Electric vehicles (EVs); Time-of-Use (TOU); Grid-to-vehicle-to-grid (G2V2G)

Availability: Sharma, S. and Jain, P. (2022). "Integrated DR and V2G Framework of EV Aggregator Under Low Carbon Paradigm." *Flexible Electronics for Electric Vehicles. Lecture Notes in Electrical Engineering*, *863*, pp. 489–503. https://doi.org/10.1007/978-981-19-0588-9_48

2.87. Title: Impact Assessment of Simultaneous Deployment of Electric Vehicle and Solar Energy Sources in Unbalanced Distribution Network

Author(s): Tripathy, S., Ghatak, S.R., Acharjee, P., and Lopes, F.

Abstract: Due to rising pollution, countries across the world are concentrating towards Electrification in the transportation sector. To meet the increasing charging demand of vehicles, integration of clean and green solar renewable sources in distribution network is a viable option. In this paper, the impact of assimilating plug in hybrid electric vehicle (PHEVs) with solar panel in the distribution network in terms of all the technical factors such as voltage profile, line loss, and voltage unbalance are analysed. Taking into account the uncertainty of PHEV load, the 24 h power demand curve of PHEVs is developed. The modelling of photovoltaic (PV) is done in OpenDSS software. The hourly load flow for unbalanced distribution system is performed in OpenDSS software interfaced with MATLAB. Highly unbalanced IEEE 13 bus system is chosen as the test network to perform the research work. The performance parameters are studied for different penetration levels of PHEVs with PV in the existing system. It is observed that with the injection of PV in the existing grid consisting of PHEVs and commercial load, voltage profile improves, and voltage unbalance and the system loss reduces. Further it was also observed from the result that deployment of PV resulted in enhancement of penetration level of PHEV in the distribution network.

Subject Areas: Plug in hybrid electric vehicle; Probability density function; Photovoltaic; Voltage profile; Voltage unbalance factor

Availability: Tripathy, S., Ghatak, S.R., Acharjee, P., and Lopes, F. (2022). "Impact Assessment of Simultaneous Deployment of Electric Vehicle and Solar Energy Sources in Unbalanced Distribution Network." *Highlights in Practical Applications of Agents, Multi-Agent Systems, and Complex Systems Simulation*, pp. 283–294. *Communications in Computer and Information Science*, *1678*. https://doi.org/10.1007/978-3-031-18697-4_23

2.88. Title: Plug-In Electric Vehicle: Challenges of Increased Penetration and Optimal Solutions Using Load Modeling, Prediction & Grid Integration

Author(s): Yusuf, J.

Abstract: Goals for sustainable transportation have encouraged people to adopt more Plug-in Electric Vehicles (PEVs). Incentives and other friendly policies are also facilitating additional PEV penetration. The increasing penetration of PEVs has put up new challenges and opportunities in both transportation and electric sector. Firstly, an optimal framework is introduced to find out the best PEV charging/discharging strategy for a microgrid in this dissertation that can aid the Distribution System Operator (DSO) in PEV Charging Station (CS) selection. Then, a comprehensive techno-economic analysis is executed for a combined Light Duty Electric Vehicle (LDEV) and Heavy Duty Electric Vehicle (HDEV) implementation. The optimal participation of PEV Vehicle to Grid (V2G) is explored later on in a critical demand response event. Finally, the load modeling aspect of PEVs is accomplished and their impacts are presented based on the variety of building load, feeder types, PEV user behavior and co-simulation for both present and future scenarios. A real-time V2G is implemented in both grid-connected and off-grid mode to show the opportunities created by the PEV integration into the grid.

Subject Areas: Plug-in Electric Vehicles; Charging/discharging strategy; Microgrid; Distribution System Operator; Vehicle to Grid

Availability: Yusuf, J. (2022). *Plug-In Electric Vehicle: Challenges of Increased Penetration and Optimal Solutions Using Load Modeling, Prediction & Grid Integration*. Doctoral Dissertation, University of California, Riverside, CA. https://escholarship.org/uc/item/39k0g2cx

2.89. Title: The Electric Ceiling: Limits and Costs of Full Electrification

Author(s): Rapson, D.S. and Bushnell, J.B.

Abstract: Electrification is a centerpiece of global decarbonization efforts. Yet there are reasons to be skeptical of the inevitability, or at least the optimal pace, of the transition. We discuss several under-appreciated costs of full, or even deep, electrification. Consumer preferences can operate in favor of and in opposition to electrification goals, and electrification is likely to encounter physical and economic obstacles when it reaches some as-yet-unknown level. While we readily acknowledge the external benefits of decarbonization, we also explore several under-appreciated external costs. The credibility and eventual success of decarbonization efforts is enhanced by foreseeing and ideally avoiding predictable but non-obvious costs of promising abatement pathways. Thus, even with all of its promise, the degree of electrification may ultimately reach a limit.

Subject Areas: Full electrification; Decarbonization; Costs

Availability: Rapson, D.S. and Bushnell, J.B. (2022). *The Electric Ceiling: Limits and Costs of Full Electrification*. Working Paper, National Bureau of Economic Research, Cambridge, MA. https://www.nber.org/papers/w30593

2.90. Title: Electric Vehicle Usage, Pollution Damages, and the Electricity Price Elasticity of Driving

Author(s): Nehiba, C.

Abstract: I study battery electric vehicle (BEV) usage and ownership characteristics with fundamental implications for transportation's electrification. Using data covering the entire BEV population in New York, I quantify BEV mileage, pollution damages, and environmental justice concerns that vehicle charging exports pollution from high- to low-income areas. Finding that mileage is a greater contributor to pollution damages than vehicle efficiency or local characteristics, I estimate the price elasticity of BEV driving. A 10% increase in per-mile electricity costs reduces mileage by 1%, but responsiveness falls as public charging stations—where prices are often decoupled from electricity costs—become available.

Subject Areas: Electric vehicles; Electricity prices; Travel demand; Air pollution; Environmental justice

Availability: Nehiba, C. (2022). *Electric Vehicle Usage, Pollution Damages, and the Electricity Price Elasticity of Driving*. Research Paper, Center for Energy Studies at Louisiana State University, Baton Rouge, LA. https://dx.doi.org/10.2139/ssrn.4239983

2.91. Title: Can Vehicle-to-Grid Facilitate the Transition to Low Carbon Energy Systems?

Author(s): Owens, J., Miller, I., and Gençer, E.

Abstract: Vehicle-to-grid (V2G) is when electric vehicles (EVs) provide services to the power grid, such as shifting when they charge or discharging to serve peak loads. At scale, an aggregator can coordinate and optimize the charge and discharge of individual vehicles to function as a synergistic, bulk energy resource and load. Here we generate new insights into V2G's long run value for deep decarbonization, assessing its potential to displace stationary storage and other generators at scale. As a case study, V2G impact is measured via the buildout and operation of a New England-sized power system subject to high EV penetration and tight emissions constraints. We find V2G's effect on system capacity and value to be substantial, with participation from 13.9% of the New England light-duty vehicle fleet displacing 14.7 GW of stationary storage (over $700 million in capital savings). On the whole, total system savings span 2.2–20.3% ($183 million to $1,326 million) between participation rates of 5% and 80%, respectively. Savings are driven first by displacement of stationary storage and second by reductions in firm generation capacity and shifts in renewable generation portfolios. When compared to traditional demand response schemes, even at modest participation rates (5–10%), V2G yields over 337% more savings and tenfold the storage displacement. V2G's marginal benefit is greatest under aggressive emission caps (10 gCO_2 per kW per h per load), as it decreases the need for excess renewables capacity and costly CCS technologies. Further, the nature of optimal V2G dispatch is shown to change non-monotonically with participation rate. Below 50% participation, V2G power injection is called on at a higher rate to shave evening charging loads, with 21.3–32.8% of charge reinjected to the grid, whereas greater participation rates require significantly less reinjection (<15%) via charge load shifting. Finally, our destination based system topology quantifies locational V2G contributions and reveals that V2G capabilities are as much as 2.5 times more valued in residential areas than at workplaces alone.

Subject Areas: Vehicle-to-grid; Electric vehicles; Stationary storage; Location value; Charging level; Participation dynamics

Availability: Owens, J., Miller, I., and Gençer, E. (2022). "Can Vehicle-to-Grid Facilitate the Transition to Low Carbon Energy Systems?" *Energy Advances*, *1*(12), pp. 943–1072. https://pubs.rsc.org/en/content/articlepdf/2022/ya/d2ya00204c

2.92. Title: A Local Flexibility Market Framework for Exploiting DERs' Flexibility Capabilities by a Technical Virtual Power Plant

Author(s): Pourghaderi, N., Fotuhi-Firuzabad, M., Moeini-Aghtaie, M., Kabirifar, M., and Dehghanian, P.

Abstract: This paper presents a new intra-day intra-hourly local flexibility market (LFM) framework to exploit distributed energy resources' (DERs) flexibility capabilities. A technical virtual power plant (TVPP) operates the LFM in which the DER aggregators participate. The TVPP offers the provided flexibility capabilities to wholesale flexibility market (WFM) as well as compensating the intra-hourly variability in power distribution network. In the proposed framework, the TVPP clears the LFM by considering hierarchical transactions with the aggregator agents to find the market equilibrium in which the DERs' flexibility capabilities are optimally exploited while all participating agents make profit by trading flexibility capabilities in the LFM. A bilevel optimization model with multiple lower levels is considered to address different agents' preferences and transactions in the LFM. In the upper-level problem, the TVPP aims at maximizing its profit while each lower-level problem represents an aggregator agent's optimization problem. The proposed model is reformulated into a single-level mixed integer linear programming problem and is implemented on the distribution network connected to Bus 5 of the Roy Billinton test system (RBTS) as well as a 119-bus test system. The results demonstrate the effectiveness of the model to utilize DERs' flexibility and provide revenue opportunities for different agents.

Subject Areas: Distributed energy resources; Local flexibility market; Technical virtual power plant; Wholesale flexibility market; Roy Billinton test system

Availability: Pourghaderi, N., Fotuhi-Firuzabad, M., Moeini-Aghtaie, M., Kabirifar, M., and Dehghanian, P. (2022). "A Local Flexibility Market Framework for Exploiting DERs' Flexibility Capabilities by a Technical Virtual Power Plant." *IET Renewable Power Generation*. https://doi.org/10.1049/rpg2.12624

2.93. Title: Service Restoration for Resilient Distribution System with Coordination of Battery Swapping Stations and Distributed Generations

Author(s): Guo, Y., Liao, K., Yang, J., and He, Z.

Abstract: Due to sufficient energy storage resources and central dispatch, the battery swapping station (BSS) offers a promising solution for the service restoration and resilience enhancement of the distribution system (DS). This paper proposes a joint service restoration strategy for the DS by coordinating BSSs and distributed generations (DGs) with distribution network reconfiguration. Firstly, the spatio-temporal distribution of battery swapping demand for electric vehicles (EVs) is analyzed. On this basis, the participation of the BSS in the DS service restoration is investigated, and the model of restoration capacity for the BSS is established, which can describe the power supply ability of the BSS to support the DS restoration. Secondly, a mathematical model for the resilient DS restoration with coordination between BSSs and DGs is established, aiming to minimize the total system cost by optimally allocating BSSs and DGs during the restoration stage. The second-order cone programming (SOCP) relaxation is also adopted to transform the proposed restoration model into a mixed-integer convex formulation, which can be tractably solved. Finally, numerical simulations are conducted based on the modified IEEE 33-bus distribution test system. The results demonstrate the effectiveness of the proposed strategy for the service restoration and resilience enhancement of the DS.

Subject Areas: Battery swapping station; Distribution system; Distributed generations; Electric vehicles; Second-order cone programming; Energy storage

Availability: Guo, Y., Liao, K., Yang, J., and He, Z. (2022). "Service Restoration for Resilient Distribution System with Coordination of Battery Swapping Stations and Distributed Generations." *IET Renewable Power Generation*, pp. 1–15. https://doi.org/10.1049/rpg2.12635

2.94. Title: A Wind Power Curtailment Reduction Strategy Using Electric Vehicles Based on Individual Differential Evolution Quantum Particle Swarm Optimization Algorithm

Author(s): Zhang, L., Yin, Q., Zhang, Z., Zhu, Z., Lyu, L., Hai, K.L., and Cai, G.

Abstract: A wind power curtailment consumption strategy using electric vehicles (EVs) based on individual differential evolution quantum particle swarm optimization algorithm (IDE-QPSO) is proposed, with the objective of reducing the system's wind curtailment in order to further improve the wind power consumption rate while effectively reducing wind power output fluctuation and amplitude. EV aggregators act as charging tariff setters, releasing dynamic time-of-use tariffs (DTOU) for EV clusters to respond to based on wind curtailment data accounted for by the dispatch center. This method first establishes an electric vehicle charging load model based on the travel chain theory and residents' travel rules, then establishes an EV user's autonomous response model based on the sensitivity of electric vehicle users to the charging prices. Second, a multi-objective optimization function is established based on the aforementioned model, which integrates wind power curtailment consumption and minimizes wind power output fluctuation and amplitude, and it is solved using an improved quantum particle swarm optimization algorithm. Finally, adequate simulation experiments show that this strategy can effectively smooth out the fluctuation of wind power output and improve the wind power consumption rate.

Subject Areas: Electric vehicle; Reduce the wind curtailment; Dynamic TOU tariffs; Individual differential evolution quantum particle swarm optimization algorithm

Availability: Zhang, L., Yin, Q., Zhang, Z., Zhu, Z., Lyu, L., Hai, K.L., and Cai, G. (2022). "A Wind Power Curtailment Reduction Strategy Using Electric Vehicles Based on Individual Differential Evolution Quantum Particle Swarm Optimization Algorithm." *Energy Reports*, *8*, pp. 14578–14594. https://doi.org/10.1016/j.egyr.2022.10.442

2.95. Title: Charging Behavior Modeling of Battery Electric Vehicle Drivers on Long-Distance Trips

Author(s): Ge, Y. and MacKenzie, D.

Abstract: Using the data from an interactive stated choice experiment, we analyzed battery electric vehicle (BEV) users' fast-charging choices on long-distance trips using both static and dynamic discrete choices models (SDCMs and DDCMs). The results show that battery state of charge (SOC) and the ability to reach the next station without deviating from the original plan are the primary factors influencing charging decisions. Charging cost, time, the detour time to reach a station, and the amenities are statistically significant predictors, but less important than SOC and the ability to complete the trip as planned. The comparison of the SDCMs and DDCMs shows that SDCMs have better goodness-of-fit than more complicated DDCMs. By comparing the relative size of the coefficient, we estimated the monetary value of increasing charging power, moving the charging stations closer to highway exits, and having amenities such as restrooms, restaurants, and Wi-Fi at the charging stations.

Subject Areas: Battery electric vehicle; Charging behavior; Long-distance trips; Direct current fast chargers

Availability: Ge, Y. and MacKenzie, D. (2022). "Charging Behavior Modeling of Battery Electric Vehicle Drivers on Long-Distance Trips." *Transportation Research Part D: Transport and Environment*, *113*. https://doi.org/10.1016/j.trd.2022.103490

2.96. Title: Economic-Environmental Energy Supply of Mobile Base Stations in Isolated Nanogrids with Smart Plug-In Electric Vehicles and Hydrogen Energy Storage System

Author(s): Bahri, R., Zeynali, S., Nasiri, N., and Keshavarzi, M.R.

Abstract: The mobile base stations (MBS) are fundamental communication devices that ensure the constant stream of interconnectivity. However, they are mostly installed in off-grid regions. This study investigates the economic-environmental energy supply of a MBS in an isolated nanogrid (ING) that also includes a hydrogen energy storage system (HES), photovoltaic (PV) system, controllable plug-in electric vehicles (PEVs), and a diesel generator (DG). A novel mixed-integer second-order cone programming (MISOCP) formulation is proposed to capture the non-linearities of the various components through a convex optimization model. The study included different uncertainties including the traffic rate of the MBS, driving schedule of the PEVs, and PV generation via a hybrid stochastic programming (SP) and robust optimization (RO) methods. The influence of the coordinated PEV charging strategy, risk-averse RO and multi-objective optimization was studied through various case studies. The outcomes show that coordinated PEV-charging can have a significant contribution in reducing the risks and curtailing both cost and emission objective functions, while using an economic-environmental operation model can cut the emissions by 17.70%.

Subject Areas: Mobile base station; Mixed-integer second-order cone programming; Plug-in electric vehicles; Robust optimization; Economic-environmental operation; Hydrogen energy storage

Availability: Bahri, R., Zeynali, S., Nasiri, N., and Keshavarzi, M.R. (2022). "Economic-Environmental Energy Supply of Mobile Base Stations in Isolated Nanogrids with Smart Plug-In Electric Vehicles and Hydrogen Energy Storage System." *International Journal of Hydrogen Energy*. https://doi.org/10.1016/j.ijhydene.2022.10.219

2.97. Title: Power Restoration Model for Distribution Networks After Extreme Rainstorm Disasters Based on Electric Vehicle Travel Characteristics

Author(s): Liu, W., Liu, Y., Yang, Y., Xu, Q., and Dong, F.

Abstract: Improving the resilience of the distribution grid to extreme rainstorms can effectively reduce the resulting outage losses. Based on the massive number of electric vehicles (EVs) with objective capacity in the distribution network environment, it is essential to study the discharge of EVs to make up for the shortage load in the distribution network's post-disaster recovery. In this paper, we first establish a coupling network integrating the distribution grid and road network, simultaneously coupling information from different levels. Then, we establish a model describing the characteristics of EV travel behavior based on the travel chain and probability distribution function to portray the spatial distribution of EVs in the time dimension. Then, we establish a model of EVs in this area and cross-area EVs participating in discharge response based on the area after EV clustering. Also, we establish the extreme storm weather affected EV discharge willingness model to describe the uncertainties of EVs. Finally, two faults set in the IEEE33 node are simulated and verified, and the model description and analysis of the influencing factors of EV participation in discharge are given.

Subject Areas: Resilience; Distribution system; Fault recovery; Electric vehicles; Extreme rainstorm disasters; Power restoration

Availability: Liu, W., Liu, Y., Yang, Y., Xu, Q., and Dong, F. (2022). "Power Restoration Model for Distribution Networks After Extreme Rainstorm Disasters Based on Electric Vehicle Travel Characteristics." *Energy Reports*, *9*(1), pp. 372–380. https://doi.org/10.1016/j.egyr.2022.10.387

2.98. Title: Hierarchical Control Strategy of Electric Vehicles with Demand Response in Retail Electricity Markets

Author(s): Skolthanarat, S., Somsiri, P., and Tungpimolrut, K.

Abstract: Uncontrolled charging of numerous electric vehicles (EVs) can cause problems on distribution transformer and feeder voltage. Demand response (DR) can reduce the loading by incentivizing EV owners to change their charging schedules. DR is composed of two mechanisms, price-based and incentive-based. For the price-based DR, EV owners manage their charging according to price signals to save their charging costs. However, the accumulated loads of the distribution network may unexpectedly increase. This paper develops a combination approach of price-based and incentive-based demand response in a hierarchical manner to alleviate the distribution network problems from passenger EV charging in retail electricity markets. On the bottom level, the EV owners optimize their charging schedules according to the day-ahead real-time pricing (DA-RTP). In case the accumulated demand is larger than the regulated value, the top-level centralized control will be initiated with incentive direct load control (DLC). To manage on dynamic characteristics of the distribution loads, heuristic algorithm is applied to reduce the run times. The developed approach is simulated with two scenarios regarding structures of retail electricity markets. Both scenarios consist of agents that interact with residential customers in providing the electrical energy and balancing supplies and loads in the distribution networks. The simulation results show that the approach can relieve the problems. Uncertainties due to traffic condition, charging and driving behavior are included in the simulations. Financial aspects of stakeholders are also analyzed.

Subject Areas: Demand response; Charging schedules; Load control; Distribution loads

Availability: Skolthanarat, S., Somsiri, P., and Tungpimolrut, K. (2022). "Hierarchical Control Strategy of Electric Vehicles with Demand Response in Retail Electricity Markets." *Energy Systems*. https://doi.org/10.1007/s12667-022-00547-y

2.99. Title: Comparing the Role of V2G Hydrogen Fuel Cell and V2G Electric Vehicles for Increased Integration of VRE in a Low Carbon Neighbourhood

Author(s): Hagos, D.A.

Abstract: The aim of this paper is to compare the role of vehicle-to-grid (V2G) hydrogen fuel cell vehicle (HFCV) and battery electric vehicle (BEV) for increased integration of VRE in a low carbon neighbourhood. Microgrid model is developed for a hypothetical model community in Trondheim city of Norway to demonstrate the case. The model run minimises the total system cost and optimises the operation costs of the microgrid. The result shows that V2G BEV is a cheaper grid balancing source than V2G HFCV. Nevertheless, the contribution of the V2G BEV for residual demand and peak load reductions is limited to 2.9% and 5.4% respectively; it depends on the connection share of the V2G vehicles during parking. There is no power dispatch from the V2G HFCV in any of the scenarios. The role of the V2G BEV is threefold: (1) replaces fossil fuels in transportation, (2) provides flexibility to the VRE by balancing excess VRE production, and (3) reduces the peak load.

Subject Areas: Heating systems; Vehicle-to-grid; Costs; Hydrogen; Urban areas; Transportation; Microgrids

Availability: Hagos, D.A. (2022). "Comparing the Role of V2G Hydrogen Fuel Cell and V2G Electric Vehicles for Increased Integration of VRE in a Low Carbon Neighbourhood." *2022 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe)*, pp. 1–5. https://doi.org/10.1109/ISGT-Europe54678.2022.9960601

2.100. Title: Time-of-Use-Aware Priority-Based Multi-Mode Online Charging Scheme for EV Charging Stations

Author(s): Anwar, M.N.B., Ruby, R., Cheng, Y., and Pan, J.

Abstract: Electric vehicle charging stations (EVCSs) play a vital role in providing charging support to EV users. In order to facilitate users in terms of charging speed, two different charging modes (L2 and L3) are currently available at public charging stations. L3 mode provides quick charging with higher power, whereas L2 mode offers moderate charging speed with low power. The integration of an EVCS into the power grid requires coordinated charging strategies in order to reduce the electricity bill for a profitable operation. However, the effective utilization of the multi-mode charging strategy to serve the maximum number of EVs for a small charging station with limited charging capacity and spots is an open issue. To this end, we propose a priority-based online charging scheme, namely PBOS, which is based on real-time information and does not depend on future knowledge. The objective is to serve as many vehicles as possible in a day while fulfilling their charging requirements under a multi-mode EVCS setting and reducing the charging costs by utilizing the time-of-use pricing based demand response strategy. Simulation results show that the proposed algorithm can increase profit for EVCS by up to 42% with a 20% lower rejection rate when compared with other schemes.

Subject Areas: Processor scheduling; Simulation; Urban areas; Pricing; Charging stations; Prediction algorithms; Electric vehicle charging

Availability: Anwar, M.N.B., Ruby, R., Cheng, Y., and Pan, J. (2022). "Time-of-Use-Aware Priority-Based Multi-Mode Online Charging Scheme for EV Charging Stations." *2022 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm)*, pp. 166–171.
https://doi.org/10.1109/SmartGridComm52983.2022.9961019

2.101. Title: Deployment Optimization Strategies for Electric Vehicle Charging Stations

Author(s): Rao, R., Shi, Y., and Wang, X.

Abstract: In recent years, with the gradual depletion of fossil energy and increasing environmental pollution, electric vehicles (EVs) have developed rapidly as one of the main substitutes for traditional fuel vehicles. Based on this, this paper firstly establishes a comprehensive optimization objective function including geographic information, charging time and charging amount. On the basis of determining the objective function, a quantum particle swarm optimization algorithm is proposed to solve the problem of optimal charging pile location and its number distribution. Secondly, a prediction model for the spatiotemporal distribution of electric vehicle users' charging demands based on fuzzy inference algorithm was proposed, and the charging load distribution curves of different functional areas were obtained by using Monte Carlo simulation method, which solved the spatiotemporal distribution of users' charging demands. Then, from the perspective of users, and taking into account the two-way cost of vehicle owners and charging station operators, a method of charging station location and capacity based on electric vehicle charging probability model is further proposed, which solves the problem of gradual expansion or reduction of charging piles. Finally, a multi-objective optimization model is established to solve the problem of optimal solutions for charging and battery swapping.

Subject Areas: Quantum particle swarm optimization algorithm; Fuzzy inference algorithm; Electric vehicle charging probability model; Multi-objective optimization

Availability: Rao, R., Shi, Y., and Wang, X. (2022). "Deployment Optimization Strategies for Electric Vehicle Charging Stations." *Highlights in Science, Engineering and Technology*, *22*, pp. 49–61. http://dx.doi.org/10.54097/hset.v22i.3292

2.102. Title: Renewable Energy and Efficiency Technologies in Scenarios of U.S. Decarbonization in Two Types of Models: Comparison of GCAM Modeling and Sector-Specific Modeling

Author(s): Binsted, M., Suchyta, H., Zhang, Y., Vimmerstedt, L., Mowers, M., Ledna, C., Muratori, M., and Harris, C.

Abstract: Energy system projections from quantitative models inform actions including nearer-term and local decisions (e.g., technology adoption, infrastructure investment) as well as global and longer-term actions (e.g., international negotiations, global targets). Computational limits require model designers to balance coverage and resolution (i.e., breadth versus depth). Some models, such as the Global Change Analysis Model (GCAM), represent all energy sources and uses with less resolution than models that focus on a single sector's energy use. GCAM balances global supply and demand of all energy carriers' projecting prices using internal calculations for energy sources and costs of greenhouse gas mitigation while capturing interlinkages between the energy system, water, agriculture and land use, the economy, and the climate. This globally comprehensive model was used to frame the *Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050*, which the White House released in 2021 and has been used to inform national and global economy-wide climate change mitigation discussions and strategy development for decades.

Unlike GCAM, sectoral models focus on a portion of the energy sector and with greater detail and resolution. The Regional Energy Deployment System (ReEDS) electricity-sector model, for example, projects electricity system capacity expansion and operation with high-fidelity representation of emerging technologies for deep decarbonization, such as variable renewable energy and energy storage, and integration of these technologies into the electric grid. The Transportation Energy and Mobility Pathway Options (TEMPO) transportation-sector model enables analysis of household choices, with a focus on adoption, charging, and use of electric vehicles. The Scout buildings-sector model supports detailed consideration of the policies and markets that can accelerate the adoption of electrification and energy conservation measures in buildings. Such sector-specific models are instrumental in informing technology research, sectoral planning strategies, and sector-specific aspects of greenhouse gas mitigation strategies in the United States.

The integrated multisector and sector-specific modeling approaches represented by GCAM and these sectoral models are complementary. The integrated multisector approach calculates energy pricing and resource allocation within the model, which is important for consistency when future conditions substantially diverge from current conditions in transformative scenarios. The sector specific approach facilitates representation of granular details across spatial, temporal, technological, and market dimensions that enable exploration of particular interactions and tradeoffs. This report presents the results of recent work to explore the differences and trade-offs between these approaches by comparing GCAM with the sector-specific ReEDS, TEMPO, and Scout models. The report compares both model structures and results, and it addresses their potential relevance and applications.

Subject Areas: Energy system; Global Change Analysis Model; Transportation Energy and Mobility Pathway Options; Hydrogen; Scout model; Regional Energy Deployment System

Availability: Binsted, M., Suchyta, H., Zhang, Y., Vimmerstedt, L., Mowers, M., Ledna, C., Muratori, M., and Harris, C. (2022). *Renewable Energy and Efficiency Technologies in Scenarios of U.S. Decarbonization in Two Types of Models: Comparison of GCAM Modeling and Sector-Specific Modeling*. Technical Report, NREL/TP-6A20-84243, National Renewable Energy Laboratory, Golden, CO. https://www.nrel.gov/docs/fy23osti/84243.pdf

2.103. Title: Electric Vehicle Infrastructure Plan in Illinois

Author(s): Kontou, E., Wu, Y.-C., and Luo, J.

Abstract: We study the allocation of dynamic electric vehicle charging investments from the policymaker's perspective, which aims to meet statewide emission-reduction targets for the Illinois passenger vehicle sector. We determine statewide charging deployment trajectories over a 30-year planning horizon and estimate their emission reduction. Electric vehicle demand functions model the electrified vehicle market growth and capture network externalities and spatial heterogeneity. Our analysis indicates that most chargers need to be deployed in the first 10 to 15 years of the transition to allow benefits to accrue for electric vehicle drivers, availability of home charging influences consumers' choice and drivers' electrified travel distance, charging stations should be prioritized for frequent long-distance drivers, and spatial effects are crucial in accurately capturing the demand for electric vehicles in Illinois. We also develop a multi-criteria suitability map to site charging stations for electric vehicles based on economic, societal, and environmental justice indicators. We identify census tracts that should be prioritized during Illinois' statewide deployment of charging infrastructure along with interstates and major highways that traverse them. Major interstates and highways I-90, I-80, I-55, and I-57 are identified as having high siting suitability scores for charging stations. Last, a novel location model was developed for equitable electric vehicle charging infrastructure placement in the Illinois interstate and major highway network. Two objectives were set to reduce detours and improve the ability to complete long-distance trips for low-income electric vehicle travelers and multi-unit dwelling residents. Our analysis indicates that if the system's efficiency is the only consideration, low-income/multi-unit housing resident travelers are most likely to fail to complete their trips, while an equitable charging siting could mitigate this issue.

Subject Areas: Electric vehicles; Charging stations; Electrical equipment; Planning; Carbon dioxide; Decarbonization; Automobile ownership; Optimization; Geographical information systems

Availability: Kontou, E., Wu, Y.-C., and Luo, J. (2022). *Electric Vehicle Infrastructure Plan in Illinois*. Research Report, No. FHWA-ICT-22-016, University of Illinois at Urbana-Champaign, Urbana, IL. https://doi.org/10.36501/0197-9191/22-023

2.104. Title: Real World Usage of Plug-In Hybrid Vehicles in the United States

Author(s): Isenstadt, A., Yang, Z., Searle, S., and German, J.

Abstract: This study examines the current state of PHEV usage in the United States using recent data from two previously unexplored sources: self-reported fuel consumption from Fuelly.com and engine-off distance traveled collected by the California Bureau of Automotive Repair (BAR).

The analysis of the new datasets presents strong evidence that real-world electric drive share is far below the utility factor label rating. Specifically, the analysis finds that real-world electric drive share may be 26–56% lower and real-world fuel consumption may be 42–67% higher than assumed within EPA's labeling program for light duty vehicles.

More data collection could provide greater precision and clarity regarding the deviation of real-world electric drive share and what is assumed in EPA labeling. As PHEVs are still a small share of the existing fleet and new sales, all data sources to date may be inherently biased towards early adopters. In addition, all datasets examined suffer from some degree of self-selection bias and potentially other confounding factors. At a minimum, the trends in the new PHEV data point to the need for closer inspection and broader investigation into PHEV usage to inform regulatory treatment.

Subject Areas: Plug-In Hybrid Vehicles; Real-world fuel consumption; Self-reported fuel consumption; Engine-off distance traveled

Availability: Isenstadt, A., Yang, Z., Searle, S., and German, J. (2022). *Real World Usage of Plug-In Hybrid Vehicles in the United States.* White Paper, International Council on Clean Transportation, Washington, D.C. https://theicct.org/publication/real-world-phev-us-dec22/

Chapter 3. Environment

3.1. Title: Climate Policy Will Fail If We Don't Address Inequities and Today's Energy Needs

Author(s): Finley, M.

Abstract: Blog.

Subject Areas: Energy price; Climate policy; Energy transition; Equity; Household income; Distributional impact

Availability: Finley, M. (2022). "Climate Policy Will Fail If We Don't Address Inequities and Today's Energy Needs." *Forbes*. https://www.forbes.com/sites/thebakersinstitute/2022/01/26/climate-policy-will-fail-if-we-dont-address-inequities-and-todays-energy-needs/?sh=7103d64368be

3.2. Title: Decarbonising Transport with Intelligent Mobility

Author(s): Bishop, J.D.K.

Abstract: Intelligent mobility is the smarter, greener, and more efficient movement of people and goods. Road transport accounted for 24 percent of global greenhouse gas emissions in 2019. Decarbonising the transport system requires decision-makers to adopt a "vision and validate" approach to promote active and sustainable travel modes and move away from schemes that lock in private vehicle use. Creating a digital twin requires models representing demand for transport, supply of transport options, the network which links origins to destinations and the decisions made by consumers. Mode choice and trip purpose can be inferred using artificial intelligence techniques which incorporate data from the full range of conventional and novel, static and continuous data sources. Digital twins developed on the basis of transparency and inclusion present a unique opportunity to engage with the public in different ways to deliver better outcomes.

Subject Areas: Intelligent mobility; Sustainable travel modes; Mode choice; Transportation network; Demand and supply

Availability: Bishop, J.D.K. (2022). "Decarbonising Transport with Intelligent Mobility." *Intelligent Decarbonisation*. *Lecture Notes in Energy*, *86*, pp. 163–172. https://doi.org/10.1007/978-3-030-86215-2_18

3.3. Title: Essays on Environmental Economics and Transportation

Author(s): Ankney, K.C.

Abstract: This dissertation studies factors influencing fuel efficiency adoption and decarbonization of the U.S. passenger vehicle fleet in three essays.

Chapter 1 explores a common explanation for the "energy efficiency gap." The "energy efficiency gap" is a puzzle characterized by consumer under-investment in energy-efficient products (e.g., hybrid vehicles), whose higher upfront cost is offset by future energy savings. One common but empirically unsubstantiated explanation for the gap is that credit constraints—prohibitively high borrowing costs or a lack of access to credit—hinder consumers' ability to make energy efficiency investments. This paper provides the first direct evidence of the relationship between credit constraints and fuel economy demand in the U.S. new vehicle market. I find a statistically significant but economically minor negative association between auto loan interest rates and fuel economy choices, suggesting that credit constraints do not explain consumers' failure to purchase fuel-efficient new vehicles.

Chapter 2 focuses on vehicle lessee valuation of fuel cost savings and is coauthored with Benjamin Leard. Vehicle leasing involves a consumer renting a car for about three years. We show that estimating valuation of leased vehicle fuel cost savings is fundamentally different from estimating valuation of purchased vehicle fuel cost savings. We find that new vehicle lessees and buyers undervalue lifetime fuel cost savings. But because leasing periods last around three years, new vehicle lessees fully value lease-specific fuel cost savings. Our estimates also imply that leasing companies set residual values—a vehicle's post-lease expected resale value—with the expectation that used vehicle buyers undervalue post-lease fuel cost savings.

Chapter 3 explores the effect of new electric vehicle subsidies on gasoline vehicle scrappage and is coauthored with Benjamin Leard and Joshua Linn. Electric vehicles remain a promising technology for decarbonizing the transportation sector. We build an equilibrium model of the passenger vehicle fleet to show that electric vehicle purchase subsidies act as a force to accelerate the rate at which the passenger vehicle fleet turns over. By lowering electric vehicle purchase costs, subsidies shift demand away from used gasoline vehicles toward electric vehicles, which lowers equilibrium used gasoline vehicle prices and accelerates fleet turnover.

Subject Areas: Environmental economics; Energy efficiency; Passenger vehicles; Fuel efficiency; Electric vehicles; Government policy; CAFE standards

Availability: Ankney, K.C. (2022). *Essays on Environmental Economics and Transportation*. Doctoral Dissertation, Georgetown University, Washington, DC. https://www.proquest.com/openview/ed95c9727d17c35b40542e477d0087c2/1?pq-origsite=gscholar&cbl=18750&diss=y

3.4. Title: Private Costs of Carbon Emissions Abatement by Limiting Beef Consumption and Vehicle Use in The United States

Author(s): McFadden, B.R., Ferraro, P.J., and Messer, K.D.

Abstract: A popular strategy for mitigating climate change is to persuade or incentivize individuals to limit behaviors associated with high greenhouse gas emissions. In this study, adults in the mid-Atlantic United States bid in an auction to receive compensation for eliminating beef consumption or limiting vehicle use. The auction incentivized participants to reveal their true costs of accepting these limits for periods ranging from one week to one year. Compliance with the conditions of the auction was confirmed via a random field audit of the behavioral changes. The estimated median abatement costs were greater than $600 per tCO2e for beef consumption and $1,300 per tCO2e for vehicle use, values much higher than the price of carbon offsets and most estimates of the social cost of carbon. Although these values may decline over time with experience or broader social adoption, they imply that policies that encourage innovations to reduce the costs of behavior change, such as meat alternatives or emission-free vehicles, may be a more fruitful than those that limit beef consumption or vehicle use.

Subject Areas: Climate change; Greenhouse gas emissions; Beef consumption; Vehicle use

Availability: McFadden, B.R., Ferraro, P.J., and Messer, K.D. (2022). "Private Costs of Carbon Emissions Abatement by Limiting Beef Consumption and Vehicle Use in The United States." *PLoS ONE*, *17*(1). https://doi.org/10.1371/journal.pone.0261372

3.5. Title: The Role of Pickup Truck Electrification in the Decarbonization of Light-Duty Vehicles

Author(s): Woody, M., Vaishnav, P., Keoleian, G.A., Kleine, R.D., Kim, H.C., Anderson, J.E., and Wallington, T.J.

Abstract: Electrification can reduce the greenhouse gas (GHG) emissions of light-duty vehicles. Previous studies have focused on comparing battery electric vehicle (BEV) sedans to their conventional internal combustion engine vehicle (ICEV) or hybrid electric vehicle (HEV) counterparts. We extend the analysis to different vehicle classes by conducting a cradle-to-grave life cycle GHG assessment of model year 2020 ICEV, HEV, and BEV sedans, sports utility vehicles (SUVs), and pickup trucks in the United States. We show that the proportional emissions benefit of electrification is approximately independent of vehicle class. For sedans, SUVs, and pickup trucks we find HEVs and BEVs have approximately 28% and 64% lower cradle-to-grave life cycle emissions, respectively, than ICEVs in our base case model. This results in a lifetime BEV over ICEV GHG emissions benefit of approximately 45 tonnes CO_2e for sedans, 56 tonnes CO_2e for SUVs, and 74 tonnes CO_2e for pickup trucks. The benefits of electrification remain significant with increased battery size, reduced BEV lifetime, and across a variety of drive cycles and decarbonization scenarios. However, there is substantial variation in emissions based on where and when a vehicle is charged and operated, due to the impact of ambient temperature on fuel economy and the spatiotemporal variability in grid carbon intensity across the United States. Regionally, BEV pickup GHG emissions are 13–118% of their ICEV counterparts and 14–134% of their HEV counterparts across U.S. counties. BEVs have lower GHG emissions than HEVs in 95–96% of counties and lower GHG emissions than ICEVs in 98–99% of counties. As consumers migrate from ICEVs and HEVs to BEVs, accounting for these spatiotemporal factors and the wide range of available vehicle classes is an important consideration for electric vehicle deployment, operation, policymaking, and planning.

Subject Areas: Electric vehicles; Pickup truck; Greenhouse gas emissions; Life cycle assessment; Charging; Climate; Energy

Availability: Woody, M., Vaishnav, P., Keoleian, G.A., Kleine, R.D., Kim, H.C., Anderson, J.E., and Wallington, T.J. (2022). "The Role of Pickup Truck Electrification in the Decarbonization of Light-Duty Vehicles." *Environmental Research Letters*, *17*(3). https://doi.org/10.1088/1748-9326/ac5142

3.6. Title: Are Electric Vehicle Targets Enough? The Decarbonization Benefits of Managed Charging and Second-Life Battery Uses

Author(s): Dean, M.D. and Kockelman, K.M.

Abstract: Vehicle electrification delivers fast decarbonization benefits by significantly improving vehicle efficiency and relying on less carbon-intense feedstocks. As power grids transition away from carbon-intensive generation and battery energy density improves, the transportation sector's greenhouse gas savings may deliver upwards of a 75% reduction in current carbon footprint for many nations. Actual savings depend on many variables, like power grid feedstocks, charging rates and schedules, driver behavior, and weather. A special synergy between power and transportation sectors comes via managed charging and second-life battery uses for energy storage systems. This paper reviews the added carbon and energy savings that can come from these two strategies. If charging stations are widely available at one's destination, utility-controlled managed charging could reduce emissions from electric vehicle charging by one-third. Downcycling electric vehicle batteries for energy storage can also lower peak power plant use, avoid curtailment of renewable feedstocks, and lessen households' power-based carbon footprints by half—or contribute up to 5 percent of grid power capacity.

Subject Areas: Electric vehicles; Transportation and sustainability; Air quality; Greenhouse gas emissions; Alternative transportation fuels; Transportation drivetrain technologies

Availability: Dean, M.D. and Kockelman, K.M. (2022). "Are Electric Vehicle Targets Enough? The Decarbonization Benefits of Managed Charging and Second-Life Battery Uses." *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(8), pp. 24–43. https://doi.org/10.1177/03611981221082572

3.7. Title: Re-Thinking Procurement Incentives for Electric Vehicles to Achieve Net-Zero Emissions

Author(s): Nunes, A., Woodley, L., and Rossetti, P.

Abstract: Procurement incentives are a widely leveraged policy lever to stimulate electric vehicle (EV) sales. However, their effectiveness in reducing transportation emissions depends on the behavioral characteristics of EV adopters. When an EV is used, under what conditions and by whom dictates whether or not these vehicles can deliver emissions reductions. Here, we document that replacing gasoline powered vehicles with EVs may—depending on behavioral characteristics—increase, not decrease, emissions. We further show that counterfactual vehicle inventory—how many vehicles a household would own absent an EV purchase—is an important influencer of these effects. We conclude that achieving emissions reductions using EVs requires redesigning procurement incentive programs in a manner that (re)distributes incentives towards the second-hand EV market. Doing so would not only facilitate emissions reductions but also address fiscal prudency and regressivity concerns associated with these programs.

Subject Areas: Environmental economics; Psychology and behavior; Sustainability

Availability: Nunes, A., Woodley, L., and Rossetti, P. (2022). "Re-Thinking Procurement Incentives for Electric Vehicles to Achieve Net-Zero Emissions." *Nature Sustainability*, *5*, pp. 527–532. https://doi.org/10.1038/s41893-022-00862-3

3.8. Title: To Reduce Transportation Emissions, Make It Realistic for People to Ditch Cars

Author(s): Scorey, D.

Abstract: Blog.

Subject Areas: Transportation; Congestion; Carbon emissions; Public transit; Climate and resilience

Availability: Scorey, D. (2022). "To Reduce Transportation Emissions, Make It Realistic for People to Ditch Cars." *Smart Cities Dive*. https://www.smartcitiesdive.com/news/to-reduce-transportation-emissions-make-it-realistic-for-people-to-ditch-c/623041/

3.9. Title: Life Cycle Climate Performance Evaluation (LCCP) of Low-GWP Refrigerants for Electric Vehicle Heat Pump Towards Carbon Neutrality

Author(s): Long, J., Yu, B., Wang, D., Ouyang, H., Shi, J., and Chen, J.

Abstract: The environmental-friendly heat pump with low global warming potential (GWP) is increasingly essential for the electric vehicle (EV) to save energy consumption and extend the driving range, it is beneficial to achieve the carbon neutrality from reducing both direct and indirect carbon emissions. The long-used R134a has a great climate impact due to its high GWP, researchers have been investigating heat pump systems with low-GWP refrigerants. Previously, the life cycle climate performance (LCCP) was a widely accepted metric to evaluate the carbon footprint of mobile air conditioning systems "from cradle to grave" for the classical engine vehicle, however, such LCCP analyses about EV heat pumps can hardly be found. To facilitate the EV industry and policymakers better understanding the environmental impacts of those low-GWP refrigerants, this study provided a comprehensive LCCP analysis for the EV heat pumps based on the system bench test results, local climates, local power supply characteristics, real-world driving patterns, vehicle cabin thermal sensation, and climate control load. Three low-GWP refrigerants, i.e., CO_2, binary blends of CO_2 and R41 (with GWP values of 49), M2 (R410A substitute with GWP values of 137), were compared against R410A and R134a. Among the selected refrigerants, CO_2/R41 shows the lowest LCCP, reducing 5–42 percent of total emissions relative to R134a in various climates, and 1–21% less than the CO_2 system.

Subject Areas: Electric vehicle; Heat pump; Carbon neutrality; Life cycle climate performance; Low-GWP refrigerant; Climate change

Availability: Long, J., Yu, B., Wang, D., Ouyang, H., Shi, J., and Chen, J. (2022). "Life Cycle Climate Performance Evaluation (LCCP) of Low-GWP Refrigerants for Electric Vehicle Heat Pump Towards Carbon Neutrality." *Applied Energy Symposium 2022: Clean Energy towards Carbon Neutrality (CEN2022)*, Ningbo, China.
https://www.researchgate.net/publication/360619769

3.10. Title: Life Cycle Environmental Impact of Mobility Servitization: The Effect of Fleet Technology Changes

Author(s): Fernando, C., Soo, V.K., Compston, P., and Doolan, M.

Abstract: In recent years, Mobility as a Service (MaaS) modes, such as carpooling (CP) and ridesourcing (RS), are gaining popularity. Although studies have explored the greenhouse gas (GHG) emissions of different MaaS modes, the integration of different powertrain systems and car body styles in MaaS fleets have not been assessed in detail. This research analyzed the full life cycle GHG impacts of MaaS fleet changes employing passenger-kilometer as the functional unit. Higher occupancy mode, CP, is shown to produce the lowest GHG emissions (up to 23 percent compared to a private car) irrespective of the powertrain system or car body style changes in the fleets. Results highlighted that the use of electric vehicles with sedan body type instead of SUVs has better potential to reduce GHG emissions (at least 57 percent compared to the current fleet) in RS. Results have also shown the higher GHG emissions of larger (comfort) vehicle models used in RS mode, an 11–382% increase compared to midsized sedans and SUVs. BEV sedan and SUV larger vehicles in the RS fleet have shown higher GHG emissions than ICEV sedan PCs. This study has shown the importance of electrifying the RS fleet, especially the larger vehicles, and increasing net occupancy to reduce GHG emissions. The study has also highlighted electric sedans as the least GHG emitting technology combination in the MaaS fleets.

Subject Areas: Mobility servitisation; Mobility as a Service; Dynamic life cycle assessment; Passenger kilometer; Electric vehicles; Light weighting

Availability: Fernando, C., Soo, V.K., Compston, P., and Doolan, M. (2022). “Life Cycle Environmental Impact of Mobility Servitization: The Effect of Fleet Technology Changes.” *Procedia CIRP*, *105*, pp. 829–834. https://doi.org/10.1016/j.procir.2022.02.137

3.11. Title: Three Essays on Environmental Economics

Author(s): Jiang, Z.

Abstract: This dissertation studies three distinctive aspects of environmental economics. Chapter 1 examines the impact of smoke from fires on agriculture production of the two main U.S. cash crops: corn and soybeans. Linking smoke plume maps derived from satellite images with county level information on corn and soybean yields, I use a panel data approach to estimate exposure to smoke plumes treating their exact frequency, timing, and location in any year as exogenous shocks. Exposure to one more day of smoke, on average, reduces yields of corn and soybeans by 0.31% and 0.23%, respectively. To help put these results in an economic context for corn and soybeans, a 10% increase in smoke relative to 2019 results in an annual loss of almost $1 billion.

Chapter 2 explores the interaction relation of temperature and precipitation with number of outdoor recreation trips. Using detailed information on outdoor recreation trips in England over a four-year period, I use a semi-parametric response surface approach to examine the interaction relation. I found that although daily visits increase with temperature and decrease with rain, these gradients only have small variations across rain or temperature. Interaction of the two variables plays a small role in outdoor recreation.

Chapter 3 examines how the introduction of ridesharing services such as Uber and Lyft into the U.S. urban market influences trip choice decisions. Using data from the 2009 and 2017 National Household Travel Surveys, I show that the longer Uber and Lyft have been in an urban market, the greater the increase in the 2017 survey trips that were made using taxi/rideshare services relative to the 2009 survey benchmark. This increase is driven by an upward shift that is more pronounced for short and longer distance trips than for middle distance trips and is also more pronounced on weekdays relative to weekends. Ridesharing services are shown to be a substitute for short haul bus trips, but a complement with longer rail trips.

Subject Areas: Environmental economics; Smoke plume; Temperature and precipitation; Outdoor recreation trips; Ridesharing services; Trip choice decisions

Availability: Jiang, Z. (2022). *Three Essays on Environmental Economics*. Doctoral Dissertation, University of California, San Diego, CA. https://escholarship.org/uc/item/1cq392j2

3.12. Title: Impact on the Reduction of CO_2 Emissions Due to the Use of Telemedicine

Author(s): Morcillo Serra, C., Aroca Tanarro, A., Cummings, C.M., Fuertes, A.J., and Martínez, J.F.T.

Abstract: Digital health can reduce CO_2 emissions thanks to telemedicine and access to digital test results and medical reports. However, the environmental impact of digital health activity is not well known. Here, we show that telemedicine reduces CO_2 emissions. We found a net total of 6,655 tons of CO_2 emissions decrease through a reduction in patient travel to surgeries and medical clinics thanks to the alternatives of digital appointments and digital access to test results and medical reports, which avoid the need to travel to a clinic for a face-to-face visit or to pick up printed results or reports. During 2020, a total of 640,122 digital appointments were carried out by the health care company, which avoided 1,957 net tons of CO_2 emissions, while patients downloaded 3,064,646 digital medical reports through the company portal, which avoided an additional 4,698 net tons of CO_2 emissions. Our results demonstrate how digital appointments and digital reports reduce CO_2 emissions by reducing the need for patient travel.

Subject Areas: Climate sciences; Health care

Availability: Morcillo Serra, C., Aroca Tanarro, A., Cummings, C.M., Fuertes, A.J., and Martínez, J.F.T. (2022). "Impact on the Reduction of CO_2 Emissions Due to the Use of Telemedicine." *Scientific Reports volume 12*. https://doi.org/10.1038/s41598-022-16864-2

3.13. Title: Assessing Environmental Benefits from Shared Micromobility Systems Using Machine Learning Algorithms and Monte Carlo Simulation

Author(s): Peng, H., Nishiyama, Y., and Sezaki, K.

Abstract: Shared micromobility systems (SMSs) are paving the way for new, more convenient travel options while also lowering transportation-related greenhouse gas (GHG) emissions. However, few studies have used real-world trip data to estimate SMSs' environmental benefits, especially for dockless scooter-sharing services. To this end, we proposed a system to estimate the GHG emission reduction affected by SMSs. First, several machine learning (ML) algorithms were utilized to identify citizens' travel mode choice preferences, and then the mode substituted by each shared micromobility trip was estimated. We compared the ML algorithms' estimation results and selected those from the random forest, lightGBM, and XGBoost model for further estimating GHG reductions. Second, the Monte Carlo simulations were used to simulate the substituted mode at the trip level to improve the reliability of the final GHG reduction estimation. Finally, the environmental benefits were calculated based on the trip distances and the travel modes that were substituted. Instead of estimating a specific number, we obtained a probabilistic outcome for the environmental benefits while considering the level of uncertainty. Our results suggest that SMSs have positive environmental impacts and have the potential to facilitate the decarbonization of urban transport. According to these findings, implications and suggestions on extending SMSs' environmental benefits are proposed.

Subject Areas: Shared micromobility; Environmental impacts; Greenhouse gas (GHG) emission; Machine learning; Big data

Availability: Peng, H., Nishiyama, Y., and Sezaki, K. (2022). "Assessing Environmental Benefits from Shared Micromobility Systems Using Machine Learning Algorithms and Monte Carlo Simulation." *Sustainable Cities and Society*, *87*. https://doi.org/10.1016/j.scs.2022.104207

3.14. Title: Autonomous Electric Vehicles Can Reduce Carbon Emissions and Air Pollution in Cities

Author(s): Ercan, T., Onat, N.C., Keya, N., Tatari, O., Eluru, N., and Kucukvar, M.

Abstract: Heavy dependence on personal vehicle usage made the transportation sector a major contributor to global climate change and air pollution in cities. In this study, we analyzed autonomous electric vehicles and compared their potential environmental impacts with public transportation options, carpooling, walking, cycling, and various transportation policy applications such as limiting lane-mile increases, and carbon tax. Fractional split multinomial logit and system dynamics modeling approaches are integrated to create a novel hybrid simulation model to process data from 929 metro/micropolitan areas in the U.S. for transportation mode choice behavior. The results show that the adoption of autonomous electric vehicles can reduce greenhouse gas emissions by up to 34% of the total emissions from transportation by 2050. This study has revealed that transportation-related impacts can only be reduced with a paradigm shift in the current practices of today's transportation industry, with disruptive reforms of automation, electrification, and shared transport.

Subject Areas: Shared micromobility; Environmental impacts; Greenhouse gas (GHG) emission; Machine learning; Big data

Availability: Ercan, T., Onat, N.C., Keya, N., Tatari, O., Eluru, N., and Kucukvar, M. (2022). "Autonomous Electric Vehicles Can Reduce Carbon Emissions and Air Pollution in Cities." *Transportation Research Part D: Transport and Environment*, *112*. https://doi.org/10.1016/j.trd.2022.103472

3.15. Title: Optimizing the Economic and Environmental Benefits of Ride-Hailing and Pooling

Author(s): Naumov, S. and Keith, D.

Abstract: Ride-hailing platforms such as Uber and Lyft promise to reduce the negative externalities of driving and improve access to transportation. However, recent empirical evidence has been mixed about the impact of ride-hailing on US cities, often resulting in a net increase in traffic congestion and greenhouse gas (GHG) emissions, largely due to increased travel demand and competition with public transit. Pooled rides, in which multiple passengers share a single vehicle, are an effective solution to improve the sustainability of ride-hailing, reducing GHG emissions and traffic congestion and appealing to price-sensitive population segments by offering relatively cheaper rides. Yet, most ride-hailing trips are unprofitable currently, resulting from ride-hailing rides being subsidized (especially pooled) to compete with cheaper transportation alternatives such as public transit. In this paper, we consider whether price optimization can be used to improve ride-hailing revenues while also reducing the environmental impacts of ride-hailing, particularly as the cost of ride-hailing is expected to fall into the future with the introduction of automated vehicles. Using a discrete choice experiment and multinomial logit choice model with a representative sample of the US population, we estimate consumer preferences for the attributes of ride-hailing services and use them to explore how ride prices affect the revenue of ride-hailing platforms and the total vehicle miles traveled (VMT) by the ride-hailing fleet. We show that as the costs of driving fall, continuously increasing the difference between the prices of individual and pooled rides is financially optimal for ride-hailing platforms. Importantly, this pricing strategy also significantly reduces total VMT, resulting in a win–win for ride-hailing platforms and cities. We perform extensive sensitivity analyses and show that our results are qualitatively robust under a wide range of consumer preferences and market conditions but that the optimal trajectory of prices and realized gains vary, highlighting opportunities for ride-hailing services to influence the future of urban transportation.

Subject Areas: Optimal pricing; Ride-sharing; Sharing economy; Sustainable transportation; Urban transportation

Availability: Naumov, S. and Keith, D. (2022). "Optimizing the Economic and Environmental Benefits of Ride-Hailing and Pooling." *Production and Operations Management*, pp. 1–26. https://doi.org/10.1111/poms.13905

3.16. Title: How to Encourage Employees to Reduce Transportation Emissions

Author(s): Not available.

Abstract: Blog.

Subject Areas: Public transportation; Carpooling; Group transport; Incentive program

Availability: Not available. (2022). "How to Encourage Employees to Reduce Transportation Emissions." *EconoTimes, Elmin Media LLC*. https://www.econotimes.com/How-to-Encourage-Employees-to-Reduce-Transportation-Emissions-1645640

3.17. Title: Active and Micro Mobility Modes Can Provide Cost-Effective Emission Reductions—If We Let Them

Author(s): Litman, T.

Abstract: Blog.

Subject Areas: Micro mobility modes; Active mode travel demands; Social equity; Cost effectiveness; Strategic objectives

Availability: Litman, T. (2022). "Active and Micro Mobility Modes Can Provide Cost-Effective Emission Reductions—If We Let Them." *Planetizen*. https://www.planetizen.com/blogs/120289-active-and-micro-mobility-modes-can-provide-cost-effective-emission-reductions-if-we

3.18. Title: Effectiveness and Cost-Effectiveness of Vehicle Lifespan Caps for Reducing Light-Duty Vehicle Fleet GHG Emissions in the U.S.

Author(s): Striepe, M.C.

Abstract: Accelerated vehicle turnover gets new technologies on the road faster but increases the rate of vehicle production and purchases. By combining vehicle fleet modelling, life cycle assessment (LCA), and total ownership costing this work estimates the GHG emissions and costs for the U.S. light-duty vehicle fleet from 2020 to 2050 under a forced early retirement program. We estimate that under current EV sales projections, even when combined with vehicle light-weighting, fuel consumption improvement, and vehicle size reduction, vehicle lifespan caps are ineffective at reducing GHG emissions. While under a 100% EV sales target by 2035, applying a 12-year lifespan cap on conventional light-duty vehicles can be effective, reducing cumulative GHG emissions from 2020 through 2050 by 6%. However, the abatement costs for this method are high, near 2020 USD 1000/tCO_2e, placing either a high burden on the government for providing incentives or markedly increasing average vehicle ownership costs.

Subject Areas: Life cycle assessment; GHG emissions reduction; Vehicle lifespan caps; Light-duty vehicle

Availability: Striepe, M.C. (2022). *Effectiveness and Cost-Effectiveness of Vehicle Lifespan Caps for Reducing Light-Duty Vehicle Fleet GHG Emissions in the U.S.* Master's Thesis, University of Toronto, Ontario, Canada.
https://tspace.library.utoronto.ca/bitstream/1807/125623/2/Cusack_Striepe_Melissa_202211_MAS_thesis.pdf

3.19. Title: Consumption-Based Emissions Inventory Methodology

Author(s): EcoDataLab.

Abstract: The consumption-based emissions inventory (CBEI) is not a direct measurement of individual households' consumption or behavior. Instead, we use a model (a series of complex calculations) to estimate consumption of goods and services, and associated emissions. Our approach uses a combination of real-world consumption or emissions data when available, along with predictions based on demographic, regional, and national averages.

Subject Areas: Consumption-based emissions inventory; Models; Consumption; Emissions; Demographics

Availability: EcoDataLab. (2022). *Consumption-Based Emissions Inventory Methodology*. Methodology Report, EcoDataLab. https://www.ecodatalab.com/cbei/methodology

3.20. Title: Evaluating Active and Micro Mode Emission Reduction Potentials

Author(s): Litman, T.

Abstract: This study examines the potential roles that active modes (walking, bicycling, and variants such as wheelchairs, strollers, and handcarts) and micro modes (e-bikes and e-scooters) can play in reducing climate emissions. Conventional planning considers these modes unimportant and ineffective at reducing emissions. More comprehensive analysis indicates that they play unique and important roles in an efficient and equitable transportation system, and can provide large and cost-effective reductions in vehicle travel and emissions. Often-cited statistics imply that active and micro modes serve a few percent of total travel, but more comprehensive surveys show that they actually serve 10–15% of trips and their potential is far higher. By helping create more compact, multimodal communities, active mode improvements can leverage large vehicle travel reductions, so each additional mile of active and micro mode travel reduces more than one motor vehicle mile. Improving these modes provides many co-benefits in addition to emission reductions. This analysis indicates that cost-effective improvements and incentives could double or triple active mode travel, and an integrated program of active and public transport improvements, TDM incentives and Smart Growth policies can reduce emissions by 15–50%. A review of recent emission reduction plans indicates that most undervalue active and micro modes. More comprehensive analysis tends to justify far more investment in these modes.

Subject Areas: Active transportation; Walking; Bicycling; Micro modes; e-Bikes; Emission reduction; Climate action

Availability: Litman, T. (2022). *Evaluating Active and Micro Mode Emission Reduction Potentials.* Paper for TRB 2023 Annual Meeting: TRBAM-23-03449, Victoria Transport Policy Institute, British Columbia, Canada. https://www.vtpi.org/amerp.pdf

3.21. Title: Monetary Evaluation of Co-Benefits of Nature-Based Flood Risk Reduction Infrastructure to Promote Climate Justice

Author(s): Stroud, H.M., Kirshen, P.H., and Timmons, D.

Abstract: Climate change disproportionately impacts socially and economically marginalized populations. To rectify this imbalance, adaptation plans can explicitly include projects that not only lower the threat for these populations but also may provide co-benefits that improve the quality of their lives. One method to evaluate these co-benefits or any additional costs to these populations in the analysis of adaptation options is to monetize them. Monetization will convert these generally non-market impacts into monetary units and allow them to be compared with each other as well as other market impacts in benefit–cost analyses. The monetized values can also be weighted by the utility of these benefits and costs to the different socio-economic groups in a population. Using illustrative case studies in two areas of Boston USA with different socio-economic conditions but similar population sizes and flood threats, this evaluation approach is tested when using nature-based solutions (NBS) to lower flood threats. The non-market benefits and costs included are improved air quality, availability of public transportation, recreational space, rent escalation due to gentrification, and prevented loss of wages due to reduction in mental stress. Utility is an inverse function of annual income. The case studies illustrate that by quantifying the non-market impacts the value of including adaptation actions that promote climate justice co-benefits can be shown.

Subject Areas: Climate justice; Adaptation; Monetization; Co-benefits; Nature-based solutions

Availability: Stroud, H.M., Kirshen, P.H., and Timmons, D. (2022). "Monetary Evaluation of Co-Benefits of Nature-Based Flood Risk Reduction Infrastructure to Promote Climate Justice." *Mitigation and Adaptation Strategies for Global Change*, *28*. https://doi.org/10.1007/s11027-022-10037-2

3.22. Title: Mitigating the Climate Impact of the ASOR Annual Meeting

Author(s): Herrmann, V.R., Vaughn, A.G., Budin, S., Catanzariti, A., Dixon, H., Harmanşah, Ö., Harvey, C., Kersel, M., MacAllister, A., and Proctor, L.

Abstract: In the face of a climate emergency that threatens not only contemporary life but also the record of our shared past, how will ASOR respond? The ad hoc Climate Impact Committee encourages the ASOR Board to adopt concrete actions toward the goal of making the Annual Meeting carbon neutral. ASOR's leadership in academic decarbonization would not only advance the public good, but would be a motivating factor in attracting and retaining the new generation of ASOR members. Reducing the carbon footprint of the Annual Meeting is the most visible and immediate action ASOR can take to reduce its climate impact.

Subject Areas: Travel emission; Carbon offsetting; Carbon impact; Mitigation strategy; Climate change

Availability: Herrmann, V.R., Vaughn, A.G., Budin, S., Catanzariti, A., Dixon, H., Harmanşah, Ö., Harvey, C., Kersel, M., MacAllister, A., and Proctor, L. (2022). *Mitigating the Climate Impact of the ASOR Annual Meeting.* Final Report of the ASOR Ad Hoc Climate Impact Committee, American Society of Overseas Research, Alexandria, VA. https://www.asor.org/wp-content/uploads/2022/11/Climate-Impact-Final-Report.pdf

3.23. Title: Essays on Energy and Public Economics

Author(s): Lyubich, E.

Abstract: Energy is an essential input into the lives of individuals and the production of firms. While energy use has numerous private benefits, it imposes an external social cost as the combustion of fossil fuels increases the concentration of greenhouse gases and accelerates the climate crisis. A central role of the public sector is to reduce such externalities. Governments can intervene by creating financial incentives such as taxes or subsidies, by investing into public goods such as research and development of green technologies or infrastructure that decreases aggregate fossil fuel energy demand, or by directly regulating emissions through caps or bans. The aggregate and distributional impact of such policies depends on baseline energy use patterns and available alternatives. My dissertation examines heterogeneity in energy use and carbon emissions—documenting it, exploring its drivers, and discussing its implications for the impact of different public sector interventions.

Subject Areas: Energy use; Fossil fuels; Social cost; Policy; Public sector interventions

Availability: Lyubich, E. (2022). *Essays on Energy and Public Economics*. Doctoral Dissertation, University of California, Berkeley, CA. https://escholarship.org/uc/item/8z09m23m

3.24. Title: Quantifying Policy Gaps for Achieving the Net-Zero GHG Emissions Target in the U.S. Light-Duty Vehicle Market Through Electrification

Author(s): Ou, S., Lin, Z., Jiang, Y., and Zhang, S.

Abstract: The U.S. light-duty vehicle (LDV) industry, a major greenhouse gas (GHG) emitting sector, is embracing decarbonization. Considering only electrification pathways, this study uses publicly available tools MA3T and VISION on vehicle market penetration, fleet accounting and life-cycle analysis to quantify the policy gaps for LDVs to achieve the net-zero GHG emissions target in nine vehicle penetration cases under two electricity mix scenarios, including the U.S. administration's decarbonization strategy—100% clean electricity by 2035. The MA3T model is a multinomial discrete choice model for market share projection by vehicle technology, and the VISION is a vehicle stocks and GHG emissions projection model by using vehicle and travel characteristics. This study projects the impacts of technology and policy enforcement on shaping the dynamics and decarbonization of the LDV market. Achieving the expected improvement of battery technology and charging infrastructure is critical but can only reduce the 2050 GHG emissions to 48–54% of the 2020 level under the electricity renewable mix scenario. It is almost impossible to achieve a 100% battery electric vehicle stock by 2050 and the 2050 net-zero target in the LDV industry unless ban of internal combustion engine technology is implemented starting in 2035 and under the 2035 100% clean electricity scenario. These extreme conditions also sacrifice most from the consumer welfare perspective. A greater policy forcing intensity accelerates plug-in electric vehicle penetration, while with declining marginal effect and reduced consumer welfare. Among the investigated policy scenarios, the policy forcing intensity equivalent to a fuel tax of $1–$2 per gasoline gallon reduces the most GHG emissions while keeping a positive consumer welfare.

Subject Areas: Consumer welfare; Electric vehicle; Vehicle and energy policy; Greenhouse gas emissions target; Internal combustion engine vehicle banning; Light-duty vehicle

Availability: Ou, S., Lin, Z., Jiang, Y., and Zhang, S. (2022). "Quantifying Policy Gaps for Achieving the Net-Zero GHG Emissions Target in the U.S. Light-Duty Vehicle Market Through Electrification." *Journal of Cleaner Production*, *380*(Part 2). https://doi.org/10.1016/j.jclepro.2022.135000

Chapter 4. Health

4.1. Title: Assessment of Disparities in Spatial Accessibility to Vaccination Sites in Florida

Author(s): Kim, K., Ghorbanzadeh, M., Horner, M.W., and Ozguven, E.E.

Abstract: Community-wide vaccinations would be the most effective way to end the COVID-19 pandemic and accessing vaccination sites would be central in this nexus. Given that the number of COVID-19 vaccines was limited to certain groups of people in the early phases of vaccine distribution, age-based prioritization may have overlooked differences in income levels and the races/ethnicities among older populations. In this vein, using two spatial accessibility measures based on spatially disaggregated hexagons, this paper assesses the disparities in spatial accessibility to vaccination sites with consideration of older populations' (65+) income levels and their races/ethnicities at the state and the county level. To evaluate the disparities and identify counties with the greatest disparities, a nonparametric two-sample Kolmogorov–Smirnov test at the state level and the G_i^* statistic at the county level are implemented. The findings of this study indicate that older blacks, older Hispanics, and older populations below the poverty level had better access compared to older whites, older non-Hispanics, and older populations above the poverty level, respectively, at the state level, whereas access disparities varied at counties and geographic locales. We thus conclude that policymakers should take into account older populations' income levels and races/ ethnicities for vaccine prioritization and should pay attention to counties with relatively high disparities in spatial access to vaccines.

Subject Areas: COVID-19; Vaccination sites; Spatial accessibility; Disparities; Hexagons

Availability: Kim, K., Ghorbanzadeh, M., Horner, M.W., and Ozguven, E.E. (2022). "Assessment of Disparities in Spatial Accessibility to Vaccination Sites in Florida." *Annals of GIS*, *28*(3), pp. 263–277. https://doi.org/10.1080/19475683.2022.2026474

4.2. Title: Health Benefits of Strategies for Carbon Mitigation in US Transportation, 2017–2050

Author(s): Maizlish, N., Rudolph, L., and Jiang, C.

Abstract: Objectives: To quantify health benefits and carbon emissions of two transportation scenarios that contrast optimum levels of physical activity from active travel and minimal air pollution from electric cars.

Methods: We used data on burden of disease, travel, and vehicle emissions in the U.S. population and a health impact model to assess health benefits and harms of physical activity from transportation-related walking and cycling, fine particulate pollution from car emissions, and road traffic injuries. We compared baseline travel with walking and cycling a median of 150 weekly minutes for physical activity, and with electric cars that minimized carbon pollution and fine particulates.

Results: In 2050, the target year for carbon neutrality, the active travel scenario avoided 167,000 deaths and gained 2.5 million disability-adjusted life years, monetized at $1.6 trillion using the value of a statistical life. Carbon emissions were reduced by 24 percent from baseline. Electric cars avoided 1400 deaths and gained 16,400 disability-adjusted life years, monetized at $13 billion.

Conclusions: To achieve carbon neutrality in transportation and maximize health benefits, active travel should have a prominent role along with electric vehicles in national blueprints.

Subject Areas: Carbon emissions; Carbon neutrality; Health benefits; Active travel; Air pollution; Electric vehicles

Availability: Maizlish, N., Rudolph, L., and Jiang, C. (2022). “Health Benefits of Strategies for Carbon Mitigation in US Transportation, 2017–2050.” *American Journal of Public Health*, *112*(3), pp. 426–433. https://doi.org/10.2105/AJPH.2021.306600

4.3. Title: Investigating the Association Between Mass Transit Adoption and COVID-19 Infections in US Metropolitan Areas

Author(s): Thomas, M.M., Mohammadi, N., and Taylor, J.E.

Abstract: Urbanization introduces the threat of increased epidemic disease transmission resulting from crowding on mass transit. The coronavirus disease 2019 (COVID-19) pandemic, which has directly led to over 600,000 deaths in the U.S. as of July 2021, triggered mass social distancing policies to be enacted as a key deterrent of widespread infections. Social distancing can be challenging in confined spaces required for transportation such as mass transit systems. Little is published regarding the degree to which mass transit system adoption effects impacted the rise of the COVID-19 pandemic in urban centers. Taking an ecological approach where areal data are the unit of observation, this national-scale study aims to measure the association between the adoption of mass transit and COVID-19 spread through confirmed cases in U.S. metropolitan areas. National survey-based transit adoption measures are entered in negative binomial regression models to evaluate differences between areas. The model results demonstrate that mass transit adoption in U.S. metropolitan areas was associated with the magnitude of outbreaks. Higher incidence of COVID-19 early in the pandemic was associated with survey results conveying higher transit use. Increasing weekly bus transit usage in metropolitan statistical areas by one scaled unit was associated with a 1.38 [95% CI: (1.25, 1.90)] times increase in incidence rate of COVID-19; a one scaled unit increase in weekly train transit usage was associated with an increase in incidence rate of 1.54 [95% CI: (1.42, 2.07)] times. These conclusions should inform early action practices in urban centers with busy transit systems in the event of future infectious disease outbreaks. Deeper understanding of these observed associations may also benefit modeling efforts by allowing researchers to include mathematical adjustments or better explain caveats to results when communicating with decision makers and the public in the crucial early stages of an epidemic.

Subject Areas: SARS-CoV-2; COVID-19; Transit; Disease transmission; Public health; Public transportation

Availability: Thomas, M.M., Mohammadi, N., and Taylor, J.E. (2022). “Investigating the Association Between Mass Transit Adoption and COVID-19 Infections in US Metropolitan Areas.” *Science of The Total Environment*, *811*. https://doi.org/10.1016/j.scitotenv.2021.152284

4.4. Title: Climate Change and Physical Activity: Ambient Temperature and Urban Trail Use in Texas

Author(s): Lanza, K., Gohlke, J., Wang, S., Sheffield, P.E., and Wilhelmi, O.

Abstract: Individuals in the USA are insufficiently active, increasing their chronic disease risk. Extreme temperatures may reduce physical activity due to thermal discomfort. Cooler climate studies have suggested climate change may have a net positive effect on physical activity, yet research gaps remain for warmer climates and within-day physical activity patterns. We determined the association between ambient temperatures (contemporary and projected) and urban trail use in a humid subtropical climate. At a trail in Austin, TX, five electronic counters recorded hourly pedestrian and cyclist counts in 2019. Weather data were acquired from World Weather Online. Generalized additive models estimated the association between temperature and trail counts. We then combined the estimated exposure–response relation with weather projections from climate models for intermediate (RCP4.5) and high (RCP8.5) emissions scenarios by NASA NEX-GDDP. From summer to autumn to spring to winter, hourly trail counts shifted from bimodal (midmorning and early-evening peaks) to one midday peak. Pedestrians were more likely to use the trail between 7 and 27 °C (45 to 81°F) with peak use at 17 °C (63°F) and cyclists between 15 and 33 °C (59–91°F) with peak use at 27 °C (81°F) than at temperature extremes. A net decrease in trail use was estimated by 2041–2060 (RCP4.5: pedestrians = −4.5 percent, cyclists = −1.1 percent; RCP8.5: pedestrians = −6.6 percent, cyclists = −1.6 percent) and 2081–2100 (RCP4.5: pedestrians = −7.5 percent, cyclists = −1.9 percent; RCP8.5: pedestrians = −16 percent, cyclists = −4.5 percent). Results suggest climate change may reduce trail use. We recommend interventions for thermal comfort at settings for physical activity.

Subject Areas: Pedestrian; Cyclist; Adaptation; Extreme heat; Apparent temperature; Humid subtropical climate

Availability: Lanza, K., Gohlke, J., Wang, S., Sheffield, P.E., and Wilhelmi, O. (2022). "Climate Change and Physical Activity: Ambient Temperature and Urban Trail Use in Texas." *International Journal of Biometeorology*. https://doi.org/10.1007/s00484-022-02302-5

4.5. Title: Improving Active Travel to School and Its Surveillance: An Overlooked Opportunity in Health Promotion and Chronic Disease Prevention

Author(s): George, S.M., Sliwa, S.A., Cornett, K.A., Do, V., Bremer, A.A., and Berrigan, D.

Abstract: Increasing active travel to school (ATS) could reduce the deficit in youth physical activity participation; however, surveillance of ATS is limited. Given that ATS contributes to our understanding of children's physical activity patterns nationwide, is influenced by local contexts and state laws, and occurs within communities, surveillance could be informative at the national, state, and local levels. Following a National Collaborative on Childhood Obesity Research workshop, this commentary offers insights into strengthening surveillance and data collection of ATS behavior as well as ATS environmental, policy, and program supports.

Subject Areas: Active travel to school; Surveillance; Policy; Program supports

Availability: George, S.M., Sliwa, S.A., Cornett, K.A., Do, V., Bremer, A.A., and Berrigan, D. (2022). "Improving Active Travel to School and Its Surveillance: An Overlooked Opportunity in Health Promotion and Chronic Disease Prevention." *Translational Behavioral Medicine, 12*(7), pp. 810–815. https://doi.org/10.1093/tbm/ibac023

4.6. Title: Assessing Public Health Benefits of Replacing Freight Trucks with Cargo Cycles in Last Leg Delivery Trips in Urban Centers

Author(s): Hartle, J.C., Elrahman, O.A., Wang, C., Rodriguez, D.A., Ding, Y., and McGahan, M.

Abstract: Increased urbanization, population growth, and demand for time-sensitive deliveries means increased freight movement in cities, which contributes to emissions, noise, and safety concerns. One innovative mode gaining widespread attention for urban deliveries is cargo cycles—bicycles adapted for freight delivery. Despite the recognized potential and possible success of transporting at least 25 percent of freight via cycle, research remains limited. This research investigates the potential of cargo cycle delivery for last mile freight in Oakland, California, with a focus on the West Oakland neighborhood. The data collection included interviews, focus groups, vehicle field observation and counts, and traffic simulation modeling. The traffic simulation examined scenarios where businesses converted different percentages of current deliveries to cargo cycles using a transfer hub as the starting point for their cargo cycle delivery. The best-case scenario—where the maximum percentage of deliveries were made with cargo cycle instead of motorized vehicles—resulted in reductions of 2600 vehicle miles traveled (VMT) per day. In that case scenario, the vehicle miles traveled (VMT) reduction is equivalent to a reduction in emissions of PM2.5, PM10, NOx, and reactive organic gas (ROG) of taking about 1000 Class 4 box trucks off the roads of West Oakland per day. In the worst-case scenario, with a significantly smaller percentage of motorized package deliveries converted to cargo cycles, there is a reduction of 160 VMT, equivalent to the removal of approximately 80 Class 4 box trucks off the roads of West Oakland per day. This potential reduction in air pollution and traffic congestion, as well as job creation, would benefit West Oakland residents.

Subject Areas: Cargo cycles; Air pollution; Noise pollution; Traffic congestion; Traffic models

Availability: Hartle, J.C., Elrahman, O.A., Wang, C., Rodriguez, D.A., Ding, Y., and McGahan, M. (2022). *Assessing Public Health Benefits of Replacing Freight Trucks with Cargo Cycles in Last Leg Delivery Trips in Urban Centers*. Technical Report, Mineta Transportation Institute, San José State University, San José, CA. https://doi.org/10.31979/mti.2022.1952

4.7. Title: Health Impacts of Nonmotorized Travel Behavior and the Built Environment: Evidence from the 2017 National Household Travel Survey

Author(s): Mahmoudi, J.

Abstract: Introduction: The health impacts of nonmotorized travel behavior (i.e., walking and bicycling) and the built environment have been widely investigated in the past. However, nationwide studies probing the association between the neighborhood built environment and individuals' nonmotorized travel and health status remain scarce. Utilizing national-level databases from the U.S., the present study examines the role of nonmotorized travel and neighborhood-level built environment attributes in residents' self-assessed overall health status.

Methods: This research relies on data from the 2017 National Household Travel Survey and employs ordered probit modeling techniques to relate self-assessed overall health status to various variables representing the extent of nonmotorized travel and physical activity as well as the built and social environment attributes of the residential location.

Results: The results indicate that individuals' self-assessed health status is associated with (i) their person-level attributes including the levels of their walking and bicycling travel and other physical activity; (ii) the social environment attributes of both their household and their residential neighborhood including income and vehicle ownership levels; and (iii) the built environment attributes of their neighborhood including the extent of: compactness, mixed-use development, transit accessibility, and automobile-friendliness of the road network within the neighborhood. Furthermore, average marginal effects computations indicate that the most important neighborhood built environment factor in increasing the likelihood of reporting a very good or excellent health status is higher levels of transit accessibility.

Conclusions: The findings of this study suggest that more effective policies to promote individuals' health through changes targeting their travel behavior and their neighborhood's built environment may be the ones that: (a) encourage walking and bicycling travel and (b) foster neighborhood designs that support more active lifestyles through increased levels of transit accessibility, activity density, and land use diversity, as well as through decreased levels of automobile-friendliness of the street network.

Subject Areas: Walking; Bicycling; Nonmotorized travel; Built environment; Health

Availability: Mahmoudi, J. (2022). "Health Impacts of Nonmotorized Travel Behavior and the Built Environment: Evidence from the 2017 National Household Travel Survey." *Journal of Transport & Health, 26*. https://doi.org/10.1016/j.jth.2022.101404

4.8. Title: Income Disparities in Driving Distance to Health Care Infrastructure in the United States: A Geographic Information Systems Analysis

Author(s): Guo, J., Hernandez, I., Dickson, S., Tang, S., Essien, U.R., Mair, C., and Berenbrok, L.A.

Abstract: Objective: Inequities in access to health care contribute to persisting disparities in health care outcomes. We constructed a geographic information systems analysis to test the association between income and access to the existing health care infrastructure in a nationally representative sample of US residents. Using income and household size data, we calculated the odds ratio of having a distance > 10 miles in nonmetropolitan counties or > 1 mile in metropolitan counties to the closest facility for low-income residents (i.e., <200% Federal Poverty Level), compared to non-low-income residents.

Results: We identified that in 954 counties (207 metropolitan counties and 747 nonmetropolitan counties) representing over 14% of the US population, low-income residents have poorer access to health care facilities. Our analyses demonstrate the high prevalence of structural disparities in health care access across the entire US, which contribute to the perpetuation of disparities in health care outcomes.

Subject Areas: Health disparities; Low income; Health care access; Health care infrastructure

Availability: Guo, J., Hernandez, I., Dickson, S., Tang, S., Essien, U.R., Mair, C., and Berenbrok, L.A. (2022). "Income Disparities in Driving Distance to Health Care Infrastructure in the United States: A Geographic Information Systems Analysis." *BMC Research Notes*, *15*. https://doi.org/10.1186/s13104-022-06117-w

4.9. Title: A Flexible Method for Identifying Spatial Clusters of Breast Cancer Using Individual-Level Data

Author(s): Kamenetsky, M.E., Trentham-Dietz, A., Newcomb, P., Zhu, J., and Gangnon, R.E.

Abstract: Prior research has shown that cancer risk varies by geography, but scan statistics methods for identifying cancer clusters in case-control studies have been limited in their ability to identify multiple clusters and adjust for participant-level risk factors. We develop a method to identify geographic patterns of breast cancer odds using the Wisconsin Women's Health Study, a series of 5 population-based case-control studies of female Wisconsin residents aged 20-–79 enrolled in 1988–2004 (cases = 16,076, controls = 16,795). We create sets of potential clusters by overlaying a 1 km grid over each county-neighborhood and enumerating a series of overlapping circles. Using a two-step approach, we fit a penalized binomial regression model to the number of cases and trials in each grid cell, penalizing all potential clusters by the least absolute shrinkage and selection operator (Lasso). We use BIC to select the number of clusters, which are included in a participant-level logistic regression model. We identify 15 geographic clusters, resulting in 23 areas of unique geographic odds ratios. After adjustment for known risk factors, confidence intervals narrowed but breast cancer odds ratios did not meaningfully change; one additional hotspot was identified. By considering multiple overlapping spatial clusters simultaneously, we discern gradients of spatial odds across Wisconsin.

Subject Areas: Spatial cluster detection; Spatial cluster; Spatial epidemiology; Breast cancer; Lasso; Case-control

Availability: Kamenetsky, M.E., Trentham-Dietz, A., Newcomb, P., Zhu, J., and Gangnon, R.E. (2022). "A Flexible Method for Identifying Spatial Clusters of Breast Cancer Using Individual-Level Data." *Annals of Epidemiology*, *73*, pp. 9–16.
https://doi.org/10.1016/j.annepidem.2022.06.006

4.10. Title: Childhood Thriving in Urban and Rural Areas During COVID-19

Author(s): Kumar, A.

Abstract: The COVID pandemic has exacerbated existing disparities in health and social needs between rural and urban settings across the United States. To discern family needs during COVID, two community-partnered surveys were developed to assess social determinants of health, flourishing, and other health information to collect actionable, real-time data and connect families to existing community resources. The surveys were administered monthly in urban and rural counties of southwestern PA. The surveys included validated and community-informed measures of child and parent wellbeing, unmet health needs, access to care, housing quality/stability, food security and social service use and needs.

Data from the September 2021 surveys were analyzed using descriptive statistics, Chi-square, and Fisher's test of differences between rural and urban participant groups. The aim of the study was to explore if the COVID-19 pandemic had similar impacts in urban and rural regions and whether rural households faced similar challenges as urban households during and after the pandemic.

A total of 158 caregivers completed the surveys in September 2021. Caregivers in rural areas reported higher levels of unmet health needs for children than caregivers in urban areas (10% vs. 3%), although not statistically significant. Rural caregivers reported greater access challenges such as transportation. A trend of greater food insecurity in rural compared to urban areas (19% vs. 10%) was observed. A significantly greater percentage of caregivers reported using economic assistance in rural (47%) compared to urban areas (16%), despite a similar level of income/employment loss due to COVID across rural and urban settings (36% vs. 31%). Caregivers in rural areas had a lower odd of meeting all child thriving measures included in the survey. Rural caregiver responses showed significantly lower odds of meeting five out of ten thriving measures such as getting food to you and children, adequate household utilities, adjusting to changes in work, employment, or income; child safety and supervision; and child protection from inequality, racism, prejudice, and exclusion.

The results suggest persistent unmet needs in urban and rural areas during COVID, with a higher trend of health and social needs in rural areas despite higher levels of social service use.

Subject Areas: COVID-19; Urban and rural communities; Health needs; Housing quality; food security; Caregiver; Inequality

Availability: Kumar, A. (2022). *Childhood Thriving in Urban and Rural Areas During COVID-19*. Master Essay, University of Pittsburgh, Pittsburgh, PA. http://d-scholarship.pitt.edu/43231/

4.11. Title: The Health and Transportation Nexus: A Conceptual Framework for Collaborative and Equitable Planning

Author(s): Fan, Y. and Phua, P.

Abstract: Transportation is a crucial contributor to health. It not only directly shapes the social and physical environments but also determines the type of places where people can live, learn, work, and play in their everyday lives. This project develops a conceptual framework for collaborative and equitable health and transportation planning by extending the social determinants of health framework to include three major pathways through which transportation factors operate on health and equity outcomes. The three major pathways are behavioral health, environmental health, and social exclusion, which are identified via a thorough review of the academic literature and gray resources on health and transportation connections. Of the three pathway mechanisms, social exclusion and environmental health are intrinsically linked to social equity and justice issues. We further review state-level initiatives linking transportation to health and interview six state departments of transportation that are pioneers in advocating and implementing integrated health and transportation planning. The interview results are summarized and discussed in the report. Based on the interviews, we make recommendations for the Minnesota Department of Transportation to help further its efforts on integrated health and transportation planning.

Subject Areas: Health framework; Transportation planning; Social exclusion; Behavioral health; Environmental health

Availability: Fan, Y. and Phua, P. (2022). *The Health and Transportation Nexus: A Conceptual Framework for Collaborative and Equitable Planning*. Transportation Research Synthesis, Humphrey School of Public Affairs, University of Minnesota, Minneapolis, MN. https://www.dot.state.mn.us/research/TRS/2022/TRS2201.pdf

4.12. Title: (Applied) Geography, Policy, & Time: Whither Health and Medical Geography?

Author(s): Planey, A.M., Wong, S., Planey, D.A., and Ko, M.J.

Abstract: In this provocation, we discuss the potential for health/medical geography to contribute to a policy-relevant geographical research agenda that remains attentive to social theory debates. We illustrate the importance of time as a social determinant of health, through the case study of racial/ethnic inequities in spatial access to acute hospitals in the U.S. South region amid rural hospital closures, conversions, and mergers, which have decreased the supply of hospitals since 1990. In sum, racial disparities in spatial access were most pronounced for travel distances/times to the nearest alternative hospital, underscoring the importance of both temporal and spatial equity.

Subject Areas: Relevance; Policy research; Healthcare access; Hospital closures

Availability: Planey, A.M., Wong, S., Planey, D.A., and Ko, M.J. (2022). "(Applied) Geography, Policy, & Time: Whither Health and Medical Geography?" *Space and Polity*, *26*(2), pp. 115–127. https://doi.org/10.1080/13562576.2022.2098649

4.13. Title: COVID's Collateral Damage: Likelihood of Measles Resurgence in the United States

Author(s): Thakur, M., Zhou, R., Mohan, M., Marathe, A., Chen, J., Hoops, S., Machi, D., Lewis, B., and Vullikanti, A.

Abstract: Background: Lockdowns imposed throughout the US to control the COVID-19 pandemic led to a decline in all routine immunizations rates, including the MMR (measles, mumps, rubella) vaccine. It is feared that post-lockdown, these reduced MMR rates will lead to a resurgence of measles.

Methods: To measure the potential impact of reduced MMR vaccination rates on measles outbreak, this research examines several counterfactual scenarios in pre-COVID-19 and post-COVID-19 era. An agent-based modeling framework is used to simulate the spread of measles on a synthetic yet realistic social network of Virginia. The change in vulnerability of various communities to measles due to reduced MMR rate is analyzed.

Results: Results show that a decrease in vaccination rate (α)(α) has a highly non-linear effect on the number of measles cases and this effect grows exponentially beyond a threshold (α)(α). At low vaccination rates, faster isolation of cases and higher compliance to home-isolation are not enough to control the outbreak. The overall impact on urban and rural counties is proportional to their population size but the younger children, African Americans and American Indians are disproportionately infected and hence are more vulnerable to the reduction in the vaccination rate.

Conclusions: At low vaccination rates, broader interventions are needed to control the outbreak. Identifying the cause of the decline in vaccination rates (e.g., low income) can help design targeted interventions which can dampen the disproportional impact on more vulnerable populations and reduce disparities in health. Per capita burden of the potential measles resurgence is equivalent in the rural and the urban communities and hence proportionally equitable public health resources should be allocated to rural regions.

Subject Areas: MMR vaccination; Home isolation; Social network; Network epidemiology; Vulnerable populations; Health equity; Agent-based model; NIS

Availability: Thakur, M., Zhou, R., Mohan, M., Marathe, A., Chen, J., Hoops, S., Machi, D., Lewis, B., and Vullikanti, A. (2022). "COVID's Collateral Damage: Likelihood of Measles Resurgence in the United States." *BMC Infectious Diseases*, *22*. https://doi.org/10.1186/s12879-022-07703-w

4.14. Title: The Complex Interplay Between Health and Walking: Assessing Trip Purposes, Work Status, and Built Environment Associations

Author(s): Pae, G.

Abstract: Promoting walking trips improves public health and supports sustainable development. Researchers in public health and transportation fields have successfully tested several hypotheses on various determinants and benefits of walking trips. Recently, the research attention has shifted from such hypothesis tests to specific estimations on inherent characteristics of main predictors of interest. This dissertation conducts an in-depth inquiry into intrinsic walking characteristics, their relationships to health, and two essential confounding variables that control individuals' daily routines: i.e., work status and the built environment. This dissertation includes three interrelated essays, focusing on the value of walking to improve public health. It relies on the 2017 National Household Travel Survey (NHTS) data sets. I use various categorical analysis methods to relate variables of interest to health status. This dissertation uses the same data and analogous methods to attain a consistent research design. The first essay examines the inherent walking characteristics and walking benefits on health outcomes. Previous studies have revealed that walking trips for different purposes have different patterns. The present study categorizes walking trip records with five trip purposes (working, shopping, recreational, other, and non-home-based walking) and examines their relations to self-assessed health outcomes. The results show that walking trips with different trip purposes have various effects on health outcomes, and the health benefits mainly come from home-based walking trips. This suggests that interventions for walkable environments should be targeted to home-based commute and recreational trips and encourage people within, to, and from their neighborhoods with a purpose. The second essay explores another intrinsic characteristic and determinant of walking trips: walking bouts and built environment densities. Previous studies argue that health outcomes can be improved by physical activities accumulated in bouts of at least 10 minutes. They also argue that health disparities are affected by built environment characteristics where individuals live. I categorize walking trips into short- (<10 minutes) and long-bout (>10 minutes) walking trips. My analyses show that long-bout walking trips are significantly associated with better health outcomes, while short-bout walking trips are not. Importantly, short-bout walking trips are, as most studies argue, associated with all density variables, but this is not the case for long-bout ones. These findings suggest that environmental factors that affect long-bout walking trips associated with health outcomes differ from those that affect short-bout ones. The third essay examines the moderation effects of travel and retirement on health outcomes. Retirement brings a tremendous alteration on individuals' lifestyles. The retirement effects on health are sparsely documented in the literature with contradictory findings. I create interaction terms to measure the effects of retirement in conjunction with daily travel. The results show that the effects of retirement on health can be indeed negative or positive depending on the amount of retirees' walking and auto trips. These findings show the essential values of walking trips as an affordable means to increase physical activities and social relationships. The present dissertation discusses how walking affects health outcomes, focusing on the complex interplay between lifestyles and built environment. Walking trips have various characteristics (i.e., purposes, durations, speeds) and this dissertation presents evidence that the relationships between walking and health are closely related to these characteristics.

Subject Areas: Walking; Public health; Mobility; Trip purpose; Active travel; Built environment; Density; Retirement

Availability: Pae, G. (2022). *The Complex Interplay Between Health and Walking: Assessing Trip Purposes, Work Status, and Built Environment Associations*. Doctoral Dissertation, Ohio State University, Columbus, OH.
http://rave.ohiolink.edu/etdc/view?acc_num=osu1657108385804691

Chapter 5. Policy and Mobility

5.1. Title: Commuter Mobility Patterns in Social Media: Correlating Twitter and LODES Data

Author(s): Petutschnig, A., Albrecht, J., Resch, B., Ramasubramanian, L., and Wright, A.

Abstract: The Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics (LODES) are an important city planning resource in the USA. However, curating these statistics is resource-intensive, and their accuracy deteriorates when changes in population and urban structures lead to shifts in commuter patterns. Our study area is the San Francisco Bay area and it has seen rapid population growth over the past years, which makes frequent updates to LODES or the availability of an appropriate substitute desirable. In this paper, we derive mobility flows from a set of over 40 million georeferenced tweets of the study area and compare them with LODES data. These tweets are publicly available and offer fine spatial and temporal resolution. Based on an exploratory analysis of the Twitter data, we pose research questions addressing different aspects of the integration of LODES and Twitter data. Furthermore, we develop methods for their comparative analysis on different spatial scales: at the county, census tract, census block, and individual street segment level. We thereby show that Twitter data can be used to approximate LODES on the county level and on the street segment level, but it also contains information about non-commuting-related regular travel. Leveraging Twitter's high temporal resolution, we also show how factors like rush-hour times and weekends impact mobility. We discuss the merits and shortcomings of the different methods for use in urban planning and close with directions for future research avenues.

Subject Areas: Urban planning; Commuter mobility; Twitter mobility; Collective movement

Availability: Petutschnig, A., Albrecht, J., Resch, B., Ramasubramanian, L., and Wright, A. (2022). "Commuter Mobility Patterns in Social Media: Correlating Twitter and LODES Data." *International Journal of Geo-Information*, *11*(1). https://doi.org/10.3390/ijgi11010015

5.2. Title: Developing an Interactive Landscape for Mobility Resources

Author(s): Janicke, L., Burch, B., Shankari, K., and Yip, A.

Abstract: As the world continues to be increasingly driven by data, the ways researchers and professionals sort and collect these data are critical. In the world of mobility data, new levels of data from public transportation systems, location services, and other means are being lost due to how little organization exists. Much of the data are proprietary, and there are few if any de jure or even de facto standards connecting data. There is also little knowledge about the gaps that exist in the data. In this project, we created an interactive landscape where mobility resources are categorized and organized in an easy to use, living document. We made this landscape with open-source code from the CNCF Cloud Native Landscape and repurposed it to the mobility data's needs. Additionally, unlike previous sources that organize mobility data, this document can be updated through GitHub by those in the field to keep its sources relevant. Following the creation of a beta version of the landscape, we conducted several interviews with industry researchers and professionals to ensure the landscape would be useful. The result is an online hub where mobility researchers and resource creators can easily access research and collaborate.

Subject Areas: Data; Standards; Living Landscape; Mobility

Availability: Janicke, L., Burch, B., Shankari, K., and Yip, A. (2022). *Developing an Interactive Landscape for Mobility Resources*. Preprint, National Renewable Energy Laboratory, Golden, CO. https://www.nrel.gov/docs/fy22osti/81740.pdf

5.3. Title: Blueprint for the Next Generation of Place-Based Policy: Policy Example—Transportation

Author(s): Freemark, Y., Tregoning, H., and Velasco, G.

Abstract: This policy example outlining a new approach to federal transportation policy is a companion to the report A Blueprint for the Next Generation of Federal Place-Based Policy. The blueprint offers a two-step process for policy analysis and program design that starts with high-level, analytical questions that help provide the aspirational framework for then addressing a series of specific design decisions. By offering recommendations across key design decisions, this policy example illustrates how equity-focused, place-based federal transportation policy and grant resources could reverse adverse environmental and social outcomes and expand mobility for the most vulnerable U.S. residents.

Subject Areas: Infrastructure; Federal urban policies; Climate mitigation, Sustainability; Energy and land use; Environmental quality and pollution; Transportation; Inequality and mobility

Availability: Freemark, Y., Tregoning, H., and Velasco, G. (2022). *Blueprint for the Next Generation of Place-Based Policy: Policy Example—Transportation*. Brief, Urban Institute, Washington, D.C. https://www.urban.org/research/publication/blueprint-next-generation-place-based-policy-policy-example-transportation

5.4. Title: The 2022-23 Budget: Green School Bus Grants

Author(s): Petek, G.

Abstract: ***School Districts Own Many Older Diesel Buses***. Districts own nearly 16,000 school buses, nearly two-thirds of which operate on diesel fuel. More than 5,000 of the diesel buses were manufactured prior to 2007, when the latest federal emission standards took effect.

Governor Proposes $1.5 Billion for Electric School Buses. The proposal would provide grants to replace existing school buses with electric buses. Districts that are small, rural, enroll high shares of disadvantaged students, or propose to replace the oldest buses would receive priority. Grant awards would begin at $500,000 and assume districts would use about $450,000 for each bus and its charging station. Districts could use the remaining $50,000 for any other school transportation expenditure. The $1.5 billion Proposition 98 General Fund proposed for this program would fund approximately 3,000 electric buses. The proposal is in addition to a similar state program created in 2021-22 and a large federal program created last November.

Electric Buses Have Several Advantages but a Few Limitations. Districts currently own a couple hundred electric buses statewide. Districts generally describe them as smooth, quiet, and clean. Electric buses release no local pollutants like nitrogen oxides and particulate matter, and they reduce greenhouse gas emissions. Electric buses also reduce fuel costs for districts. The main drawback is their limited range, which can make them unsuitable for long routes and certain strenuous conditions. An electric bus also costs more than twice as much as a diesel bus.

Subject Areas: Electric school buses; Range limit; General fund; Transportation expenditures; Recommendation for adoption

Availability: Petek, G. (2022). *The 2022-23 Budget: Green School Bus Grants*. Budget Report, Legislative Analyst's Office, Sacramento, CA. https://lao.ca.gov/Publications/Report/4525

5.5. Title: To Reduce Traffic Congestion, Increase Local Micromobility

Author(s): Descant, S.

Abstract: Blog.

Subject Areas: Mass Transit; Transportation; Emissions; Climate change; Infrastructure; Micromobility

Availability: Descant, S. (2021). "To Reduce Traffic Congestion, Increase Local Micromobility." *Governing*. https://www.governing.com/community/to-reduce-traffic-congestion-increase-local-micromobility

5.6. Title: Mobility and traffic models for VANETs

Author(s): El Joubari, O.

Abstract: The ever-growing traffic congestion is becoming a serious issue that needs to be urgently addressed. The growing number of traffic accidents, the environmental footprint of transport, commercial speed of public transportation and traffic jams are few examples of the adverse consequences of congestion. This calls for an upgrade of the transport system in order to ensure road users safety and effectively enhance the transportation infrastructure. Intelligent Transport System have grown in importance as a promising solution to the congestion issue. These systems rely on the most advanced technologies to provide intelligent and robust safety services that seek to prevent road incident that may threaten the life of passengers. One of the most stringent requirements of these applications is an error-free and reliable transmission of data packets. Vehicular Adhoc Network (VANET) were designed specifically to provide a wireless communication infrastructure to allow vehicles and road equipment to exchange traffic data. The particular feature of this network is the highly dynamic mobility which results in frequent changes in the topology and density of the network. This has negative effects on the network performance which does not allow to cater safety applications requirements. In this thesis, we address specifically channel access methods for VANET that are based on time division multiple access (TDMA) method. TDMA has been proven the most suitable access technique for VANET as it allows a single node to access the channel at any time slot. However, conventional TDMA-based protocols might encounter difficulties in a dynamic network such as access collision and unfair use of resources. Hence, a good understanding of mobility will allow the design and evaluation of channel access methods that are efficient and robust even in a mobile environment. Although faithful mobility models are found in the literature, they fail to accurately capture some aspects of vehicular mobility. The traffic behaviour is influenced by several factors such as road layout, speed limits, traffic rules and individual vehicle's behaviour. Consequently, it is compulsory to include all these features in a mobility model for accurate results. In this context, we develop in this thesis stochastic Markov chain models based on real vehicle traces collected by RSUs using V2X communication to emulate vehicular behaviour in both urban and highway roads. The proposed models have the twofold benefit of modelling and predicting traffic. Using a direct numerical resolution technique, traffic density, waiting queue lengths, travel times and delays are predicted. The predicted traffic density is then exploited to design a Traffic-aware TDMA channel access method that aims to reduce access collisions and enhance resource utilization through mobility prediction and clustering. To evaluate the performance of the proposed method, a queue-based mobility simulation framework was developed using the SimEvents toolbox. The simulation framework allows the generation of synthetic measures relevant to the assessment of road network performance. The TA-TDMA MAC protocol was then implemented and compared with an existing MAC protocol called VeMAC, under different scenarios and environments. The proposed solution has shown better results than the VeMAC protocol in terms of efficiency and robustness against topological changes.

Subject Areas: Intelligent transport system; Vehicular Adhoc Network; Mobility models; Markov chains; Time division multiple access; Channel access methods

Availability: El Joubari, O. (2022). *Mobility and traffic models for VANETs*. Doctoral Dissertation, Université Paris-Saclay, Gif-sur-Yvette, France. https://tel.archives-ouvertes.fr/tel-03627931

5.7. Title: What Are the Multimodal Patterns of Individual Mobility at the Day Level in the Paris Region? A Two-Stage Data-Driven Approach Based on the 2018 Household Travel Survey

Author(s): Yin, B. and Leurent, F.

Abstract: Human mobility patterns and their socio-demographic association have been widely studied on travel behavior analysis. To better suit the services of multimodal transport systems, people's travel behavior needs to be examined at different levels, concerning the complexity of their multimodal trips or trip-chains. This article aims to reveal multimodal patterns of individual mobility and their relationships with socio-demographic characteristics and with travel complexities based on the 2018 Household Travel Survey in the Paris region. To identify the multimodal patterns, a two-stage statistical analysis is conducted. At the first stage (at the trip level), fifteen trip types are identified depending on the categories of travel modes and the degrees of modal trip lengths, duration, and departure time. At the second stage (at the day level), the individuals are characterized by their mobility profiles that are interpreted with the respective frequencies of the fifteen trip types on the day. Based on the profiles, six clusters, i.e., six daily mobility patterns, are obtained. Among the patterns, the daily travel distances vary widely (from 1 to 7 times), as do the daily travel time budgets (from 1 to 3 times). From the relationship analysis, we find that the obtained mobility patterns come along with specific features of car ownership and transit subscription. Socio-demographic associations to the clusters are also distinct. The daily mobility patterns demonstrate an adverse correlation between the trip complexity and the trip chain complexity. The findings in this study could help policy makers to implement concrete strategies for targeted people at multimodality circumstances.

Subject Areas: Travel time budget; Daily mobility pattern; Multimodality; Complexity; Socio-demographics

Availability: Yin, B. and Leurent, F. (2022). "What Are the Multimodal Patterns of Individual Mobility at the Day Level in the Paris Region? A Two-Stage Data-Driven Approach Based on the 2018 Household Travel Survey." *Transportation*. https://doi.org/10.1007/s11116-022-10285-w

5.8. Title: Equity and Mileage-Based User Fees: An Analysis of the Equity Implications of Mileage-Based User Fees Compared to the Gas Tax in the SCAG Region

Author(s): Park, S.

Abstract: California has set goals to reduce greenhouse gas emissions, prompting stakeholders in the transportation sector to research ways to reduce vehicle miles of travel (VMT) through possible pricing strategies to incentivize less driving. The current transportation funding mechanism relies on the state gas tax. This tax is not a sustainable source of revenue since increases in the fuel economy of vehicles—absent an increase in the tax—will reduce revenue generation. One potential strategy for resolving this is a mileage-based user fee, also called a VMT fee. Rather than taxing the use of gasoline, a VMT fee directly taxes driving based on the number of miles driven.

The Southern California Association of Governments (SCAG) is interested in understanding the equity implications of adopting a VMT tax since one concern that needs to be addressed before introducing a VMT fee is how the program might affect low-income drivers. This study draws on data from the 2017 National Household Travel Survey to estimate the effects of a mileage-based user fee compared to the current gas tax system on drivers by income in the SCAG region. Overall, all households would experience a tax cost increase under the 2.5 cents per mile fee tax scheme, but the increase would vary by household location and income group. Higher-income households would experience a greater increase in their total tax, but only a 0.03% increase relative to their income. Low-income households on average would pay 0.1% more of their income under the VMT tax.

Subject Areas: Equity; Transportation planning; California; Congestion pricing

Availability: Park, S. (2022). *Equity and Mileage-Based User Fees: An Analysis of the Equity Implications of Mileage-Based User Fees Compared to the Gas Tax in the SCAG Region*. Technical Report, Institute of Transportation Studies, University of California, Los Angeles, CA. https://doi.org/10.17610/T6K89H

5.9. Title: Smart Urban Transport and Logistics: A Business Analytics Perspective

Author(s): He, L., Liu, S., and Shen, Z.M.

Abstract: New technologies and innovative business models are leading to connected, shared, autonomous, and electric solutions for the tomorrow of urban transport and logistics (UTL). The efficiency and sustainability of these solutions are greatly empowered by the capability of understanding and utilizing the tremendous amount of data generated by passengers, drivers, and vehicles. In this study, we first review the innovative applications in UTL and several related research areas in the operations management (OM)/operations research (OR) literature. We then highlight the sources, types, and uses of data in different applications. We further elaborate on business analytics techniques and software developed to facilitate the planning and management of UTL systems. Finally, we conclude the paper by reflecting on the emerging trends and potential research directions in data-driven decision making for smart UTL.

Subject Areas: Logistics; Predictive analytics; Prescriptive analytics; Smart cities; Transportation

Availability: He, L., Liu, S., and Shen, Z.M. (2022). "Smart Urban Transport and Logistics: A Business Analytics Perspective." *Production and Operations*, *31*(10), pp. 3771–3787. https://doi.org/10.1111/poms.13775

5.10. Title: The Effect of Gasoline Prices on Suburban Housing Values in China

Author(s): Zhang, T. and Burke, P.J.

Abstract: By raising road transportation costs, an increase in gasoline prices should be expected to reduce housing demand in locations further from the central business district (CBD) relative to inner-city locations. This study uses a monthly real estate area dataset for 19 large cities in China over 2010–2018 to investigate the impact of gasoline prices on intra-city spatial differentials in housing prices. The findings suggest that higher gasoline prices on average lead to a relative decline in housing prices in outer suburbs, with a 1% increase in gasoline prices on average leading to a 0.004% relative reduction in home values for every additional kilometer from the CBD. The effect is larger in cities that have higher automobile ownership rates and that are less densely populated. The results are consistent with a conclusion that the rise of electric vehicles, autonomous vehicles, and working from home is likely to contribute to a lowering of geographical price differentials within Chinese cities over time.

Subject Areas: Gasoline price; Housing price; Transportation cost

Availability: Zhang, T. and Burke, P.J. (2022). "The Effect of Gasoline Prices on Suburban Housing Values in China." *China Economic Review*, *72*.
https://doi.org/10.1016/j.chieco.2022.101762

5.11. Title: A Forecast of State Motor Fuel Revenues: The Effect of New Technologies and the State Vehicle Fleet Mix on Georgia Motor Fuel Receipts

Author(s): Wheeler, L., Omar, M., and Prates, J.T.

Abstract: This research focuses on the impact of greater rates of adoption of higher fuel-economy vehicles and electric vehicles (EVs) on anticipated motor fuel receipts from 2022 through 2050. We find that motor fuel consumption has increased in Georgia over the 2000–2019 period, but it has fallen on a per capita basis. Also, during this time, the trend in EV adoption is increasing. Motor fuel receipts are increasing but only due to the indexing of the state motor fuel rate. Close examination of motor fuel consumption in the state reveals that increases in the miles per gallon (MPG) of conventional internal combustion engine (ICE) vehicles are currently having a greater negative effect on motor fuel consumption than the adoption of electric vehicles. Two forecasts are produced for this research. The first is an econometric forecast based on historical data of motor fuel consumption and important determinants of motor fuel consumption. The second model is more conservative and is constructed from the detailed tables available from the Annual Energy Outlook (AEO). The optimistic forecast model projects a slightly increasing trend in motor fuel consumption of 0.3 percent annually over the 2022–2050 period for Georgia. Under this forecast, motor fuel receipts are forecast to increase at an average annual rate of 0.6 percent over the forecast window of 2022–2050. The conservative forecast projects a slightly declining average annual growth rate of motor fuel consumption of −0.1 percent. Receipts under this forecast are expected to increase 0.2 percent on average annually over the 2022–2050 period.

Subject Areas: Motor fuel revenues; Electric vehicles; Alternative transportation funding; Battery-powered electric vehicles; Plug-in hybrid electric vehicles; Alternative fuel vehicle

Availability: Wheeler, L., Omar, M., and Prates, J.T. (2022). *A Forecast of State Motor Fuel Revenues: The Effect of New Technologies and the State Vehicle Fleet Mix on Georgia Motor Fuel Receipts*. Final Report, Georgia State University Research Foundation, Inc., Atlanta, GA. https://g92018.eos-intl.net/eLibSQL14_G92018_Documents/20-21.pdf

5.12. Title: EV Incentive Policies Should Target Reducing Gasoline Use

Author(s): Metz, M. and London, J.

Abstract: Gasoline is the source of 17 percent of U.S. carbon emissions. To achieve emissions reductions consistent with the 2030 goals set by the Joseph Biden Administration and the Intergovernmental Panel on Climate Change, annual U.S. gasoline use by light-duty vehicles will need to decline by 67 percent, or 96 billion gallons, in the next eight years. Electric vehicles (EVs) cause much lower carbon and particulate emissions than gasoline-burning internal combustion engine vehicles, while providing comparable (and often superior) performance and mobility. Thirteen state governments offer EV incentives to encourage their residents to purchase EVs. While flat-rate incentives have been effective in helping EV models achieve a foothold in the market, they have been relatively ineffective in reducing gasoline consumption and resulting vehicle emissions. Current policies are failing to maximize cuts in vehicle emissions that disproportionately affect communities of color and low-income communities. Given the growing need to achieve rapid, near-term cuts in carbon emissions and the demand for more equitable distribution of EV subsidies, this Comment suggests new EV policies are needed.

Subject Areas: Electric vehicles incentive policies; Carbon emissions; Electric vehicles adoption

Availability: Metz, M. and London, J. (2022). "EV Incentive Policies Should Target Reducing Gasoline Use." *Environmental Law Reporter*, *2*. https://www.elr.info/articles/elr-articles/ev-incentive-policies-should-target-reducing-gasoline-use

5.13. Title: Counteracting Electric Vehicle Range Concern with A Scalable Behavioral Intervention

Author(s): Herberz, M., Hahnel, U.J.J., and Brosch, T.

Abstract: All-electric vehicles remain far from reaching the market share required to meaningfully reduce transportation-related CO_2 emissions. While financial and technological adoption barriers are increasingly being removed, psychological barriers remain insufficiently addressed. Here we show that car owners systematically underestimate the compatibility of available battery ranges with their annual mobility needs and that this underestimation is associated with increased demand for long battery ranges and reduced willingness to adopt electric vehicles. We tested a simple intervention to counteract this bias: providing tailored compatibility information reduced range concern and increased willingness to pay for electric vehicles with battery ranges between 60 and 240 miles, relative to a 50–mile–range baseline model. Compatibility information more strongly increased willingness to pay than did information about easy access to charging infrastructure, and it selectively increased willingness to pay for car owners who would derive greater financial benefits from adopting an electric vehicle. This scalable intervention may complement classical policy approaches to promote the electrification of mobility.

Subject Areas: Energy and behavior; Environmental studies; Human behavior; Psychology and behavior

Availability: Herberz, M., Hahnel, U.J.J., and Brosch, T. (2022). "Counteracting Electric Vehicle Range Concern with A Scalable Behavioral Intervention." *Natural Energy*, *7*, pp. 503–510. https://doi.org/10.1038/s41560-022-01028-3

5.14. Title: Adoption of Electric Vehicles: Analysis of Consumer Perception in Ghana

Author(s): Ackaah, W., Kanton, A.T., and Adams, C.A.

Abstract: Several countries have introduced electric vehicles (EVs) to ensure sustainable transport. Germany, UK, Norway, and France are some of the countries phasing out internal combustion engine vehicles, which contribute to a significant proportion of CO_2 emissions. The government of Ghana has plans to develop policies to ensure consumers change from fossil fuel–based vehicles to electric vehicles. The aim of this research was to find factors which will influence consumers' intentions to purchase electric vehicles. A questionnaire survey was conducted in the cities of Kumasi and Accra, Ghana. A convenience sampling method was used and the data analysed using IBM SPSS 23. The questions on which respondents were quizzed included environmental concern, consumer knowledge/awareness, attitudes and government policy. From the analysis, the least consideration the respondents had when purchasing an EV was the environment. The most important factor considered by respondents (34.38 percent) in their purchase intention was the availability of infrastructure (e.g., charging stations and aftersales service centres). The purchase price and cost of operating of the vehicle was not given important consideration (1.17 percent). The most important feature/attribute of the EV that respondents considered was driving range (17.63 percent) and recharge time (16.13 percent). Significant proportion of respondents were worried about the reliability of electricity supply. Overall, 94 percent expected their vehicles to be charged under 30 minutes. An assessment of the daily travel patterns showed that range shouldn't be a problem as only 6.2 percent travel more than 50 km among the respondents. Emissions reduction was not one of the important attributes when it came to purchase intention of electric vehicles. Consumers were more concerned about the driving range and available infrastructure. Government must provide incentives to the private sector to enable them setup maintenance and service centres and also ensure stable and reliable power supply.

Subject Areas: Electric vehicles; Purchase intentions; Sustainable transport; Environment; Ghana

Availability: Ackaah, W., Kanton, A.T., and Adams, C.A. (2022). *Adoption of Electric Vehicles: Analysis of Consumer Perception in Ghana*. Semantic Scholar. https://www.semanticscholar.org/paper/Adoption-of-Electric-Vehicles%3A-Analysis-of-Consumer-Ackaah-Kanton/bb127676bc1528a265f22e3326276bc694e91b13

5.15. Title: Using Mapping Tools to Prioritize Electric Vehicle Charger Benefits to Underserved Communities

Author(s): Zhou, Y., Gohlke, D., Sansone, M., Kuiper, J., and Smith, M.P.

Abstract: Mapping tools can play an important role in incorporating equity into planning, implementing, and evaluating investments in electric vehicle (EV) charging stations, also referred to as EV chargers or electric vehicle supply equipment (EVSE). Federal, state, and local organizations need methodologies for using mapping tools as they pursue equity-focused goals to ensure that the benefits of investments in EV chargers flow to energy and environmental justice (EEJ) underserved communities. This report provides examples of how to apply mapping tools to identify priority locations for installing EV chargers that may benefit EEJ underserved communities through four EV charger planning approaches: corridor charging, community charging, fleet electrification, and diversity in STEM and workforce development. It also explores various methodologies for calculating low-public EVSE density. Ensuring that the benefits of EV charger investments flow to underserved communities involves prioritizing locally identified needs and incorporating community input when choosing charging station locations. Installing EV chargers in a census tract identified as an EEJ underserved community does not inherently mean that those EV chargers provide benefits to residents of that community. In addition, representatives of historically disadvantaged communities or environmental justice communities have concerns that installing EV chargers in their communities could potentially exacerbate or propagate existing inequities. While the methodologies described in this report may help identify priority census tracts for equity-focused EV charger investment, additional community engagement and site evaluation are necessary to determine whether EV chargers are accessible, affordable, and convenient to EEJ underserved community residents and what benefits the local community is looking to realize with EV charger installations.

This report is the culmination of many discussions with project leaders from DOE-funded projects deploying EV chargers in communities across the nation, organizations representing EEJ underserved communities, state agencies developing EV investment plans, utilities making major EV investments, and DOE national laboratory experts working in transportation electrification. The authors distributed a draft report for peer review, and reviewer comments are summarized in this report. These methodologies are likely to evolve as more EV charger funding programs are implemented and more real-world data is available to measure the effectiveness of strategies for incorporating equity in EV charger deployment projects. Continued efforts to document best practices and critically evaluate whether equity-focused programs achieve their goals are needed as transportation electrification proceeds at the local, regional, and national levels.

Subject Areas: Electric vehicles; Electric charging infrastructure; Transportation; Equity; Mapping tools; Energy justice; Environmental justice; Justice40

Availability: Zhou, Y., Gohlke, D., Sansone, M., Kuiper, J., and Smith, M.P. (2022). *Using Mapping Tools to Prioritize Electric Vehicle Charger Benefits to Underserved Communities*. Argonne National Laboratory, Lemont, IL. https://www.osti.gov/biblio/1870157

5.16. Title: Analyzing and Optimizing Shared Mobility Fleet Impacts

Author(s): Bruchon, M.B.

Abstract: Passenger vehicles enable activity, but they generate unpriced negative externalities such as air emissions and traffic. Those externalities constitute a market failure that may justify policy intervention. Passenger vehicle travel, especially within urban areas, is being transformed by vehicle electrification and by shared mobility options offered by ridesourcing services such as Uber and Lyft. These transformations' impacts on externalities are unclear a priori, as is the role of policy to influence them. To investigate these externalities and what options can address them, I use a mixture of simulation and empirical analysis.

One study asks how much an efficiently priced Pigovian tax on unpriced air emissions externalities would incentivize a ridesourcing service to increase vehicle fleet electrification and reduce its emissions. Applying a mathematical optimization of fleet size and powertrain mix with and without a tax, the study finds the tax increases the optimal usage of battery electric vehicles by 5 to 156 percent and reduces emissions externalities of the optimal fleet by 10 to 22 percent.

The second study assesses the potential of ridesplitting services—that is, services that combine multiple rides in one car at the same time (e.g., UberPool or Lyft Line)—in a similar manner, asking how much a Pigovian tax on air emissions and traffic (congestion, collisions, and noise) would incentivize increased ridesplitting. Using a dynamic fleet dispatch mathematical optimization problem with and without a tax, the study finds the tax increases use of ridesplitting by 2 percentage points and reduces externalities by 1 percent.

The third study uses the case study of Chicago's ridesourcing congestion charge policy to ask whether taxes can be practically effective at discouraging solo ridesourcing rides and encouraging ridesplitting. This study conducts an empirical analysis, using a difference–indifferences model to find a downtown zone surcharge reduced total (solo plus ridesplitting) ridesourcing rides by a mean [95% confidence interval] of 8.2% [7.6%, 8.7%], increased ridesplitting opt-in rates by 4.2 [4.0, 4.3] percentage points, and increased ridesplitting rides that were successfully matched with another ride by 3.4 [3.3, 3.5] percentage points. Special attention is given to spatially autocorrelated outcomes and potential spillover effects, and the direction of results is robust across modeling choices.

To enable these insights, each study considers challenges and applies methods for use of travel data in policy analysis. Specifically, all three apply unsupervised machine learning to make modeling datasets resemble a representative or average set of travel demand, and the first two use supervised learning to estimate varying road network conditions. These steps mitigate avoidable bias in policy findings when using high-volume trip-level travel data.

These studies can inform transportation companies, policymakers, and other stakeholders on the market failures involved with passenger vehicle travel and what policies can help correct for those failures. They also help characterize how effective different transformation pathways in passenger transportation (i.e., electrification or shared mobility) are as solutions to those negative impacts.

Subject Areas: Ridesourcing services; Pigovian tax; Ridesplitting services; Congestion charge policy; Difference-indifferences model; Unsupervised machine learning

Availability: Bruchon, M.B. (2022). *Analyzing and Optimizing Shared Mobility Fleet Impacts*. Doctoral Dissertation, Carnegie Mellon University, Pittsburgh, PA. https://www.proquest.com/openview/2dd0fd7374b0a482ba9f27742e38992a/1.pdf?pq-origsite=gscholar&cbl=18750&diss=y

5.17. Title: Estimating Rebound Effect for Passenger Cars and Its Effects on US Policy Regulations

Author(s): Cirillo, C., Lin, S., Burra, L.T., and Rathbun, D.K.

Abstract: Policies regulating the fuel economy of passenger vehicles have been implemented by many nations around the world to mitigate greenhouse gas emissions and improve energy efficiency. Such policies lead to advancements in-vehicle technology and improved fuel efficiency which then reduce per-mile driving costs. This reduction in passenger vehicle driving cost may result in the rise of vehicle miles traveled, which is referred to as the rebound effect. This study aims at estimating the rebound effect and at covering the difference (if any) between the rebound effect and gasoline price elasticity to vehicle miles traveled. The analysis is based on the 2017 National Household Travel Survey. We estimate a rebound effect in the range of 20–26%, with estimation consistent across Ordinary Least Square (OLS) and Instrumental Variable (IV) approach. Interestingly we observe an absence of rebound effect in vehicles up to three years old and a much smaller rebound effect in hybrid vehicles.

Subject Areas: Rebound effect; SAFE rule; transport policy; vehicle technology; vehicle miles traveled

Availability: Cirillo, C., Lin, S., Burra, L.T., and Rathbun, D.K. (2022). *Estimating Rebound Effect for Passenger Cars and Its Effects on US Policy Regulations*. Report, EPFL, Switzerland. https://transp-or.epfl.ch/heart/2022/abstracts/231.pdf

5.18. Title: Sharing Automated Vehicles: Policies and Ideas to Improve the Sharing Experience to Reduce Congestion and Energy Use in a Post-COVID World

Author(s): Auld, J., Baker, D., Chou, D., Foss, A., Machek, E., Riggs, W., and Smith, S.

Abstract: Research suggests widespread proliferation of automated vehicles (AVs) can potentially greatly increase transportation energy use and congestion [1]. One of the ways to mitigate such increases is to increase sharing in order to provide more environmentally and financially sustainable and cost effective services that match consumer demands for reliability and convenience. This chapter explores how sharing can be encouraged through economic, technological, procedural/legal, and cultural levers in order for AV transportation systems to reduce energy use and congestion.

Subject Areas: Automated vehicles; Transportation system; Sharing; Transportation network company; Ride-hail; Car-share; Sustainability; Energy; Congestion

Availability: Auld, J., Baker, D., Chou, D., Foss, A., Machek, E., Riggs, W., and Smith, S. (2022). "Sharing Automated Vehicles: Policies and Ideas to Improve the Sharing Experience to Reduce Congestion and Energy Use in a Post-COVID World." *Road Vehicle Automation 9*, pp. 71–82. https://doi.org/10.1007/978-3-031-11112-9_7

5.19. Title: How the Urban Microclimate and Outdoor Thermal Comfort Can Affect Intra-City Mobility Patterns: Evidence from New York City

Author(s): Yang, Y., Wang, D., and Dogan, T.

Abstract: Employing urban planning and design to promote active travel modes, such as walking and biking, are important for decarbonizing urban mobility. This paper proposes a modeling framework that investigates the interdependencies between the built environment and travel behaviors through the lens of urban microclimates. We combine travel data, built environment data, and Universal Thermal Climate Index (UTCI) calculations for New York City and train a predictive model for intra-city mobility patterns. Then, impacts of UTCI features are studied through a sensitivity analysis and a spatial heterogeneity analysis. Results show that impacts of UTCI features can account for up to 4% change in the choice of active travel mode in dense urban areas. Also, impacts of microclimate vary across different travel contexts regarding season, time of day, activity, built environment, and traveler type. Our methodology and findings can inform future decision-making of microclimate-oriented spatial planning and design interventions.

Subject Areas: Thermal factors; Microclimate; Sensitivity analysis; Decision making; Urban planning; Urban mobility; Urban design; Predictive models

Availability: Yang, Y., Wang, D., and Dogan, T. (2022). "How the Urban Microclimate and Outdoor Thermal Comfort Can Affect Intra-City Mobility Patterns: Evidence from New York City." *2022 Annual Modeling and Simulation Conference (ANNSIM)*, pp. 523–536. https://doi.org/10.23919/ANNSIM55834.2022.9859328

5.20. Title: Public Acceptance and Socio-Economic Analysis of Shared Autonomous Vehicles: Implications for Policy and Planning

Author(s): Gkritza, K., Gkartzonikas, C., Losada-Rojas, L.L., and Candanedo, R.E.

Abstract: Shared transportation has grown significantly as renewed interest in urbanism and growing social and economic concerns have strengthened the need for sustainable alternatives. Shared autonomous vehicles (SAVs) are emerging as an alternative mode of transportation that could improve mobility and accessibility. However, the implications of SAVs on social equity are still under research and uncertainty exists regarding the potential adoption and market penetration within transportation-disadvantaged populations. The objective of this study is to assess the extent to which transportation-disadvantaged groups intend to adopt SAVs at two study areas with different density and travel characteristics, and to identify the potential geographical areas where SAVs could be effectively deployed. Public acceptance towards SAVs was assessed via stated preference surveys while a multispatial perspective approach was adopted to identify transportation disadvantaged groups in the two study areas. The results of the spatial market segmentation analysis showed that most of the respondents located in areas in Indianapolis identified as transportation disadvantaged are classified as early adopters and innovators, while the opposite conclusion was reached for the respective areas in Chicago, except for those closer to the downtown area. The results of this study could be useful to three stakeholders: ridesharing service providers, for their marketing and pricing-scheme decisions; public transportation planning agencies, for their policy making and investment decisions; and transportation planners, for infrastructure preparations towards the emergence of SAVs.

Subject Areas: Autonomous vehicles; Shared autonomous vehicles; Shared mobility; Transportation-disadvantaged areas; Adoption; Stated preference

Availability: Gkritza, K., Gkartzonikas, C., Losada-Rojas, L.L., and Candanedo, R.E. (2022). *Public Acceptance and Socio-Economic Analysis of Shared Autonomous Vehicles: Implications for Policy and Planning*. Final Report, Center for Connected and Automated Transportation, Purdue University, West Lafayette, IN. http://dx.doi.org/10.5703/1288284317568

5.21. Title: Smart Cities, Urban Mobility and Autonomous Vehicles: How Different Cities Needs Different Sustainable Investment Strategies

Author(s): Richter, M.A., Hagenmaier, M., Bandte, O., Parida, V., and Wincent, J.

Abstract: The Smart city is important for sustainability. Governments engaged in developing urban mobility in the smart city need to invest their limited financial resources wisely to realize sustainability goals. A key area for such sustainability investment is how to implement and invest in emerging technologies for urban mobility solutions. However, current frameworks on how to understand the impact of emerging technologies aligned with long-term sustainability strategies are understudied. This article develops a simulation-based comparison between different cities and autonomous vehicle (AV) adoption scenarios to understand which aspects of cities lead to positive AV implementation outcomes. As urban mobility and cities will become smart, the analysis represents a first attempt to explore the impact of AVs on a large scale across different cities around the world. Archetypes are formed and account for most, if not all, world cities. For three of our archetypes (car-centric giants, prosperous innovation centers, and high-density megacities), promoting AV-shuttle use would deliver the greatest advantage as measured by improvements in the model's KPIs. To develop urban powerhouses, however, micromobility would deliver greater benefits. For highly compact middleweights, a shift from private cars to other non-AV modes of transportation would be the smartest choice.

Subject Areas: Smart city; Urban mobility; Autonomous vehicles; Sustainability; Traffic simulation

Availability: Richter, M.A., Hagenmaier, M., Bandte, O., Parida, V., and Wincent, J. (2022). "Smart Cities, Urban Mobility and Autonomous Vehicles: How Different Cities Needs Different Sustainable Investment Strategies." *Technological Forecasting and Social Change*, *184*. https://doi.org/10.1016/j.techfore.2022.121857

5.22. Title: Light-Duty Vehicle Transportation Policy and Implication on Greenhouse Gas Emissions

Author(s): Ou, S. et al.

Abstract: The transportation sector accounts for 16% of global greenhouse gas (GHG) emissions and is under formidable pressure to decarbonize. With a growing number of countries making commitments to achieve carbon neutrality or "net-zero" emissions within the next few decades, it is imperative for transportation researchers and policymakers to understand the viable pathways towards achieving carbon neutrality for light-duty transport. This chapter discusses the transportation policies and GHG emissions of the three largest markets in the world—the U.S., China, and the European Union. The life cycle GHG emissions of various vehicle technologies are evaluated while highlighting the regional and temporal differences. We then use market penetration and fleet models, developed specifically for each market, to comprehensively assess the light-duty transport energy demand and GHG emissions under various scenarios. The modeling results show that battery electric vehicles (BEVs) will increase in market share, but internal combustion engine vehicles (ICEVs) will continue to dominate the passenger vehicle stock in the next 20 years under most scenarios. Improving ICEV efficiency can play a critical role in meeting GHG regulations in the near- and medium-term. BEVs, whose GHG emissions are highly dependent on the source of electricity generation, will play an essential role in the long-term as the electric grid becomes cleaner. In summary, transportation policies should be technology agnostic and consider emissions based on the whole life cycle. Moreover, a holistic approach to reducing transportation GHG emissions is key to achieving global environmental goals.

Subject Areas: Batteries; Electrical energy; Energy; Fossil fuels; Fuels

Availability: Ou, S. et al. (2022). "Light-Duty Vehicle Transportation Policy and Implication on Greenhouse Gas Emissions." *Energy Transition: Climate Action and Circularity*, pp. 21–81. https://pubs.acs.org/doi/full/10.1021/bk-2022-1412.ch002

5.23. Title: Uncovering Taxi Mobility Patterns Associated with the Public Transportation Shutdown Using Multisource Data in Washington, D.C.

Author(s): Jia, J., Zhang, H., and Shi, B.

Abstract: The relationship between taxi travel patterns and public transportation disruption has not been extensively explored. In this study, we investigated the impact of public transportation disruption on the taxi mobility patterns during the metro shutdown in Washington, D.C.. Multiple data sources involving taxi trips, traffic analysis zone, and point of interest (POI) information were collected to compare the taxi travel patterns before, during, and after the metro shutdown. The number, distance, and duration of taxi trips were found to be significantly higher during the metro shutdown; specifically, the number of taxi trips was found to be 19.8% larger. Furthermore, a POI auxiliary analysis was performed to investigate the variation in community structure during the disruption of public transport using the modularity maximization approach. The results of this study will be useful for the development of taxi scheduling strategies and traffic management.

Subject Areas: Public transportation disruption; Spatial-temporal mobility pattern; Complex network approach; POI auxiliary analysis

Availability: Jia, J., Zhang, H., and Shi, B. (2022). "Uncovering Taxi Mobility Patterns Associated with the Public Transportation Shutdown Using Multisource Data in Washington, D.C." *KSCE Journal of Civil Engineering*, *26*, pp. 5291–5300. https://doi.org/10.1007/s12205-022-0434-5

5.24. Title: Framework for Assessment of Societal Impact of Innovation: A Case of Transport and Mobility Sector

Author(s): Letaba, P.

Abstract: A slow-down in economic performance of various countries created a huge attention in seeking the solutions and new sources of growth that can improve the GDP growth. These include the role of science, technology and innovation. However, there is also a recognition that innovation can be used for improvement of society in terms of health, education, mobility, food security, water security, security, etc. While there is a plethora of frameworks that deal with research, technology and innovation assessment for economic impact, there is still a knowledge gap regarding the impact on society. The challenges include the absence of common assessment framework and in some cases the lack of comparable indicators. A framework for assessment of innovation for social impact is proposed in this paper by identifying internationally comparable social indicators. Through citation analysis of scientific publications, the identified societal issues are then mapped to the science, technology and innovation activities. A transport and mobility sector is used as a case study. Both transport and mobility have great influence on the societal dynamics and quality of life.

Subject Areas: Technological innovation; Patents; Economic indicators; Databases; Education; Citation analysis; Transportation

Availability: Letaba, P. (2022). "Framework for Assessment of Societal Impact of Innovation: A Case of Transport and Mobility Sector." *2022 Portland International Conference on Management of Engineering and Technology (PICMET)*, pp. 1–7. https://doi.org/10.23919/PICMET53225.2022.9882535

5.25. Title: Aging in Place or Stuck in Place? Transportation Planning for Older Americans in the Digital Era

Author(s): Li, S.

Abstract: This dissertation examines the interaction of the built environment, travel behavior, and technology usage among older adults. Decades-long transportation policies favoring vehicle owners have made many older adults disadvantaged in daily travel. Studies and policies specifically addressing older adults' travel needs do not keep pace with the increasing number and diversity of the aging population. To fill the research gaps, I conducted a series of empirical studies to analyze the travel pattern trends of older adults in order to identify their difficulties in travel. I first examine how older adults travel differently since 2000. Descriptive analysis and a quasi-panel design using the National Household Travel Survey show that those aged 55–74, the baby boomer generation, did not have higher vehicle travel, especially non-work travel, per person, than people at the same age decades ago. Results also show the travel difficulties of low-income older adults. Second, I use cross-sectional and longitudinal data to identify older adults who had difficulties owning and maintaining vehicles. I find that households headed by retirees, those who had lost their partner, and those who lived alone had a higher possibility of living in low-density areas without vehicles. These families also tended to have a decline in vehicle ownership and did not relocate. Third, given the potential role of information communication technology (ICT) in mitigating older adults' travel difficulties, I surveyed 2,510 older adults, examining the relationship between ICT usage and travel before and during the pandemic. Results show that overall, those who used ICT less also traveled less. In particular, older adults with low incomes and less education, older adults who lived alone, and older African Americans had lower daily vehicle travel and more difficulties using most technology applications. However, health and social technology applications could reduce the difficulties in daily travel for people of color and those with medical conditions. The survey also reveals that age added to the transport disadvantage and digital divide during the pandemic. This dissertation sheds light on transport equity theories, as well as transportation, land use, and technology policies, in order to promote sustainability and equity in an aging society.

Subject Areas: Built environment; Travel behavior; Technology usage; Older adults; Transportation policies; Travel difficulties; Sustainability; Equity

Availability: Li, S. (2022). *Aging in Place or Stuck in Place? Transportation Planning for Older Americans in the Digital Era*. Doctoral Dissertation, University of Pennsylvania, Philadelphia, PA. https://repository.upenn.edu/edissertations/5538

5.26. Title: Transportation Impact Fees Scaled to Residential Unit Size in Tucson, Arizona

Author(s): Bise, C.

Abstract: With few exceptions, impact fees for streets and highways use the Institute of Transportation Engineers' Trip Generation Manual. A key limitation is that for residential land uses, there is no variation based on the size of the residential unit. Yet, data from such sources as the National Household Transportation Survey for 2017 show that larger households have more trips than smaller ones. We also know from the American Housing Survey for the same year, 2017, that as the size of the dwelling unit increases, so does the number of occupants. Clearly, transportation impact fees based on the average for a residential unit will overcharge smaller units and undercharge larger ones. This is both inefficient and inconsistent with the ethics of equity. TischlerBise was retained by the City of Tucson, Arizona, to create transportation impact fees that were consistent with the ethics of impact fee equity. This chapter presents our analytic steps for both residential and nonresidential development through focusing on how we used data and reasoning to vary residential impact fees by the size of the residential unit.

Subject Areas: Impact fees; Residential land uses; Household travel; Equity; Residential unit size

Availability: Bise, C. (2022). "Transportation Impact Fees Scaled to Residential Unit Size in Tucson, Arizona." *Proportionate Share Impact Fees and Development Mitigation*, New York: Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781003336075-34/transportation-impact-fees-scaled-residential-unit-size-tucson-arizona-carson-bise

5.27. Title: Mobility of Indonesian During Early Pandemic: Insights from Mobile Positioning Data

Author(s): Widyawan, Syarif, M., and Pratama, A.R.

Abstract: Mobile Positioning Data (MPD) contains information on the location of the mobile phone by approximating mobile phones' location relative to fixed infrastructures (e.g., telecommunication towers that transmit signals). While the data query is technically straightforward, obtaining this dataset requires particular permission to protect customers' privacy. Additionally, the dataset has large volumes of data (i.e., up to 300 GB per day), resulting in not many researchers holding this data source to analyze the mobility of people. In this work, we collaborate with one of the biggest telecommunication service providers in Indonesia to collect MPD and prepare the big data infrastructure. We thus analyze mobility patterns during the early phase of COVID-19 in 2020 using actual Mobile Positioning Data in five provinces in Java. We use three metrics, namely, the number of visits, averaged travel distance, and Origin-Destination matrix. The findings indicate that the social restriction in the corresponding provinces has reduced the average traveled distance of the people, but not their number of visits. That is, while the traveled distance has declined more than eight times compared to the baseline, the number of visits may rocket up, up to nine times. It indicates that people are still having shorter trips even though their regular activities (working, schooling, etc.) have been restricted. The data also show that during Ramadhan month, the government has a successful intervention in restricting people for mudik Lebaran, The number of visits dropped to below 30 visits during Ramadhan and only small spikes exist during "labor lebaran."

Subject Areas: Big data; Visualization; Mobility; Pandemic; Positioning

Availability: Widyawan, Syarif, M., and Pratama, A.R. (2022). "Mobility of Indonesian During Early Pandemic: Insights from Mobile Positioning Data." *2022 14th International Conference on Information Technology and Electrical Engineering (ICITEE)*, pp. 1–6. https://doi.org/10.1109/ICITEE56407.2022.9954078

5.28. Title: Introducing a New Car-Sharing Concept to Build Driving Communities for Work-Commuting

Author(s): Witte, J.-H.

Abstract: South Africa is currently facing various mobility problems. On the one hand, more and more people are moving up into the middle class, which increases the number of private vehicles on the roads and leads to congestion, increased pollutant emissions, and overcrowded cities. On the other hand, public transportation in the form of buses and trains are hardly used due to their current state in terms of safety, efficiency, or availability, making low-cost trips much more difficult for people without private vehicles. The daily commute to work becomes particularly challenging due to crowded roads and the lack of public transportation alternatives. During the 2018 HEdIS Summer School, an international group of students from South & West Africa and Germany collaborated to develop innovative ideas to address these issues. Using the design thinking process, a new car-sharing concept was developed to enable the potential formation of consistent driving communities. The goal is to match users who live in proximity to each other and are employed by the same company or by companies that are near each other. Safety is ensured by only giving access to users who are currently employed by a company with which the platform currently has a partnership. By effectively matching people with the same work commute, it is intended to provide an alternative commuting option that is safer, more efficient, and less time-consuming compared to other available modes of transportation and to overall reduce the number of vehicles on the road to address traffic congestion.

Subject Areas: Mobility; Car-sharing; Design thinking

Availability: Witte, J.-H. (2022). "Introducing a New Car-Sharing Concept to Build Driving Communities for Work-Commuting." *Digital Transformation for Sustainability*, pp. 215–232. https://doi.org/10.1007/978-3-031-15420-1_10

5.29. Title: Targeting Incentives Cost Effectively: "Rebate Essential" Consumers in the New York State Electric Vehicle Rebate Program

Author(s): Williams, B.D.H.

Abstract: To increase the cost-effectiveness of electric vehicle (EV) incentives and outreach, this research examined consumers who would not have purchased/leased their EV without New York State's Drive Clean Rebate—or "Rebate Essentials." Using survey responses from 5,191 participants rebated for 2017–2019 adoption, it analyzed consumers of plug-in hybrid EVs (PHEVs), Tesla battery EVs (BEVs), and non-Tesla BEVs separately. Weighted descriptive statistics and logistic regressions identified factors that increase the odds of a consumer being Rebate Essential, and dominance analysis rank-ordered factors for prioritization. Profiles generated for each vehicle category summarize characteristics and describe top opportunities for reinforcing Rebate Essential adoption through incentive design and outreach. Recommendations are provided. Among the factors discussed are: 1) interest in EVs at the beginning of the car search, 2) rebate awareness before visiting the dealership, 3) other perks for EVs, 4) having lower income, and 5) giving relatively lower importance to environmental impacts.

Subject Areas: Incentive; Market development; Marketing; Policy; State government

Availability: Williams, B.D.H. (2022). *Targeting Incentives Cost Effectively: "Rebate Essential" Consumers in the New York State Electric Vehicle Rebate Program*. 35th International Electric Vehicle Symposium and Exhibition (EVS35), Oslo, Norway. https://www.researchgate.net/publication/365977245_Targeting_Incentives_Cost_Effectively_Rebate_Essential_Consumers_in_the_New_York_State_Electric_Vehicle_Rebate_Program

5.30. Title: Large Cities Are Less Efficient for Sustainable Transport: The ABC of Mobility

Author(s): Prieto-Curiel, R. and Ospina, J.P.

Abstract: The distance travelled by car in a city has many negative impacts on its population, including pollution, noise and the use of space. Yet, quantifying the motorisation of urban mobility is a serious challenge, particularly across cities of different regions. Here we model the number of kilometres travelled by different modes of transport in a city by aggregating active mobility (A), public transport (B) and cars (C), thus expressing the modal share of a city by its ABC triplet. Data for over 800 cities across over 60 countries is used to model kilometres travelled by car and its relationship with city size. Our findings suggest that although public transport is more prominent in large cities, it is insufficient to reduce the distance travelled by car users within the city and, ultimately, their emissions. For cities outside the US, results show that although the proportion of journeys by car decreases in larger cities, distances become more prolonged, thus experiencing more distance travelled by car. When a city doubles its size, it has 87% more car journeys, but they are 41% longer, thus experiencing 2.6 times more vehicle kilometres travelled. Further, by matching cities of similar size inside and outside the US, we estimate that cities in the US have 2.3 times more vehicle kilometres travelled than cities elsewhere.

Subject Areas: Urban mobility; Mode share; Vehicle trips; Vehicle trip distance

Availability: Prieto-Curiel, R. and Ospina, J.P. (2022). *Large Cities Are Less Efficient for Sustainable Transport: The ABC of Mobility*. arXiv preprint, arXiv:2212.13956v1 [physics.soc-ph]. https://doi.org/10.48550/arXiv.2212.13956

5.31. Title: Interest of Shared Mobility and Emerging Vehicle Technologies in Rural America

Author(s): Godavarthy, R. and Hough, J.

Abstract: Shared-use mobility services such as ridesourcing, bikesharing, and carsharing have been introduced in a few rural communities and a fair number of small-urban communities. Input about the interest and potential willingness to use these services, and adoption of various emerging vehicle technologies, could help improve understanding and planning for appropriate shared mobility services to meet the transportation needs in rural and small-urban communities. This study analyzed the interest and adoption patterns for shared mobility and emerging vehicle technologies in rural and small-urban communities. The study also explored the characteristics of shared mobility users in rural America by analyzing the 2017 National Household Travel Survey. Among all rural respondents, about 1.8% use rideshare services, about 0.2% use carshare services, and about 0.3% use bikeshare services. Another important finding from the study is that a significant portion of rideshare users (29.9%), carshare users (28.8%), and bikeshare (20.1%) users are also public transit users. Regarding the adoption of advanced technologies, both Fargo and Dickinson were observed to have high adoption rates for advanced technologies such as smartphones, trip planning apps, and Amazon Prime. Rideshare service has a high adoption rate in Fargo but moderate adoption rate in Dickinson.

Subject Areas: Shared-use mobility services; Emerging vehicle technologies; Adoption patterns; Rural and small-urban communities

Availability: Godavarthy, R. and Hough, J. (2022). *Interest of Shared Mobility and Emerging Vehicle Technologies in Rural America*. Research Report, SURTCOM 22-15, North Dakota State University, Fargo, ND.
https://www.ugpti.org/resources/reports/details.php?id=1109&program=surcom

5.32. Title: Assessing the Travel Demand and Mobility Impacts of Transformative Transportation Technologies in Indiana

Author(s): Luo, H., Chahine, R., Rambaram, A., Rosenzweig, E. T., Gkritza, K., and Cai, H.

Abstract: The rapid development of transformative transportation technologies, such as bike-sharing, shared e-scooters, and ride-hailing systems, is reshaping the transportation landscape. These transformative transportation technologies have the potential to significantly change travel behavior, travel demand, and affect transportation agencies' planning, operations, and decision-making. The objective of this project is to develop a framework and models to quantify the potential travel demand and mobility impacts of transformative transportation technologies in Indiana cities. This project analyzed historical system usage data and conducted survey studies to evaluate the availability and use of transformative transportation technologies in select Indiana cities. The project also proposed a data-driven model to study the relationship between shared micro-mobility and the existing transit system and developed a simulation model to analyze the potential mode choice change under different future development scenarios. Additionally, based on a comprehensive literature review, a list of operations; environmental, health and safety; and accessibility and equity metrics were identified as the Key Performance Indicators to evaluate transformative transportation technologies. Furthermore, as this study was conducted in the midst of the COVID-19 pandemic, the impacts of the pandemic on both traditional and transformative transportation systems were also examined as documented in the literature and stated in our survey.

Subject Areas: Transformative transportation technology; Travel demand; Bike-sharing; Shared e-scooters; Ride-hailing; Multi-modal transportation; COVID-19 pandemic

Availability: Luo, H., Chahine, R., Rambaram, A., Rosenzweig, E. T., Gkritza, K., and Cai, H. (2022). *Assessing the Travel Demand and Mobility Impacts of Transformative Transportation Technologies in Indiana*. Final Report, FHWA/IN/JTRP-2022/11, Purdue University, West Lafayette, IN. https://docs.lib.purdue.edu/jtrp/1803/

Chapter 6. Special Population Groups

6.1. Title: Person-Environment Interactions and Older Adult Mobility

Author(s): Freed, S.A.

Abstract: Maintenance of personal mobility is one of the most important components of lifespan development and indicators of successful aging. Given its associations with older adults' health and well-being, this dissertation takes a developmental approach in considering mobility an indicator of successful aging. Guided by theories by Hans Werner-Wahl and Paul Baltes, the dissertation aims to elucidate person-environment interactions in determining older adults' mobility. Though mobility research often conceptualizes mobility as driving versus not driving, this dissertation considers the full spectrum of older adult mobility including not only the modes of transportation older adults take but also multiple indicators of driving mobility in order to gain a fuller picture of older adults' mobility.

Subject Areas: Aging; Development; Transportation; Mobility; Driving; Older adults; Environment; Gerontology

Availability: Freed, S.A. (2021). *Person-Environment Interactions and Older Adult Mobility*. Doctoral Dissertation, Penn State University, State College, PA. https://etda.libraries.psu.edu/catalog/22150syf5079

6.2. Title: Modelling Commuting Tours Versus Non-Commuting Tours for University Students. A Panel Data Analysis from Different Contexts

Author(s): Sottile, E., Tuveri, G., Piras, F., and Meloni, I.

Abstract: University students' mobility represents a significant part of the mobility demand, since the right to mobility becomes yet more significant, as it directly translates into the right to education. At the same time, lifestyle evolution and changes has yield to a boost in the number of non-commuting tours, which are now recognized as a key component of any travel demand system. However, their analysis is often overlooked due to their randomness and difficult detectability.

Motivated by this shortfall, the current study sought to explore the university students' mobility by focusing on (i) a comparison among commuting and non-commuting tour, (ii) analysing non-commuting patterns and (iii) identifying factors affecting the tour generation. A joint mixed logit model was specified and estimated using panel data collected in two Italian Universities (Cagliari and Rome).

This study represents a pilot test conducted for the purpose of providing scientific justification for implementing Voluntary Travel Behaviour Change programmes and Travel Demand Management policies in Italian Universities. Our results indicate that the number of non-commuting tours, when compared with commuting tours, is not negligible (around 28 percent of tours are non-commuting tours) and we detected no significant differences between Cagliari and Rome with respect to the tour characteristics. In Cagliari women, individuals who have a high number of household members, people living in areas characterized by high building densities and a small number of shops, and in Rome students living in small families and those who own a car, are more apt to travel for discretionary purposes.

Subject Areas: University students; Non-commuting tours; Panel data; Joint mixed; Mobility demand; Voluntary travel behavior change

Availability: Sottile, E., Tuveri, G., Piras, F., and Meloni, I. (2022). "Modelling Commuting Tours Versus Non-Commuting Tours for University Students. A Panel Data Analysis from Different Contexts." *Transport Policy*, *118*, pp. 56–67.
https://doi.org/10.1016/j.tranpol.2021.12.019

6.3. Title: Impact of Health on Driving for America's Older Adults: A Nationwide, Longitudinal Study

Author(s): Wang, X.

Abstract: By 2030, one in every five Americans will be 65 or older. To better serve the mobility needs of a rapidly aging population, a better understanding of older adults' driving behavior is needed. This study explores the impact of health on driving reduction for America's older adults, using a nationwide, longitudinal dataset from the Health and Retirement Study (HRS). I propose two outcome variables: having driven in the past month and having driven beyond nearby places; and measure health using overall self-rated health status and specific sensory, mobility and physical conditions. Controlling for socio-demographics, residential patterns, personal fixed effects, time fixed effects, and regional fixed effects, I find that older adults with lower self-rated health were less likely to drive or drive beyond nearby places. The magnitudes of such effects vary by race but not by gender. I also identify specific health conditions that could predict driving reduction. The findings imply that in the near future, there will be a large number of older adults suffering from unmet travel demands due to declining health conditions. Hence, planners and policy makers should be proactive in seeking for solutions, including using my findings to identify at-risk older drivers and provide various types of mobility assistance.

Subject Areas: Aging; Elderly; Mode choice; HRS; Longitudinal study; Well-being

Availability: Wang, X. (2022). "Impact of Health on Driving for America's Older Adults: A Nationwide, Longitudinal Study." *Transport Policy*, *120*, pp. 69–79. https://doi.org/10.1016/j.tranpol.2022.02.005

6.4. Title: Travel Behavior of Transportation-Disadvantaged Populations: Trends and Geographic Disparities

Author(s): Mattson, J. and Molina, A.

Abstract: Older adults, people with disabilities, individuals in low-income households, and those living in rural areas can face significant mobility challenges. This study examines travel behavior and mobility of these transportation-disadvantaged groups, including trip rates, miles driven, mode shares, and other behavior, by analyzing data from the 2017 National Household Travel Survey (NHTS). The study also examines trends in travel behavior, by comparing results to data from 2009 and 2001. The data reveal significant differences in travel behavior based on age, disability, income, and geography. Older adults, people with disabilities, and those with low income are shown to drive less and make fewer trips. Results from a cluster analysis show that groups comprised of people who are lower income, older, and those who have a condition or disability were the most transportation disadvantaged. Those in rural areas are more reliant on the automobile, and while they drive more miles, they take fewer trips per day on average. Results also show a continuation of trends, including a narrowing of the gender gap for older adults, a decrease in overall trip rates and miles driven, and an increase in transit mode shares. Understanding trends in the travel behavior of transportation-disadvantaged populations in rural areas and other geographic contexts is important for understanding how well the mobility needs of these populations are being met and for informing policy and transportation investment decisions.

Subject Areas: Cluster analysis; Mobility; Transportation disadvantaged persons; Travel behavior; Trend (statistics)

Availability: Mattson, J. and Molina, A. (2022). *Travel Behavior of Transportation-Disadvantaged Populations: Trends and Geographic Disparities*. Research Report, North Dakota State University, Fargo, ND. https://www.ugpti.org/resources/reports/details.php?id=1057

6.5. Title: Systematic Review of Active Travel to School Surveillance in the United States and Canada

Author(s): Wolfe, M., McDonald, N., Ussery, E., George, S., and Watson, K.

Abstract: Active travel to school is one way youth can incorporate physical activity into their daily schedule. It is unclear the extent to which active travel to school is systematically monitored at local, state, or national levels. To determine the extent of active travel to school surveillance in North America and catalog the types of measures captured, we conducted a systematic review of peer-reviewed literature documenting active travel to school surveillance published from 2004 to February 2018. A study was included if it addressed children's school travel mode across two or more time periods in North America. Criteria were applied to determine whether a data source was considered an active travel to school surveillance system. We identified 15 unique data sources; 4 of these met our surveillance system criteria. One system is conducted in the United States, is nationally representative, and occurs every 5–8 years. Three are conducted in Canada, are limited geographically to regions and provinces, and are administered with greater frequency (e.g., 2-year cycles). School travel mode was the primary measure assessed, most commonly through parent report. None of the systems collected data on school policies or program supports related to active travel to school. We conclude that incorporating questions related to active travel to school behaviors into existing surveillance systems, and maintaining them over time, would enable more consistent monitoring. Concurrently capturing behavioral information along with related environmental, policy, and program supports may inform efforts to promote active travel to school.

Subject Areas: Active travel to school; Active transportation; Surveillance system; School commutes; Physical activity

Availability: Wolfe, M., McDonald, N., Ussery, E., George, S., and Watson, K. (2021). "Systematic Review of Active Travel to School Surveillance in the United States and Canada." *Journal of Healthy Eating and Active Living*, *1*(3), pp. 127–141. https://doi.org/10.51250/jheal.v1i3.24

6.6. Title: People with Disabilities and Use of Public Transit: The Role of Neighborhood Walkability

Author(s): Kwon, K. and Akar, G.

Abstract: This study examines the links between neighborhood walkability and transit use with a focus on the differences between disabled individuals and others. Using the detailed individual-level data from the 2017 National Household Travel Survey-California Add-on (2017 NHTS-CA), we develop a walkability index using the z-scores of net residential density, street connectivity, and land use mix within a ¼ mile radius of one's residential location. We employ a negative binomial regression model to analyze the determinants of individuals' transit use with consideration of a travel-limiting disability. Some key findings are as follows. First, disabled individuals tend to have more frequencies of transit use than their nondisabled counterparts. Second, individuals living in walkable neighborhoods are more likely to use transit in general. Third, after controlling for various other factors, non-worker disabled individuals are less likely to use public transit than others. Lastly, higher levels of walkability are positively associated with transit use of disabled individuals than others. This indicates that enhancing neighborhood walkability has a much larger effect on disabled individuals than their non-disabled counterparts.

Subject Areas: Public transit use; Disabled individuals; Walkability index; Negative binomial regression model

Availability: Kwon, K. and Akar, G. (2021). "People with Disabilities and Use of Public Transit: The Role of Neighborhood Walkability." *Journal of Transport Geography*, *100*. https://doi.org/10.1016/j.jtrangeo.2022.103319

6.7. Title: Trip Deprivation Among Older Adults in The Context of the Capability Approach

Author(s): Deka, D.

Abstract: Transportation researchers have been increasingly interested in integrating the capability approach (CA) into transportation equity analysis during the past decade. The limited number of empirical studies published in that context have assessed individuals' capabilities (i.e., freedom or opportunities) and functionings (i.e., achievements) by variables such as accessibility, transit availability, ability to use transit, ideal travel options versus actual travel, etc. This paper argues that trip deprivation can legitimately reflect both functioning and capability when deprivation is carefully defined. Using data from a recent survey of 3003 older adults in New Jersey, it subsequently compares the personal, household, and locational characteristics of the trip-deprived with the characteristics of other older adults with a multi-level logit model. The trip-deprived are defined in this research as people who had forgone trips for lacking transportation at least sometimes during a six-month period. Consistent with mainstream CA literature, evidence was found that trip deprivation is significantly explained by personal attributes, household resources, and relational support, but not by location-related variables such as jobs or transit stations/stops in municipalities. The results provide empirical evidence supporting recent theoretical studies in the CA context asserting that accessibility in equity analysis should be defined as the ease of travel for individuals instead of aggregation of proximate activities. The paper concludes by suggesting that meaningful questions about potential trips, deprived trips, and the importance of visiting specific activities should be included in the National Household Travel Survey as well as various metropolitan household travel surveys for improved transportation equity analysis.

Subject Areas: Capability approach; Trip deprivation; Older adult; Accessibility; Unmet mobility

Availability: Deka, D. (2021). "Trip Deprivation Among Older Adults in the Context of The Capability Approach." *Journal of Transport Geography*, *100*. https://doi.org/10.1016/j.jtrangeo.2022.103325

6.8. Title: Study: Black Workers Face Longer Commute Times Despite an Uptick in Car Ownership

Author(s): Wilson, K.

Abstract: Blog.

Subject Areas: Race; Commuting; Roads

Availability: Wilson, K. (2022). "Study: Black Workers Face Longer Commute Times Despite an Uptick in Car Ownership." *Greater Greater Washington*. https://ggwash.org/view/84472/study-car-ownership-doesnt-always-cut-black-workers-commutes

6.9. Title: The Association Between Adolescent Active Commuting to School and Parent Walking Behavior: The FLASHE Study

Author(s): Kwon, S., Mason, M., Wang-Schweig, M., Morrissey, J., Bartell, T., and Kandula, N.R.

Abstract: Purpose: To examine the relationship between adolescent active commuting to school (ACS; walking or biking to/from school) and parent walking activity.

Design: Cross-sectional.

Setting: U.S. nationwide online surveys.

Sample: 1367 parent–adolescent (12–17 years) dyads among the Family Life, Activity, Sun, Health, and Eating (FLASHE) study participants (29.4% response rate).

Measures: Online surveys asked about adolescent ACS and parent walking activity in the past week. Adolescents who reported ACS at least once in the past week were categorized as engaging in ACS. Parent walking frequency was categorized into 0–2, 3–5, and 6–7 days.

Analysis: Logistic regression analysis was conducted to compare the probability of adolescent ACS by parent walking activity, adjusted for sociodemographic factors and adolescent-, parent-, and neighborhood-level covariates.

Results: 28.5 percent of adolescents engaged in ACS at least once in the past week. Compared to 0–2 days/week of parent walking activity, ORs for adolescent ACS for 3–5 and 6–7 days/week of parent walking activity were 1.98 (95% CI = 1.38–2.87) and 1.81 (1.23–2.68), respectively. In stratified analyses by parent and adolescent sex, father–son dyads presented the strongest association between adolescent ACS and parent walking 3–5 and 6–7 days/week (ORs = 4.17 [1.46–11.91] and 3.95 [1.45–10.77], respectively).

Conclusions: Adolescents with parents who engaged in walking activity ≥3 days/week were more likely to actively commute to school. Parent walking activity may have positive intergenerational effects on adolescent ACS and physical activity.

Subject Areas: Active transport; Physical activity; Child; Dyads; Built environment

Availability: Kwon, S., Mason, M., Wang-Schweig, M., Morrissey, J., Bartell, T., and Kandula, N.R. (2022). "The Association Between Adolescent Active Commuting to School and Parent Walking Behavior: The FLASHE Study." *American Journal of Health Promotion*, *36*(8), pp. 1265–1274 https://doi.org/10.1177%2F08901171221099271

6.10. Title: Planning for an Aging Population: The Sustainability Conundrum

Author(s): Rosenbloom, S.

Abstract: By 2030 more than one in four Americans will be 65 years of age or older. What role do city planning academics and practitioners play in planning for the inevitable and increasing aging of society? I examined original research and reviewed articles published in three major planning journals, reviewed the websites of ten Planning Accreditation Board (PAB) accredited planning programs, and evaluated the websites of the American Planning Association's divisions and special interest groups to determine how each demonstrated or portrayed the value and importance of aging issues in planning scholarship, pedagogy, and practice. I found that these key pillars of the profession and discipline of planning give almost no attention to aging issues. I suggest that planners are fairly ignorant about older people and their needs, that there is substantial ageism and sexism in these discussions, and that planners face a conundrum because seniors often make important lifestyle decisions that defy a variety of planners' sustainability objectives. These sweeping socio-demographic changes will not go away, however. Planners therefore must develop an arsenal of tools to help seniors safely and securely live in their communities, continuing to make valuable contributions to their family, friends, and community. If planners do not step up, the aging of society will likely overtake them and make much of what they do irrelevant.

Subject Areas: Aging population; Planning program; Age-friendly community

Availability: Rosenbloom, S. (2022). "Planning for an Aging Population: The Sustainability Conundrum." *Journal of Comparative Urban Law and Policy*, *5I*(1), pp. 135–175. https://readingroom.law.gsu.edu/jculp/vol5/iss1/16

6.11. Title: A Factor Analysis for Identifying People with Disabilities' Mobility Issues in Built Environments

Author(s): Hwang, J.

Abstract: Neighborhood built environments (BE) have been recognized as an important aspect that can, directly and indirectly, impact people with disabilities' mobility. While many efforts have been made to improve the quality of BE, people with disabilities still perceive inequality in BE. The objective of this study is to identify the factors influencing people with disabilities' attitudes toward BE that can facilitate or suppress their mobility, using exploratory factor analysis. This study specifically focuses on people with physical disabilities and people with visual impairments living in Austin, TX and Houston, TX metropolitan areas in USA. Data was gathered through an online survey. This study identified three factors from the sample: (1) barrier-free BE; (2) BE supporting safe travel; and (3) walkable BE. In addition, the factors were compared according to the respondents' demographic information, such as income level, disability type, and private car use availability in households. Regarding income level, low-income individuals with disabilities perceived BE more negatively than their counterparts did. As for private car availability, people with disabilities who have no car in their households had a more negative perception of BE. However, no differences were found in the attitudes across disability types. This study contributes to understanding what BE factors are important for people with disabilities. The findings suggest the importance of establishing more targeted and prioritized strategies, considering people with disabilities' neighborhoods and individual characteristics, for the improvement of their mobility.

Subject Areas: People with disabilities; Mobility issues; Built environments; Exploratory factor analysis

Availability: Hwang, J. (2022). "A Factor Analysis for Identifying People with Disabilities' Mobility Issues in Built Environments." *Transportation Research Part F: Traffic Psychology and Behaviour*, *88*, pp. 122–131. https://doi.org/10.1016/j.trf.2022.05.016

6.12. Title: Transportation Equity for Older Adults

Author(s): Fraade-Blanar, L., Best, R., and Shih, R.A.

Abstract: In the United States, older adults are at particular risk of having unmet transportation needs as individual mobility challenges mount and driving ability declines with age. Furthermore, these risks are occurring in an economic environment of rapid change in transportation technology and in a societal environment that does not always support or prioritize older-adult mobility. This perspective provides an overview of — and weighs solutions to — the equity concerns surrounding older-adult transportation. Next, a framework is presented for communities to explore and assess how well they are serving the transportation needs of older adults as a population and specific older-adult subpopulations. Last, ideas for future exploration and action are presented. This perspective is intended to provide guidance for communities and advocates for older adults in identifying and strengthening transportation systems.

Subject Areas: Communities; Older adults; Public transportation

Availability: Fraade-Blanar, L., Best, R., and Shih, R.A. (2022). *Transportation Equity for Older Adults*. RAND Corporation, Santa Monica, CA. https://doi.org/10.7249/PEA1615-1

6.13. Title: Buying Access One Trip at a Time

Author(s): Brown, A., Klein, N.J., Smart, M.J., and Howell, A.

Abstract: New transportation options like ride-hail can expand accessibility without the costs of car ownership. Ride-hail's potential is particularly salient for lower-income and zero-car households. We used interviews and a national (U.S.) survey to examine how and why lower-income travelers in the United States use ride-hail. Survey and interview responses provided a temporal snapshot and thus reflect, in part, travel challenges specific to COVID-19. Findings suggest that lower-income travelers, particularly those without personal cars, use ride-hail in ways distinct from those typically reported in broader travel surveys. Individuals without cars are more likely to use ride-hail, and use it more often, compared with people with cars, particularly to fill spatial and temporal gaps in public transit service and to access medical care and groceries. Costs and price unpredictability remain significant barriers limiting travelers' use of ride-hail services.

Subject Areas: Car access; Low-income travel; Ride-hail; Transportation network company

Availability: Brown, A., Klein, N.J., Smart, M.J., and Howell, A. (2022). "Buying Access One Trip at a Time." *Journal of the American Planning Association*, *88*(4), pp. 495–507. https://doi.org/10.1080/01944363.2022.2027262

6.14. Title: How Well Do New K-12 Public School Sites in California Incorporate Mitigation Measures Known to Reduce Vehicle Miles Traveled?

Author(s): Vincent, J.M., Maves, S., and Thomson, A.

Abstract: California law (SB 743) requires school districts to measure the impact of school construction on the production of greenhouse gas emissions (GHG) and identify feasible mitigation measures that eliminate or substantially reduce the number of vehicle miles traveled (VMT) generated. This study analyzes 301 new schools constructed between 2008–2018 with respect to four VMT mitigation measures identified by the Governor's Office of Planning and Research (OPR) known to minimize VMT (proximity to high quality transit areas, proximity to roads with bicycle facilities, walkability scores, and proximity to electric vehicle charging stations). The analysis reveals mixed findings. Only about 16 percent of the new schools sited are located within one half mile from high quality transit. About 65 percent of new school sites either connected or are close to (0.06 miles or less) a bicycle network. Walkability scores varied greatly by location; approximately 60 percent of new school sites in "city" locales are considered walkable while sites in "rural" areas have low walkability scores. Nearly 60 percent (179) of new school sites are located within one mile of an EV charger, but only 19 percent are within one quarter mile.

Subject Areas: K-12 schools; Vehicle miles of travel; Active transportation; Accessibility; Greenhouse gases; Location; Policy analysis

Availability: Vincent, J.M., Maves, S., and Thomson, A. (2022). *How Well Do New K-12 Public School Sites in California Incorporate Mitigation Measures Known to Reduce Vehicle Miles Traveled?* Final Report, Institute of Transportation Studies, University of California, Berkeley, CA. https://escholarship.org/content/qt19p2t3vb/qt19p2t3vb.pdf

6.15. Title: California Is Richer Than Ever. Why Is It Last in the Nation for School Bus Access?

Author(s): Mays, M.

Abstract: Blog.

Subject Areas: School bus; Access to education; Rural school district; Low-income families; Accessibility; California; Funding

Availability: Mays, M. (2022). "California Is Richer Than Ever. Why Is It Last in the Nation for School Bus Access?" *Los Angeles Times*. https://www.latimes.com/california/story/2022-06-22/theres-a-human-cost-to-this-california-ranks-lowest-in-nation-for-school-bus-use

6.16. Title: Micromobility Promises and Challenges in the Pacific Northwest

Author(s): Chen, C., Chand, C., Wang, H., Hurwitz, D., and Belz, N.

Abstract: This study used a questionnaire survey method to understand how people use micromobility and the opportunities and challenges associated with its adoption in the Pacific Northwest (Alaska, Oregon, Washington, and Idaho). With 527 respondents who generally represented the demographics of the area, this study found that micromobility is becoming an important mode share in daily life. Using micromobility is positively associated with the possession of a higher education degree, being employed, living in an urban area, and the perception that using micromobility can benefit environmental and social issues. It is negatively associated with increasing age, self-identifying as female, and having a disability. People use micromobility more for commuting and recreational purposes. Commuting use is significantly positively affected by respondents' perceptions of micromobility's benefits, but negatively affected by income, being female, and having a disability. Recreational use is significantly positively affected by age, being female, and marital status. We also found that younger respondents tend to use micromobility more for occasional purposes (e.g., recreation, shopping, and social visits), but older respondents use it more for commuting. In considering the impacts of COVID-19, we found a significant decrease in usage frequency when the stay-at-home orders were implemented in terms of four ride purpose categories (commuting, recreational, shopping, and social). Furthermore, this study identified three reasons people have for not using micromobility: lack of access, lack of ability or skills, and worry about safety. However, we also found the potential for a large mode shift toward micromobility if those issues were resolved. Combining the findings about the usage of micromobility and public transit, evidence was provided to support that micromobility can be an effective standalone mode or a first- and last-mile mode for public transit to address current transportation issues such as traffic congestion and emissions. Based on the findings from the survey, this study also provides recommendations for authorities to support policymaking and infrastructure. investment.

Subject Areas: Micromobility; Transportation mode; Scooter; Bicycle; COVID-19

Availability: Chen, C., Chand, C., Wang, H., Hurwitz, D., and Belz, N. (2022). *Micromobility Promises and Challenges in the Pacific Northwest*. Final Project Report, PacTrans, University of Washington, Seattle, WA.
https://digital.lib.washington.edu/researchworks/bitstream/handle/1773/48584/Wang%20Micromobility%20Final-Report-Pactrans.pdf?sequence=1

6.17. Title: Domestic Burden in an Unfamiliar New Homeland: Gender, Immigration, and Household-Serving Trip Frequencies

Author(s): Hsu, H.-P.

Abstract: Research shows that immigrants face greater mobility constraints in an unfamiliar environment, particularly immigrant women. But whether and how immigrant women adjust their household-serving trip frequencies accordingly remains largely unknown. Utilizing data of adult male and female members in nuclear families from the 2017 National Household Travel Survey conducted in the United States and applying the negative binomial regression model, it is found that, all else holds constant, being a woman correlates with making more escorting and shopping trips, but being an immigrant does not. In other words, immigrant women escort others and go shopping as often as native-born women. However, it is also found that, all else being equal, spouses of immigrants make more escorting and shopping trips than spouses of natives, especially husbands of immigrant women. Taken together, these results suggest that although men with an immigrant wife take on more household-serving travel duties so that the within-household gender travel gap narrows, the household-serving travel burden on immigrant women is not lessened compared to that on native-born women. Therefore, while encouraging male participation in household labor is a common strategy to reduce women's domestic load, assistance from outside the home should be provided in particular to immigrant women for alleviating their household-serving travel burden.

Subject Areas: Gender; Immigration; Trip frequency; Escorting; Shopping

Availability: Hsu, H.-P. (2022). "Domestic Burden in an Unfamiliar New Homeland: Gender, Immigration, and Household-Serving Trip Frequencies." *Transportation*. https://doi.org/10.1007/s11116-022-10310-y

6.18. Title: Rideshare Use Among People with Disabilities: Patterns and Predictors Based on a Large Nationally Representative Survey

Author(s): Eisenberg, Y., Hofstra, A., Tilahun, N., and Shanley, J.

Abstract: People with disabilities have more difficulty getting around due to lack of transportation. Rideshare has the potential to improve mobility by addressing many limitations of fixed-route and paratransit services. However, it is unclear whether people with disabilities have access to and are benefiting from rideshare or how those benefits differ by type of disability. The purpose of this study was to examine rideshare use among people with disabilities and identify personal, household, and community characteristics associated with adoption and frequency of rideshare use. We leveraged data from the most recent US National Household Travel Survey and ran regression models to study the separate processes of adoption and frequency. We found that having a disability of any type was associated with a lower likelihood of adopting rideshare. However, among those who do adopt rideshare, having any type of disability was associated with higher rate of trip taking compared to people without disabilities. Higher frequency of rideshare use among people with disabilities was associated with being in better health, being younger, Black, better educated, employed or student, and living in densely populated areas. Our results show how rideshare behavior differs for people with disabilities compared to those without and the role of assistive devices used by people with different types of disabilities. To develop rideshare as an equitable mobility option, transportation planners, policy makers, disability advocates, and the rideshare industry need to address both the lack of access to rideshare and the socio-economic factors impacting rideshare use among people with disabilities.

Subject Areas: Rideshare; Disability; Travel behavior; Mobility; Assistive devices; Inequality

Availability: Eisenberg, Y., Hofstra, A., Tilahun, N., and Shanley, J. (2022). "Rideshare Use Among People with Disabilities: Patterns and Predictors Based on a Large Nationally Representative Survey." *Travel Behaviour and Society*, *29*, pp. 246–256. https://doi.org/10.1016/j.tbs.2022.07.001

6.19. Title: Riding the Yellow School Bus: Equity in Bus Transportation Across Districts, Schools, and Students

Author(s): Weinstein, M., Cordes, S.A., Rick, C., and Schwartz, A.E.

Abstract: While the yellow school bus is emblematic of American education, there is variation in bus service across the country. Millions of students rely on the bus, making transportation an essential part of a student's educational experience. Thus, equity in transportation access is a key component of educational equity. Using national district-level data and New York City student-level data, we examine equity in transportation finance and bus provision. Our findings indicate significant racial and ethnic disparities, both nationally and in NYC. These results may help schools and districts design bus services to level the playing field and enhance student outcomes.

Subject Areas: Yellow school bus; Equity; Transportation access; New York City; Education

Availability: Weinstein, M., Cordes, S.A., Rick, C., and Schwartz, A.E. (2022). "Riding the Yellow School Bus: Equity in Bus Transportation Across Districts, Schools, and Students." *Urban Education*. https://journals.sagepub.com/doi/abs/10.1177/00420859221114084

6.20. Title: Disability, Access to Out-of-Home Activities, and Subjective Well-Being

Author(s): Ralph, K., Morris, E.A., and Kwon, J.

Abstract: People with disabilities tend to participate in fewer out-of-home activities, raising concerns about their well-being. This paper investigates travel and activity barriers faced by people with disabilities using data from the American Time Use Survey from 2008 to 2019. Our dependent variable of interest is a measure of realized accessibility known as a travel time price: that is, the number of travel minutes associated with each minute of out-of-home activity time. In using this measure, we first confirm that out-of-home activities are associated with greater subjective well-being, that travel is associated with relatively low well-being, and that travel time prices are negatively associated with life satisfaction. We next find that people with disabilities typically pay a travel time price premium 50% higher than those without disabilities for all out-of-home activities, and 11% higher for work trips. These premiums narrow but persist when accounting for personal characteristics and travel mode. We discuss the unique contributions of simple linear and multiple regression results, given that disability is so closely linked to personal characteristics like employment, income, and marital status. We then disaggregate the results by type of disability and close by presenting ideas for removing transportation and activity barriers for the heterogenous population of people with disabilities.

Subject Areas: Disability; Access; Travel time price; Out-of-home activities; Travel; Subjective well-being

Availability: Ralph, K., Morris, E.A., and Kwon, J. (2022). "Disability, Access to Out-of-Home Activities, and Subjective Well-Being." *Transportation Research Part A: Policy and Practice*, *163*, pp. 209–227. https://doi.org/10.1016/j.tra.2022.06.006

6.21. Title: Vehicle Travel and Ownership Among the US Older Adults in the Digital Era

Author(s): Li, S. and Guerra, E.

Abstract: This project examines the interaction of the built environment, travel behavior, and technology usage among older adults. Decades-long transportation policies favoring vehicle owners have made many older adults disadvantaged in daily travel. Studies and policies specifically addressing older adults' travel needs do not keep pace with the increasing number and diversity of the aging population.

Subject Areas: Aging; Vehicle; Baby boomer; Information communication technology; Aging in place

Availability: Li, S. and Guerra, E. (2022). *Vehicle Travel and Ownership Among the US Older Adults in the Digital Era*. Technical Report, Weitzman School of Design, University of Pennsylvania, Philadelphia, PA. https://sites.utexas.edu/cm2/files/2022/07/CM2-66_Guerra-and-Alex-Li.pdf

6.22. Title: Let Go and Let Grow: An Assessment of a School and Community-Based Intervention Encouraging Independence in Children

Author(s): Elsharouny, M.

Abstract: Overinvolved parenting is on the rise, despite its association with negative outcomes for children (Twenge, 2017; American Psychological Association (APA), 2019; Segrin et al., 2013). Its emerging counterpart, free-range parenting, urges parents to offer their children more independence and less supervision (Skenazy, 2009). However, no quantitative, peer-reviewed research has been conducted on the effects of independent task engagement on children's independence and resilience. The present study evaluated the effects of The Let Grow Project (Skenazy, 2018), a school-based intervention aimed at increasing resilience and independence in children by assigning homework to engage in tasks independently. Children completed measures of independence, resilience, helicopter parenting, and anxiety at pre-intervention, postintervention and after a one-month follow up. Parents of participants completed measures of parent stress, child's independence, child anxiety, child resilience, and overparenting. The current study found that independent task completion has significant, if inconsistent effects on children's independence and resilience, and significant effects on child anxiety and helicopter parenting behaviors. The results could have theoretical implications relating to our understanding of free-range parenting practices and their impacts on children's independence and resilience.

Subject Areas: Parenting; Parent Stress; Child independence and resilience; Child anxiety

Availability: Elsharouny, M. (2022). *Let Go and Let Grow: An Assessment of a School and Community-Based Intervention Encouraging Independence in Children*. Doctoral Dissertation, Long Island University, Brookville, NY. https://digitalcommons.liu.edu/post_fultext_dis/43/

6.23. Title: What Everyone Can Learn from a Traveler with a Disability

Author(s): Coyle, M.

Abstract: Blog.

Subject Areas: Disability; Traveling; Trip planning

Availability: Coyle, M. (2022). "What Everyone Can Learn from a Traveler with a Disability." *nerdwallet*. https://www.nerdwallet.com/article/travel/what-everyone-can-learn-from-a-traveler-with-a-disability

6.24. Title: Driving, Residential Location, and Employment Outcomes Among Older Adults

Author(s): Schouten, A., Blumenberg, E., and Wachs, M.

Abstract: The ability to drive is positively associated with workforce participation among older adults. However, residence in neighborhoods where destinations are easy to reach by public transit could potentially narrow the employment gap between older drivers and non-drivers. This study examines the relationship between driving, residential location characteristics, and employment outcomes among older adults. Findings show that both drivers and non-drivers are more likely to be employed if they live in neighborhoods with high levels of access to jobs via public transit. However, the positive relationship between transit access to jobs and employment outcomes is particularly strong among non-drivers. These findings indicate that although older adult drivers are more likely to work than their non-driving counterparts, the gap in employment outcomes is mitigated by living in dense, transit-rich neighborhoods. Results suggest that policies supporting both automobile access and transit-rich residential environments can facilitate labor force participation among older adults.

Subject Areas: Older adults; Employment; Residential location characteristics; Drivers; Transit

Availability: Schouten, A., Blumenberg, E., and Wachs, M. (2022). "Driving, Residential Location, and Employment Outcomes Among Older Adults." *Journal of Applied Gerontology*, *41*(12), pp. 2447–2458. https://doi.org/10.1177/07334648221120081

6.25. Title: Redlining and Neighborhood Walking in Older Adults: The 2017 National Household Travel Survey

Author(s): Besser, L.M., Mitsova, D., Williams, C.L., and Wiese, L.

Abstract: Introduction: In the 1930s, Black, working-class, and immigrant neighborhoods were color coded on maps (i.e., redlining) indicating investment risk, which negatively impacted mortgage attainment/homeownership for these groups and led to long-standing segregation by race/ethnicity and socioeconomic status. Limited studies have investigated the health impacts of redlining, particularly among older adults who tend to stay closer to their residences. This study examines whether older adults in historically redlined neighborhoods report less neighborhood walking and whether associations vary by race/ethnicity and income.

Methods: The sample included 4,651 individuals aged ≥65 years from the 2017 U.S. National Household Travel Survey. U.S. Census tract–based redlining scores were 1 = best, 2 = still desirable, 3 = definitely declining, and 4 = hazardous. Multivariable negative binomial regression tested the associations between redlining and neighborhood walking/day in the overall sample and with stratification by poverty status (analyzed in 2022).

Results: Participants were on average aged 73 years, and 11% were African/American Black, 75% were White, 8% were Hispanic/Latinx, and 6% were of other race/ethnicity. Participants reported a mean of 7.1 neighborhood walking minutes/day (SD = 20.6), and 60% lived in definitely declining or hazardous neighborhoods. Individuals in hazardous neighborhoods (versus those in best neighborhoods) reported less neighborhood walking (prevalence ratio = 0.64; [95% CI: (0.43, 0.97)]. Among those living in poverty, living in definitely declining and hazardous neighborhoods was associated with less neighborhood walking (prevalence ratio = 0.39 [95% CI: (0.20, 0.79)] and 0.39 [95% CI: (0.18, 0.82)], respectively).

Conclusions: Less neighborhood walking was reported among individuals living in neighborhoods with a historic redlining score of definitely declining or hazardous. Future studies using larger, more diverse cohorts may elucidate whether associations differ by race/ethnicity and geographic location/city.

Subject Areas: Historical redlining; Neighborhood walking; Race and ethnicity; Household income

Availability: Besser, L.M., Mitsova, D., Williams, C.L., and Wiese, L. (2022). "Redlining and Neighborhood Walking in Older Adults: The 2017 National Household Travel Survey." *American Journal of Preventive Medicine*, *63*(6), pp. 926–934. https://doi.org/10.1016/j.amepre.2022.06.010

6.26. Title: Getting Around in a College Town: A Case Study of Transportation Barriers Faced by International Students at UA

Author(s): Islam, R., Rafique, S., Bredikhina, O.A., and Jones, S.

Abstract: University students' day-to-day lives largely depend on transportation. Public transit alternatives are not widely available in small-town, rural, and suburban collegiate environments in the United States (U.S.). In this study, an online survey was disseminated among international students studying at The University of Alabama (UA) campus, a predominantly white institution located in Tuscaloosa, Alabama. The objective of this research was to investigate and analyze international student travel experiences in a city with a significant college-affiliated population, as well as to highlight particular transportation issues in the area. The survey results show that international students find it difficult to travel within Tuscaloosa without a personal vehicle, as other modes of transportation including walking, biking, and using public transportation are not always convenient or reliable. The study findings may be of interest to transportation experts, city planners, university administrators, and college students who want to better understand travel-related challenges experienced by international students.

Subject Areas: Automobile-Dependency; Mobility; International Students; Accessibility

Availability: Islam, R., Rafique, S., Bredikhina, O.A., and Jones, S. (2022). *Getting Around in a College Town: A Case Study of Transportation Barriers Faced by International Students at UA*. arXiv preprint, arXiv:2208.06434v1 [physics.soc-ph]. https://arxiv.org/abs/2208.06434

6.27. Title: Young Children Who Walk or Bike to School Are More Likely to Continue the Habit as They Age

Author(s): Rutgers University-New Brunswick.

Abstract: Blog.

Subject Areas: Active commuting; Travel habits; Distance to school

Availability: Rutgers University-New Brunswick. (2022). "Young Children Who Walk or Bike to School Are More Likely to Continue the Habit as They Age." *Newswise, Inc*. https://www.newswise.com/articles/young-children-who-walk-or-bike-to-school-are-more-likely-to-continue-the-habit-as-they-age

6.28. Title: Who Lives in Vehicles and Why? Understanding Vehicular Homelessness in Los Angeles

Author(s): Giamarino, C., Blumenberg, E., and Brozen, M.

Abstract: Homelessness continues to grow and to affect the lives of an increasingly diverse group of individuals. Many scholars have studied people living in homeless shelters and outdoors in tents. An overlooked population is the growing number of the unhoused living in vehicles. We draw on data from the Los Angeles Homeless Services Authority's Homeless Demographic Survey to understand the characteristics of people living in vehicles and the extent to which they differ from the nonvehicular unhoused population. Compared to those living in tents, in makeshift shelters, and in public spaces, people living in vehicles are more likely to be women and to live in larger households with children, and are less likely to be chronically unhoused. These findings will help effectively target policies and services. Safe parking programs can provide temporary relief to those living in vehicles and, if done well, the interventions necessary to transition into permanent housing.

Subject Areas: Vehicular homelessness; Transportation; Safe parking; Housing; Los Angeles

Availability: Giamarino, C., Blumenberg, E., and Brozen, M. (2022). "Who Lives in Vehicles and Why? Understanding Vehicular Homelessness in Los Angeles." *Housing Policy Debate*. https://doi.org/10.1080/10511482.2022.2117990

6.29. Title: Bronco Shuttle Buses Offer Benefits, Both Environmental and Communal, to the Local Community

Author(s): Myers, K.

Abstract: Blog.

Subject Areas: Campus shuttle bus; Public transportation; Boise State; Health benefit

Availability: Myers, K. (2022). "Bronco Shuttle Buses Offer Benefits, Both Environmental and Communal, to the Local Community." *The Arbiter*. https://arbiteronline.com/2022/11/03/bronco-shuttle-buses-offer-benefits-both-environmental-and-communal-to-the-local-community/

6.30. Title: No, the IIHS Isn't Recommending 'Monster Trucks' for Teen Drivers

Author(s): McParland, T.

Abstract: Blog.

Subject Areas: Teen driver; Size of the car; Safety

Availability: McParland, T. (2022). "No, the IIHS Isn't Recommending 'Monster Trucks' for Teen Drivers." *Yahoo*. https://www.yahoo.com/now/no-iihs-isnt-recommending-monster-200000942.html

6.31. Title: Traffic from Car-Driving Charter School Parents Vexes Upper Manhattan; City Provides No Oversight

Author(s): Kessler, E.

Abstract: Blog.

Subject Areas: Charter school; Car drop-offs and pick-ups; Traffic; Traffic police

Availability: Kessler, E. (2022). "Traffic from Car-Driving Charter School Parents Vexes Upper Manhattan; City Provides No Oversight." *StreetBlog NYC*. https://nyc.streetsblog.org/2022/11/01/traffic-from-car-driving-charter-school-parents-vexes-upper-manhattan-city-provides-no-oversight/

6.32. Title: Access to Food and Physical Activity Environment Resources in Rural Communities: Impact of Using Driving Time Versus Physical Distance Indicators

Author(s): Dixon, B.N., Hong, Y.-R., Perri, M.G., Allen, A., Aufmuth, J., and Ross, K.M.

Abstract: Introduction: The one-mile buffer is commonly used in examining associations between the built environment and weight-related outcomes; however, this buffer may not adequately capture access to built environment resources among individuals residing in geographically dispersed rural communities. Thus, there is need to explore how different buffer sizes and types capture access to built environment resources in rural communities.

Objective: This study compared two physical distance buffers (i.e., one-mile and two-mile) against two driving distances (i.e., 15-min and 30-min) to determine ability to capture access to built environment resources related to dietary intake and physical activity for participants in a weight management trial across rural counties.

Methods: Data from the Rural Lifestyle Eating and Activity (Rural LEAP) trial were combined with publicly available geospatial datasets to identify and examine built environment resources for individuals residing in 13 rural counties in Florida. Descriptive statistics were calculated to determine access to built environment resources, and paired samples t-tests were used to compare access across various buffers and by level of rurality.

Results: Results demonstrated limited resources available within the one- and two-mile buffers; however, participants had greater access to resources in the 15- and 30-min driving distances. Using supermarkets and grocery stores as an example, findings also demonstrated that participants residing in less rural counties compared to more rural counties had greater access to supermarkets and grocery stores within the 15-min (mean [SD] 9.16 [6.03], $p < .0001$) and 30-min (mean [SD] 24.82 [9.19], $p = .007$) driving distance buffers. There were no significant differences in the number of supermarkets between more or less rural counties for the one- and two-mile buffers.

Conclusion: Driving distances may be useful measures to capture access to built environment resources in rural communities. Future studies should examine alternative buffers that adequately capture built environment resources accessed by rural residents.

Subject Areas: Built environment; Rural; Weight

Availability: Dixon, B.N., Hong, Y.-R., Perri, M.G., Allen, A., Aufmuth, J., and Ross, K.M. (2022). "Access to Food and Physical Activity Environment Resources in Rural Communities: Impact of Using Driving Time Versus Physical Distance Indicators." *Journal of Transport & Health*, *27*. https://doi.org/10.1016/j.jth.2022.101521

6.33. Title: Statistics Matter

Author(s): Gray, R.

Abstract: Blog.

Subject Areas: Student transportation; School buses; School district; Trip to and from school

Availability: Gray, R. (2022). "Statistics Matter." *School Transportation News*. https://stnonline.com/blogs/statistics-matter/

6.34. Title: Cheapest Car Insurance with Kids

Author(s): Shaughnessy, L.

Abstract: Blog.

Subject Areas: Car insurance; Young drivers; Telematics programs

Availability: Shaughnessy, L. (2022). "Cheapest Car Insurance with Kids." *MarketWatch, Inc.* https://www.marketwatch.com/picks/guides/insurance/cheapest-car-insurance-with-kids/

6.35. Title: Evaluating Spatial and Temporal Patterns of Tick Encounters Using Community Science Data Submitted Through a Smartphone Application

Author(s): Kache, P.A. et al.

Abstract: Research initiatives that engage the public (i.e., community science) increasingly provide insights into tick exposures in the United States. However, these data have limitations, particularly with respect to reported travel history and tick identification. Here, we assessed whether The Tick App provides reliable and novel insights into tick exposures across three domains—travel history and habitat exposure, broad spatial and temporal patterns of species-specific encounters, and tick identification. During 2019–2021, we received 11,424 tick encounter submissions from across the United States, with nearly all generated in the Midwest and Northeast regions. Encounters were predominantly with human hosts (71%); although one-fourth of ticks were found on animals. Half (51%) of the reported encounters resulted from peri-domestic exposures, while 37% were recreational exposures. Using phone-based location services, we detected differences in travel history outside of the users' county of residence along an urbanicity gradient. Approximately 75% of users from large metropolitan and rural counties had travel out-of-county in the four days preceding tick detection, whereas an estimated 50–60% of users from suburban or smaller metropolitan areas did. Furthermore, we generated tick encounter maps for Dermacentor variabilis and Ixodes scapularis that accounted for travel history to the extent possible—overall mirroring previously published species distributions, while revealing 45 counties with new reports of D. variabilis exposures. Finally, using photo submissions, prompts of tick coloration and size engaged and guided users towards species and life stage classification moderately well, with 60% of users correctly identifying D. variabilis adults and 46% correctly identifying I. scapularis adults. Together, these results indicate the importance of bolstering the use of mobile applications to engage community scientists and complement other methods of active and passive tick surveillance.

Subject Areas: Ticks; Tick encounters; Tick surveillance; Citizen science

Availability: Kache, P.A. et al. (2022). *Evaluating Spatial and Temporal Patterns of Tick Encounters Using Community Science Data Submitted Through a Smartphone Application*. Preprint Research Article, Research Square, Durham, NC. https://doi.org/10.21203/rs.3.rs-2222034/v1

6.36. Title: How and Why Do People with Disabilities Use App-Based Ridehailing?

Author(s): Cochran, A.L.

Abstract: Over 40 million people in the United States live with disabilities. Yet, relatively little is known about the travel behavior of people with disabilities, particularly as it relates to their use of emerging services like app-based ridehailing provided by transportation network companies (TNCs), such as Uber and Lyft. Analyzing in-depth interviews with 32 individuals with disabilities living in the San Francisco Bay Area, I find that TNC use depends on respondents' prior experience using transportation and smartphones. Older adults and those who acquired their disabilities relatively recently had difficulty using app-based ridehailing due to perceived and experienced challenges hailing a ride, finding the vehicle, and getting to their destination independently. Younger respondents and those who had lived with their disabilities longer perceived ridehailing to be reliable and convenient, and found it relatively more affordable than taxis. They liked having app-based ridehailing as an option. This was also true among respondents who used motorized wheelchairs, but they said that the availability and quality of wheelchair-accessible ridehailing services were lacking. Subsidizing app-based ridehailing may encourage greater use of these services among some people with disabilities. However, this approach and new policies aimed at improving wheelchair-accessible ridehailing services do not address expressed barriers to ridehailing use—especially among older adults with disabilities. Other interventions, such as training programs for ridehailing drivers as well as potential riders, might help address some of these barriers.

Subject Areas: Disability; Qualitative research; Ridehailing; Transportation network companies (TNCs); Travel behavior

Availability: Cochran, A.L. (2022). "How and Why Do People with Disabilities Use App-Based Ridehailing?" *Case Studies on Transport Policy*, *10*(4), pp. 2556–2562. https://doi.org/10.1016/j.cstp.2022.11.015

6.37. Title: Travel Patterns and Characteristics of Elderly Population in New York State: 2017 Update

Author(s): Liu, Y., Hwang, H.-L., Uddin, M., Reuscher, T., and Chin, S.-M.

Abstract: According to US Census Bureau, the elderly population (individuals 65 years and older) has grown by over one-third during the past decade (20102019), and by 3.2% from 2018 to 2019. It is essential for policymakers and planners to understand transportation issues associated with the elderly to meet their increasing travel demands. These issues include transportation and mobility of the elderly population, factors impacting their travel behavior, and transportation safety.

In this study, Oak Ridge National Laboratory was tasked by the New York State Department of Transportation (NYSDOT) to conduct a detailed examination of travel behaviors and identify patterns and trends of its elderly residents. The National Household Travel Survey (NHTS) was used as the primary data source to analyze subjects and address questions such as: Are there differences in traveler demographics between the elderly population and those of younger age groups who live in various New York State (NYS) regions, e.g., New York City (NYC), other urban areas of NYS, or other parts of the country? How do they compare with the population at large? Are there any regional differences (e.g., urban vs. rural)? Do any unique travel characteristics or patterns exist within the elderly group? How did these patterns change over time?

In addition to the analysis of NHTS data, roadway travel safety concerns associated with elderly travelers were also investigated. Specifically, data on crashes involving the elderly (including drivers, passengers, and pedestrians) as captured in the Fatal Analysis Reporting System database was analyzed to examine elderly drivers and elderly pedestrian travel safety issues in NYS.

This study report provides a summary of travel behavior and socio-demographic characteristics of NYS elderly residents. These statistics could be used to examine equity issues concerning elderly New Yorkers, as well as to evaluate how well their mobility needs are being met. With a deeper understanding of issues and needs that this special population group is facing, policymakers and transportation planners would be able to make informed decisions on transportation investments and design services that could better address them.

Subject Areas: Total cost of ownership analysis; Plug-in electric vehicles; Internal combustion engine vehicles; Market segments; Vehicle purchase choice; Driving and charging behavior; sociodemographic attributes

Availability: Liu, Y., Hwang, H.-L., Uddin, M., Reuscher, T., and Chin, S.-M. (2022). *Travel Patterns and Characteristics of Elderly Population in New York State: 2017 Update*. Technical Report, ORNL/TM-2022/2614, Oak Ridge National Laboratory, Oak Ridge, TN. https://info.ornl.gov/sites/publications/Files/Pub183550.pdf

6.38. Title: Active Transportation and Physical Activity Accumulation Among a National Sample of People with Disabilities

Author(s): Eisenberg, Y., Twardzik, E., and Hofstra, A.

Abstract: Background: People with disabilities have higher rates of physical inactivity, obesity, and other chronic conditions than people without disabilities. In the general population, active transportation (e.g., walking to public transit or nearby destinations) is a recommended approach to increasing physical activity but its transferability to people with disabilities is unknown. To address this gap, we examined active transportation among a nationally representative sample of people with disabilities.

Methods: Using the 2017 National Household Travel Survey (NHTS), we summarized counts, duration, and purpose of walking/wheeling trips using survey weights where applicable. We tested differences among people with travel-limiting disabilities who did and did not engage in active transportation. Disability, types of assistive device, and active transportation were self-reported.

Results: 14.5% (n = 2,767) of people with disabilities took an average of 2.54 active transportation trips (SD = 0.07). The count and duration of trips varied by assistive device used as white cane users took the most trips (M = 3.0 min. (SD = 0.5 min.)), while ambulatory device users took the longest trips ((M = 18.0 min. (SD = 1.0 min.)). Walking/wheeling trips to shopping were longest (M = 9.4 min. (SD = 0.66 min.) and to work were shortest (M = 1.3 min. (SD = 0.2 min.)) Engagers in active transportation (compared to non-engagers), were more often an immigrant, Black, Hispanic, more educated, working, without access to a car, without a driver's license, low income, and living alone (all significant at $p < 0.001$).

Discussion: Interventions to promote active transportation may increase physical activity among people with disabilities. Understanding the intersectionality of disability and other identities in relation to active transportation can inform the target of and implementation factors for future interventions.

Subject Areas: Active transportation; Physical activity; People with disabilities

Availability: Eisenberg, Y., Twardzik, E., and Hofstra, A. (2022). *Active Transportation and Physical Activity Accumulation Among a National Sample of People with Disabilities*. 2022 American Public Health Association Annual Meeting and Expo, Boston, MA. https://apha.confex.com/apha/2022/meetingapi.cgi/Session/66401?filename=2022_Session66401.pdf&template=Word

6.39. Title: OP-ED: Closing the Accessibility Gap with Accessibility-First Transit Systems

Author(s): Desai, K.

Abstract: Blog.

Subject Areas: Public transit; Accessibility; Applications and information systems; Mobility as a Service; Collaboration

Availability: Desai, K. (2022). "OP-ED: Closing the Accessibility Gap with Accessibility-First Transit Systems." *Mass Transit*. https://www.masstransitmag.com/alt-mobility/article/21290511/cubic-transportation-systems-closing-the-accessibility-gap-with-accessibilityfirst-transit-systems

Chapter 7. Survey, Data Synthesis, and Other Applications

7.1. Title: A Time-Constrained Capacitated Vehicle Routing Problem in Urban E-Commerce Delivery

Author(s): Cokyasar, T., Larson, J., Stinson, M., and Sahin, O.

Abstract: Electric vehicle routing problems can be particularly complex when recharging must be performed mid-route. In some applications such as the e-commerce parcel delivery truck routing, however, mid-route recharging may not be necessary because of constraints on vehicle capacities and maximum allowed time for delivery. In this study we develop a mixed-integer optimization model that exactly solves such a time-constrained capacitated vehicle routing problem, especially of interest to e-commerce parcel delivery vehicles. We compare our solution method with an existing metaheuristic and carry out exhaustive case studies considering four U.S. cities—Austin, TX; Bloomington, IL; Chicago, IL; and Detroit, MI—and two vehicle types: conventional vehicles and battery electric vehicles (BEVs). In these studies, we examine the impact of vehicle capacity, maximum allowed travel time, service time (dwelling time to physically deliver the parcel), and BEV range on system-level performance metrics including vehicle miles traveled (VMT). We find that the service time followed by the vehicle capacity plays a key role in the performance of our approach. We assume an 80-mile BEV range as a baseline without mid-route recharging. Our results show that BEV range has a minimal impact on performance metrics because the VMT per vehicle averages around 72 miles. In a case study for shared-economy parcel deliveries, we observe that VMT could be reduced by 38.8 percent in Austin if service providers were to operate their distribution centers jointly.

Subject Areas: Time-constrained vehicle routing; Delivery planning; Optimization

Availability: Cokyasar, T., Larson, J., Stinson, M., and Sahin, O. (2022). *A Time-Constrained Capacitated Vehicle Routing Problem in Urban E-Commerce Delivery.* arXiv preprint, arXiv:2201.04036 [math.OC]. https://arxiv.org/abs/2201.04036

7.2. Title: SLOPE Scenario Planner 2021 Data Sources & Methodology

Author(s): Irish, M. and Murphy, C.

Abstract: The Department of Energy's State and Local Planning for Energy (SLOPE) Platform, published by the National Renewable Energy Laboratory (NREL), aims to empower data-driven state and local energy planning. This documentation explains SLOPE's new web-based map interface called the SLOPE Scenario Planner, which delivers energy system scenario data down to a county-level spatial resolution. The SLOPE Scenario Planner offers users the chance to compare how various energy strategies would influence energy consumption, associated carbon dioxide (CO_2) emissions, and energy system costs out to 2050 at the county, state, and quasi-national (conterminous United States) levels. This document outlines the data that can be accessed via the SLOPE Scenario Planner, the sources of the data, and the methodologies used to create them.

Subject Areas: State and Local Planning for Energy (SLOPE); SLOPE Scenario Planner; Energy strategies; Energy consumption; Data source; Methodologies

Availability: Irish, M. and Murphy, C. (2021). *SLOPE Scenario Planner 2021 Data Sources & Methodology*. National Renewable Energy Laboratory, Golden, CO. https://gds-files.nrelcloud.org/auto-sync/slope/SLOPE-Scenario-Planner-Methodology.pdf

7.3. Title: Mathematical Problems in Industry, 2021 Differential Privacy in Travel Data

Author(s): Aminian, M. et al.

Abstract: The report below describes the breadth of work done during the 2021 Mathematical Problems in Industry workshop project provided by Resource Systems Group, Inc (RSG) investigating techniques to ensure privacy in large-scale travel behavior datasets. In working with such large, publicly funded data, the importance and need of making actionable information available to the public and policymakers needs to be balanced with the need to protect the privacy of individuals included within. During the workshop, we investigated algorithms and theoretical guarantees in the Differential Privacy framework, and the subtleties therein when applied to a complex data set. We report some preliminary results with extensions of DP algorithms, such as the "Random Response" algorithm, to a setting with categorical variables and uneven weighting (such as when dealing with vehicle makes and models). This extension introduces a parameter which directly allows one to balance between privacy and utility of the data. Lastly, we investigate some approaches to perturbation of trip start/end location data using the Laplace mechanism, and provide recommendations given observations during the workshop as well as directions for future work.

Subject Areas: Privacy; Large-scale travel behavior datasets; Differential Privacy framework; Laplace mechanism

Availability: Aminian, M. et al. (2021). *Mathematical Problems in Industry, 2021 Differential Privacy in Travel Data*. Report, University of Delaware, Newark, DE. https://www1.udel.edu/dedwards/pubs/pubo33.pdf

7.4. Title: Introducing CRISTAL: A model of collaborative, informed, strategic trade agents with logistics

Author(s): Stinson, M. and Mohammadian, A.

Abstract: Freight transportation has major economic, energy, and sustainability impacts. As a result, forecasting tools for analyzing policy scenarios are critical. However, existing freight transportation modeling tools have major gaps, especially in agent representation, prediction of fleet and distribution center control, and strategic alignment of agent decisions. We address these gaps by developing a new architecture for freight transportation modeling called CRISTAL: Collaborative, Informed, Strategic Trade Agents with Logistics. CRISTAL is an agent-based model that includes both firms and establishments (establishments are members of firms). Agents collaborate to form supply chain partnerships in trade and logistics. An Effect of Information captures information sharing in the supply chain, providing a mechanism to operationalize the push–pull boundary, which occurs at the customer-order decoupling point. Agents form strategies then align subsequent decisions with these strategies. Our CRISTAL implementation is multi-resolution, with urban freight linked to national and global supply chains. It is integrated with passenger activity, including household e-commerce use and passenger traffic. The framework has been applied to study e-commerce and truck traffic. This paper summarizes the conceptual model, its initial implementation, and applications to date.

Subject Areas: Agent-based; Freight; Strategy; Supply chain; Sustainability; E-commerce

Availability: Stinson, M. and Mohammadian, A. (2022). "Introducing CRISTAL: A model of collaborative, informed, strategic trade agents with logistics." *Transportation Research Interdisciplinary Perspectives*, *13*. https://doi.org/10.1016/j.trip.2022.100539

7.5. Title: Use of a Poverty Screening Question to Predict Social Determinants

Author(s): Meyer, J.R., DeBonis, R.S., and Brodersen, L.D.

Abstract: The high correlation of poverty to social determinants of health (SDoH) suggests poverty screening could be a viable first step in SDoH screening. This study examined the relationship of SDoH to poverty and evaluated whether screening revealed needs previously unknown to providers. An SDoH Survey with an embedded poverty screening question was completed by 144 urban and 141 rural primary care patients. Nine of 10 SDoH were correlated with positive poverty screening. Needs previously unknown to providers were identified. Using a poverty screening question to identify patients needing full SDoH screening is supported, with some caveats.

Subject Areas: Patient screening; Primary care; Social determinants of health

Availability: Meyer, J.R., DeBonis, R.S., and Brodersen, L.D. (2022). "Use of a Poverty Screening Question to Predict Social Determinants." *Health Policy*, *18*(5), pp. 553–557. https://doi.org/10.1016/j.nurpra.2021.12.020

7.6. Title: Modeling Multimodal Access to Primary Care in An Urban Environment

Author(s): Del Conte, D.E., Locascio, A., Amoruso, J., and McNamara, M.L.

Abstract: Access to primary health care facilities is a key component of public health, and measuring that access is vital to understanding how to target interventions. Transportation is one dimension of access and measuring distance via multiple modes allows better understanding of how varied populations access health care, particularly those who do not have access to a personal vehicle. This work builds on the 2-Step Floating Catchment Area (2SFCA) method to include travel by car, bus, bicycle, and walking. Travel time data are sourced from OpenStreetMap and transit data incorporates stop and schedule information from the General Transit Feed Specification (GTFS). Open source data analysis tools are used to aid reproducibility in other geographic contexts. Modal weights are assigned to measure the population accessing each facility by each mode. Access values for Milwaukee County in Wisconsin, USA are presented, with clear differences shown among modes accessing primary healthcare. Car access is high and consistent across the county, while biking and walking access are more impacted by distance to destination. Transit access is unequal across the county with some tracts showing no access at all. The highly varied access results by mode emphasize the importance of measuring access and travel by non-car modes, particularly when targeting communities with high rates of no car ownership. Improvement of multimodal access measurement will allow for targeted interventions that account for the availability of modes in each community.

Subject Areas: Spatial accessibility; Spatial equity; Primary healthcare; 2-Step floating catchment area (2SFCA); Geographic information system (GIS); Multimodal network

Availability: Del Conte, D.E., Locascio, A., Amoruso, J., and McNamara, M.L. (2022). "Modeling Multimodal Access to Primary Care in An Urban Environment." *Transportation Research Interdisciplinary Perspectives*, *13*. https://doi.org/10.1016/j.trip.2022.100550

7.7. Title: Exploring Accelerated Evolutionary Parameter Search for Iterative Large-Scale Transport Simulations in A New Calibration Testbed

Author(s): Hörl, S.

Abstract: Large-scale agent-based transport models of whole territories have become an important tool in research and planning of new services and policies. Yet, studies based on those tools are rarely reproducible due to the complexity of data sources and modeling processes. One important element towards fully replicable simulations is automatic calibration of behavioral and infrastructural model parameters. The present paper contributes to standardizing the calibration process by describing a consistent framework for benchmarking calibration objectives and optimization algorithms. Furthermore, the paper advances the current state of the art by exploring the integration of a search acceleration method for iterative simulators (*opdyts*) with sample-based evolutionary search algorithms. In a use case for Paris and the MATSim simulator, we demonstrate the applicability of the framework. We show that *opdyts* accelerates the parameter search process, although its comparative runtime benefits decrease with higher availability of computational resources.

Subject Areas: Transport simulation; Calibration; Parameter search; Acceleration; Mode share; MATSim

Availability: Hörl, S. (2022). *Exploring Accelerated Evolutionary Parameter Search for Iterative Large-Scale Transport Simulations in A New Calibration Testbed*. Institut de Recherche Technologique SystemX, France.
https://www.researchgate.net/publication/358106366_Exploring_accelerated_evolutionary_parameter_search_for_iterative_large-scale_transport_simulations_in_a_new_calibration_testbed

7.8. Title: Breaking Out from Food Desert Boundaries: Using Travel Behavior and Location-Choice Modeling to Measure Food Accessibility

Author(s): Abel, K.C., Nair, G.S., Bhat, C., and Faust, K.M.

Abstract: In both rural and urban environments, transportation and access to food are coupled, especially in regions known as food deserts (FDs). However, transportation is not the only factor that may impede food access. This study identifies factors that influence where a household chooses to shop by creating a location-choice model using real travel patterns of low-income households in Dallas. While this analysis shows that travel time to the store remains the most important factor, the results indicate that accessibility also depends on the (1) age of household members (e.g., the presence of seniors or children), (2) access to mobility options, (3) built environment and urban development, (4) household size, and (5) employment. A new metric of food accessibility is formulated, incorporating multiple contributors to inaccess and overcoming limitations of the USDA FD definition. The results show that the proposed metric adapts to any level of aggregation, identifies where targeted interventions could be implemented, and allows for the integration of real travel and shopping behaviors to better coordinate urban planning approaches that increase access to food in the urban environment.

Subject Areas: Food access; Location-choice model; Travel patterns; Low-income households; Shopping behaviors; Dallas

Availability: Abel, K.C., Nair, G.S., Bhat, C., and Faust, K.M. (2022). "Breaking Out from Food Desert Boundaries: Using Travel Behavior and Location-Choice Modeling to Measure Food Accessibility." *Journal of Urban Planning and Development*, *148*(2). https://doi.org/10.1061/(ASCE)UP.1943-5444.0000823

7.9. Title: A New Closed-Form Two-Stage Budgeting-Based Multiple Discrete-Continuous Model

Author(s): Bhat, C.R.

Abstract: In this paper, we propose a multiple discrete-continuous (MDC) model approach that (a) does not need the total budget to be observed or predetermined, (b) allows for any finite or not-so-finite budget over the entire set of inside and outside goods, and (c) preserves a strong endogenous utility-theoretic link between inside good consumptions and the budget allocated to the inside goods (that is, to the product group of interest). We show that our proposed model, including a fractional MDC model at the lower level linked up to a Tobit model for the budget allocation to the inside goods, is strictly consistent with a two-stage budgeting utility theoretic structure. As importantly, by using reverse Gumbel distributional assumptions for the stochastic terms in the model system, we derive an incredibly simple closed-form model that, to our knowledge, is a first of its kind in the econometric literature. In doing so, we formally introduce a new distribution, which we label as the minLogistic distribution, to the statistical literature, and derive the properties of the distribution that is then used in the forecasting stage of the proposed model. An application of the proposed model to investigate the household vehicle fleet composition and usage demonstrates its potential relative to an unlinked and exogenously developed budget for the inside goods. The proposed model has the potential to open up a whole new world of MDC applications in general, and particularly for those cases with an unobserved total budget over the inside and outside goods.

Subject Areas: Multiple discrete-continuous model; Two-stage budgeting; Reverse Gumbel distribution; Utility-theoretic model; Vehicle fleet modeling

Availability: Bhat, C.R. (2022). "A New Closed-Form Two-Stage Budgeting-Based Multiple Discrete-Continuous Model." *Transportation Research Part B: Methodological*, *164*, pp. 162–192. https://doi.org/10.1016/j.trb.2022.08.006

7.10. Title: Feasibility of a One-Day Driving Workshop for Combat Veterans During COVID-19

Author(s): Stetten, N., Wandenkolk, I., Jeghers, M., Poojary, P., Winter, S., and Classen, S.

Abstract: Background: Driving fatalities are a leading cause of death among combat Veterans. To improve Veterans' fitness-to-drive abilities, evidence-based interventions must be implemented.

Objectives: Assess the feasibility of a one-day driving intervention for combat Veterans.

Methods: The study objectives were examined using feasibility guidelines that examine recruiting capability; data collection procedures and outcome measures; acceptability and suitability of the intervention; available resources and participant responses.

Results: COVID-19 and the study's inability to convert to an online format (due to engagement with the driving simulator) hindered recruitment and study participation. Additional challenges for participants include fear of consequences from study participation, self-reflection of driving habits, workshop time burden, restrictive eligibility criteria and competing with another Veteran study.

Conclusions: Despite meeting criteria for feasibility success, COVID-19 posed difficulties the study was unable to overcome. As recruitment efforts evolve to an online format, targeted social media marketing may be considered.

Subject Areas: COVID-19; Veterans; Automobile driving; Feasibility studies; Driving simulation

Availability: Stetten, N., Wandenkolk, I., Jeghers, M., Poojary, P., Winter, S., and Classen, S. (2022). *Feasibility of a One-Day Driving Workshop for Combat Veterans During COVID-19*. Preprint Research Article, Research Square, Durham, NC. https://doi.org/10.21203/rs.3.rs-1327734/v1

7.11. Title: Robust and Efficient Bayesian Inference for Non-Probability Samples

Author(s): Rafei, A., Elliott, M.R., and Flannagan, C.A.C.

Abstract: The declining response rates in probability surveys along with the widespread availability of unstructured data has led to growing research into non-probability samples. Existing robust approaches are not well-developed for non-Gaussian outcomes and may perform poorly in presence of influential pseudo-weights. Furthermore, their variance estimator lacks a unified framework and rely often on asymptotic theory. To address these gaps, we propose an alternative Bayesian approach using a partially linear Gaussian process regression that utilizes a prediction model with a flexible function of the pseudo-inclusion probabilities to impute the outcome variable for the reference survey. By efficiency, we mean not only computational scalability but also superiority with respect to variance. We also show that Gaussian process regression behaves as a kernel matching technique based on the estimated propensity scores, which yields double robustness and lowers sensitivity to influential pseudo-weights. Using the simulated posterior predictive distribution, one can directly quantify the uncertainty of the proposed estimator and derive associated 95% credible intervals. We assess the repeated sampling properties of our method in two simulation studies. The application of this study deals with modeling count data with varying exposures under a non-probability sample setting.

Subject Areas: Non-probability sample; Doubly robust; Semi-parametric Bayesian modeling; Gaussian process regression; Count data

Availability: Rafei, A., Elliott, M.R., and Flannagan, C.A.C. (2022). *Robust and Efficient Bayesian Inference for Non-Probability Samples*. arXiv preprint, arXiv:2203.14355 [stat.ME]. https://arxiv.org/abs/2203.14355

7.12. Title: Feasibility of Adapting VisionEval for Scenario Planning

Author(s): Miller, J.S., Flynn, D.F., Englin, E., Raw, J., Adel, S.H., and Dougald, L.E.

Abstract: Transportation investment decisions require consideration of uncontrolled events (e.g., changes in family size, vehicle technology, population, fuel prices, or societal norms such as telecommuting) along with possible policy responses to achieve desired goals. Although the possibility of these multiple alternative futures suggests one should explicitly consider them when making investment decisions, using more detailed models to support scenario planning is hampered by extensive data requirements and difficulty evaluating many different scenarios. One tool that has the potential to fill this gap is the VisionEval platform, which has less detail than an operational model with a transportation network but more detail than sketch approaches. VisionEval is an open-source scenario planning platform under development as part of a Federal Highway Administration–led pooled fund study in which Virginia is participating.

The purpose of this study was to determine the benefits, staff time requirements, and feasibility of applying VisionEval to explore 43 scenarios of interest to VDOT planning staff and planning partners with respect to their impact on vehicle miles traveled and carbon dioxide equivalent emissions. The primary benefit of this scenario planning tool is the rapid identification of which areas merit greater examination; in this case study region, telecommuting, truck electrification, and household vehicle electrification have relatively large potential impacts on emissions (on the order of 13, 6, and 4 percent, respectively) such that these areas merit greater study. By contrast, changes in household size, population, transit vehicle technology, and increased availability of carsharing vehicles had lesser impacts. Presently, VisionEval appears deployable with about 500 hours of staff time for a case study area with three localities, 1.43 million people, and 712 transportation analysis zones.

The tool addresses two key obstacles to enabling scenario planning in the VDOT environment: multiple potential inputs and substantial data requirements, although a limitation is that some scenarios, such as those relating to the density of pedestrian friendly intersections, are not feasible with the current iteration of VisionEval. The study thus recommends the use of this platform for scenarios where sensitivity analyses show it is appropriate. The study further recommends changes to this platform in order to address these limitations. Two action items for putting these two recommendations into practice are given in the Implementation subsection of this report.

Subject Areas: Scenario planning; Forecasting; Strategic planning; Problem solving

Availability: Miller, J.S., Flynn, D.F., Englin, E., Raw, J., Adel, S.H., and Dougald, L.E. (2022). *Feasibility of Adapting VisionEval for Scenario Planning*. Final Report, VTRC 22-R21, Virginia Transportation Research Council, Charlottesville, VA.
https://www.virginiadot.org/vtrc/main/online_reports/pdf/22-R21.pdf

7.13. Title: Metropolitan Planning Organizations: Strategies for Future Success

Author(s): Lane, J.S., Duncan, C., Carroll, W., Miller, M., Glassman, H., Kemp, K., Billings, J., Rotert, D., Ewing, R., and Siracuse, B.

Abstract: While metropolitan planning organizations generally adhere to the same federal laws and guidance, each MPO works within a unique framework of state, environmental, resource, and political contexts. External forces of changing technologies, economics, culture, and demographics are creating a formidable array of challenges for MPOs in the coming years. Over 100 MPOs participated in this project, which included an extensive literature review, surveys, and input sessions (both MPO Roundtables and nationwide Information Forums).

Subject Areas: Metropolitan Planning Organizations; Innovation database; Global pandemic; Regional roundtables; Information forums

Availability: Lane, J.S., Duncan, C., Carroll, W., Miller, M., Glassman, H., Kemp, K., Billings, J., Rotert, D., Ewing, R., and Siracuse, B. (2022). *Metropolitan Planning Organizations: Strategies for Future Success*. Pre-publication draft of NCHRP Research Report 1002, National Academies of Sciences, Engineering, and Medicine, Washington, DC. https://nap.nationalacademies.org/catalog/26555 /metropolitan-planning-organizations-strategies-for-future-success

7.14. Title: A Scalable Vehicle Assignment and Routing Strategy for Real-Time On-Demand Ridesharing Considering Endogenous Congestion

Author(s): Zhou, Z. and Roncoli, C.

Abstract: On-demand ridesharing has been recognised as an effective way to meet travel needs while significantly reducing the number of required vehicles. As the growth of on-demand mobility services and the advent of shared autonomous vehicles are envisioned to boost the presence of ridesharing vehicles, these may soon significantly affect traffic patterns in our cities. However, most previous studies investigating dynamic ridesharing systems overlook the effects on travel times due to the assignment of requests to vehicles and their routes. In order to assign the ridesharing vehicles while considering network traffic dynamics, we propose a strategy that incorporates time-dependent link travel time predictions into the request–vehicle assignment to avoid or mitigate traffic congestion. In particular, we formulate an efficient linear assignment problem that considers multiple path alternatives and accounts for the impact on travel times, which may be potentially caused by vehicles assigned to specific routes. Simulation experiments reveal that using an appropriate congestion avoidance ridesharing strategy can remarkably reduce passenger average travel and waiting times by alleviating endogenous congestion caused by ridesharing fleets.

Subject Areas: Traffic control; Dynamic ridesharing; Network traffic; Vehicle assignment and routing

Availability: Zhou, Z. and Roncoli, C. (2022). "A Scalable Vehicle Assignment and Routing Strategy for Real-Time On-Demand Ridesharing Considering Endogenous Congestion." *Transportation Research Part C: Emerging Technologies*, *139*. https://doi.org/10.1016/j.trc.2022.103658

7.15. Title: Estimates of Total Household Trips for Areas with Zero Sample: A Maryland Statewide Analysis of Household Trip Production

Author(s): Al-Khasawneh, M.B., Cirillo, C., and Lahiri, P.

Abstract: This study applies Small Area Estimation (SAE) methods to a Regional Travel Survey (RTS) in order to derive statewide household person trips at the PUMA level when no sample is available. Several methods have been tested; those include area and unit synthetic model with both Ordinary Linear Square and Poisson regression and the Fay-Herriot model. Empirical results have been obtained for the State of Maryland, using the 2018 MWCOG Regional Travel Survey and the American Community Survey (ACS). RTS provides both the direct estimates of household person trips and the auxiliary variables for the synthetic model estimation, but only for PUMAs included in the survey. ACS provides the auxiliary variables for the entire state, including PUMAs with no RTS sample. Based on out-of-sample tests, it can be concluded that the area level linear model with RTS auxiliary variables performs better when compared to the other specifications proposed. This model was then applied to estimate household person trips for the area with no sample. We finally applied the Fay-Herriot method to the PUMAs in RTS and found that the combination of direct and synthetic estimation reduces the Coefficient of Variation. This application demonstrates that SAE methods can produce reliable transportation statistics by linking information from several datasets and could potentially reduce survey data collection costs.

Subject Areas: Small area estimation; PUMA; Household trips; Zero sample

Availability: Al-Khasawneh, M.B., Cirillo, C., and Lahiri, P. (2022). *Estimates of Total Household Trips for Areas with Zero Sample: a Maryland Statewide Analysis of Household Trip Production*. EasyChair Preprint, No. 7836, 12th International Conference on Transport Survey Methods, Lisbon, Portugal. https://easychair.org/publications/preprint_open/ZLbL

7.16. Title: Customer Journey Mapping Using Stochastic Models

Author(s): Ding, Y. and MacDonald, E.F.

Abstract: A customer journey map is a visual representation of the process that a person goes through when interacting with a product or service and it is often related to human-centered design. The process of which customer journey maps are built is referred to as customer journey mapping (CJM) and traditionally this process includes techniques such as observations, interviews, and surveys. However, the emergence of new data collection techniques such as interactive mobile applications has made richer data available for service designers. This emerging data availability poses both challenges and opportunities for CJM. In this paper, we propose an innovative stochastic-based method to tackle these challenges while preserving the advantages of traditional CJM. Specifically, the proposed method models user-generated customer experiences as Markov chains and amalgamate the large quantities of experiences into a small number of customer journey maps which are easier to analyze for service designers. This method is based on a clustering algorithm that achieves the maximum posterior likelihood post-clustering. By employing our method on collected data, service designers can discover key components in customers' experiences in addition to some edge cases. We will demonstrate the effectiveness of this method using sample data from the 2017 National Household Travel Survey (NHTS).

Subject Areas: Customer journey mapping; New data collection techniques; Stochastic-based method; Clustering algorithm

Availability: Ding, Y. and MacDonald, E.F. (2022). *Customer Journey Mapping Using Stochastic Models*. Proceedings of the American Society of Mechanical Engineers (ASME) 2022, International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, St. Louis, MO. https://doi.org/10.1115/DETC2022-90000

7.17. Title: Draining the Tobacco Swamps: Shaping the Built Environment to Reduce Tobacco Retailer Proximity to Residents in 30 Big US Cities

Author(s): Combs, T.B., Ornstein, J.T., Chaitan, V.L., Golden, S.D., Henriksen, L., and Luke, D.A.

Abstract: Combining geospatial data on residential and tobacco retailer density in 30 big U.S. cities, we find that a large majority of urban residents live in tobacco swamps—neighborhoods where there is a glut of tobacco retailers. In this study, we simulate the effects of tobacco retail reduction policies and compare probable changes in resident-to-retailer proximity and retailer density for each city. While measures of proximity and density at baseline are highly correlated, the results differ both between effects on proximity and density and across the 30 cities. Context, particularly baseline proximity of residents to retailers, is important to consider when designing policies to reduce retailer concentration.

Subject Areas: Tobacco retailer density; Tobacco retailer proximity; Retail tobacco policy

Availability: Combs, T.B., Ornstein, J.T., Chaitan, V.L., Golden, S.D., Henriksen, L., and Luke, D.A. (2022). "Draining the Tobacco Swamps: Shaping the Built Environment to Reduce Tobacco Retailer Proximity to Residents in 30 Big US Cities." *Health & Place*, *75*. https://doi.org/10.1016/j.healthplace.2022.102815

7.18. Title: A Framework for Estimating Commute Accessibility and Adoption of Ridehailing Services under Functional Improvements from Vehicle Automation

Author(s): Zou, T., Aemmer, Z., MacKenzie, D., and Laberteaux, K.

Abstract: This paper develops an analytical framework to estimate commute accessibility and adoption of various ridehailing service concepts across the U.S. by synthesizing individual commute trips using national Longitudinal Employer-Household Dynamics Origin–Destination Employment Statistics (LODES) data. Focusing on potential improvements in cost and time that could be enabled by vehicle automation, we use this modeling framework to simulate a lower-price autonomous service (e.g., 50% or 75% lower) with variable wait times and implementation levels (solo, pooled, and first/last mile transit connections services, alone or in combination) to determine how they might affect adoption rates. These results are compared across metrics of accessibility and trip density, as well as socioeconomic factors such as household income. We find—unsurprisingly—that major cities (e.g., New York, Los Angeles, and Chicago) support the highest adoption rates for ridehailing services. Decreases in price tend to increase market share and accessibility. The effect of a decrease in price is more drastic for lower income groups. The proposed method for synthesizing trips using the LODES contributes to current travel demand forecasting methods and the proposed analytic framework can be flexibly implemented with any other mode choice model, extended to non-commute trips, or applied to different levels of geographic aggregation.

Subject Areas: New mobility services; Autonomous vehicles; Ridehailing; Accessibility

Availability: Zou, T., Aemmer, Z., MacKenzie, D., and Laberteaux, K. (2022). "A Framework for Estimating Commute Accessibility and Adoption of Ridehailing Services under Functional Improvements from Vehicle Automation." *Journal of Transport Geography*, *102*. https://doi.org/10.1016/j.jtrangeo.2022.103357

7.19. Title: A Tailored Pricing Strategy for Different Types of Users in Hybrid Carsharing Systems

Author(s): Lu, R., Zhao, X., and Wang, Y.

Abstract: Considering the characteristics of different types of users in hybrid carsharing systems, in which sharing autonomous vehicles (SAVs) and conventional sharing cars (CSCs) coexist, a tailored pricing strategy (TPS) is proposed to maximize the operator's profit and minimize all users' costs. The fleet sizes and sizes of SAVs' stations are also determined simultaneously. A bi-objective nonlinear programming model is established, and a genetic algorithm is applied to solve it. Based on the operational data in Lanzhou, China, carsharing users are clustered into three types. They are loyal users, losing users, and potential users, respectively. Results show the application of the TPS can help the operator increase profit and attract more users. The loyal users are assigned the highest price, while they still contribute the most to the operator's profit with the highest number of carsharing trips. The losing users and potential users are comparable in terms of the number of trips, while the latter still makes more profit.

Subject Areas: Sharing autonomous vehicles; Conventional sharing cars; Hybrid carsharing systems; Tailored pricing strategy; User clustering

Availability: Lu, R., Zhao, X., and Wang, Y. (2022). "A Tailored Pricing Strategy for Different Types of Users in Hybrid Carsharing Systems." *Algorithms*, *15*(5). https://doi.org/10.3390/a15050172

7.20. Title: Characterizing Tourist Daily Trip Chains Using Mobile Phone Big Data

Author(s): Luo, Y.

Abstract: Tourists tend to visit multiple destinations out of their variety-seeking motivations in their trips. Thus, it is critical to discover travel patterns involving multi-destinations in tourism research. Existing relevant research most relied on survey data or focused on citizens due to the lack of large-scale, fine-grained tourism datasets. Several scholars have mentioned the notion of trip chains, but few works have been done towards quantitatively identifying the structures of trip chains. In this paper, we propose a model for quantitatively characterizing tourist daily trip chains. After applying this model to tourist mobile phone big data, underlying tourist travel patterns are discovered. Through the framework, we find that: (1) Most "hybrid" (inter-city and intra-city) and "intra-city" (only intra-city) patterns can be captured by only 13 key trip chains relatively; (2) For two continuous days, almost all kinds of original chains have a rather high probability to transfer to either the first two transferred chains, or other infrequent chains in our study areas; (3) The principle of least efforts (PLE) affects tourists' structures of trip chains. We can use average degree and average travel distance to interpret tourist travel behavior (achieving tasks in PLE). This study not only demonstrate the complex daily travel trip chains from tourism big data, but also fill the gap in tourism literature on multi-destination trips by discovering significant and underlying patterns based on mobile datasets.

Subject Areas: Trip chain; Mobile phone data; Tourism travel patterns

Availability: Luo, Y. (2022). *Characterizing Tourist Daily Trip Chains Using Mobile Phone Big Data*. arXiv preprint, arXiv:2205.14395v1 [cs.SI]. https://arxiv.org/abs/2205.14395

7.21. Title: Empirical Essays in Industrial Organization

Author(s): Kim, T.

Abstract: This dissertation contributes to the extant economics literature on industrial organization via three empirical essays that explore the strategic decisions of firms that compete in imperfectly competitive markets. By using data based on the United States' airline industry, I combine reduced-form analysis with structural form analysis to investigate the market- and industry-level behavior of oligopolistic firms.

Chapter 1 deliberates on the counterfactual merger simulations that have been carried out to establish the value of requiring slot divestiture at slot-controlled airports. I focus on two cases: the United Airlines–Continental Airlines merger and the American Airlines–US Airways merger. Slot divestment is done according to the requirements of antitrust enforcement agencies. The simulation results from three selected airports, Newark Liberty International Airport, Ronald Reagan Washington National Airport, and LaGuardia Airport, indicate that the average airfare reduced for all post-merger air travel products. As a result, the airlines attracted more passengers, creating consumer surplus at the airports. Nonetheless, the airlines are still struggling to alleviate anticompetitive risks resulting from overlapping non-stop routes. These problems occur when slot purchaser fail to enter the market for those routes. To address the structural limitations linked to slot divestiture, I tested other behavioral alternatives besides slot divestment: forcing the surrender of slots operating monopolistic routes, requiring code sharing between merged airlines and low-cost carriers, and opening frequent flyers programs to competitors and/or new entrants. Simulation results from these cases revealed that after merging the operations, the alternative solutions would reduce the average airfare and the number of problematic routes. Therefore, the impact of price was dominant compared to only when slot divestment was needed. Also, requiring slot divestiture, combined with forcing slot purchasers to enter the market for overlapping nonstop routes and promoting code sharing, would have lowered the average airfare for all products and the overlapping non-stop routes. However, requiring slot divesture combined with the opening of the merged airlines' frequent flyer programs would not have addressed the problem of anti-competition on overlapping nonstop routes.

Chapter 2 is an investigation into the possibility that multimarket contacts result in collusion in the setting of capacity in the U.S. domestic airline market. I first provide reduced-form evidence on the effect of multimarket contacts on the possibilities of firms colluding in setting capacity by demonstrating that levels of multimarket contract have significant negative correlations with the quantity of seats that airlines release. Specifically, the effect of multimarket contact is primarily led by the four largest airlines (Southwest, United, Delta, and American); this has a greater effect in smaller markets in comparison to medium-sized and larger ones. Lead by the evidence, I estimate structural model of demand and supply system with conduct parameter which capture the degree of collusion in setting capacity. The conduct parameter is specified as a function of multi market contact; it will be demonstrated that the conduct parameter shows that there is a significant and positive correlation between multimarket contact and collusion, suggesting that the greater the level of multimarket contact, the lower the quantity of seats that will be offered in comparison to non-collusive oligopoly equilibrium.

Chapter 3 empirically investigates how three recent major U.S. airline mergers affected their air travel product quality, focusing on passengers' convenience, connectivity, and flexibility arising from the merged airlines' network restructuring. Passenger convenience is measured via the difference between total travel time and average nonstop travel time between the origin and destination airports, termed extra travel time. Passenger connectivity is measured as the number of destinations offered at a given airport. Finally, passengers' travel flexibility is measured via the proxy of the merged airline's flight frequency on a given route. The regression results indicate that, in general, mergers significantly increase passengers' extra travel time in the short and long terms. Specifically, mergers lead to more extra travel time from/to de-hubbed airports. Furthermore, each merger was found to associate with increased extra travel time in markets in which the merging carriers had previously competed. In terms of passenger connectivity, while mergers result in an increased number of destinations, the number of destinations served by nonstop flights is not significantly affected. However, the number of nonstop destinations offered at de-hubbed airports reduces considerably following a merger. This study finds no evidence that the mergers' impact on the number of destinations differs in the case of pre-merger competition between the merging firms. Meanwhile, the results also indicate that mergers tend to lead to a decrease in flight frequency, meaning passengers experience less flexibility concerning flight options, with the effect appearing to be stronger for markets in which the merging carriers had previously competed.

Subject Areas: Airline market; Multimarket contacts; Airline mergers

Availability: Kim, T. (2022). *Empirical Essays in Industrial Organization*. Doctoral Dissertation, George Washington University, Washington, DC.
https://www.proquest.com/openview/7bad078b23ad5cb3dcb05317ceed4001/1?pq-origsite=gscholar&cbl=18750&diss=y

7.22. Title: Household-based E-commerce Demand Modeling for an Agent-Based Urban Transportation Simulation Platform

Author(s): Sakai, T., Hara, Y., Seshadri, R., Alho, A.R., Hasnine, M.S., Jing, P., Chua, Z., and Ben-Akiva, M.

Abstract: The e-commerce market has grown rapidly in the past two decades. The need for predicting e-commerce demand and evaluating relevant policies and solutions is increasing. However, the existing simulation models for e-commerce demand are still limited and do not consider the impacts of delivery options and their attributes that shoppers face on multiple dimensions of e-commerce demand. We propose a novel framework involving disaggregate behavioral models that jointly predict e-commerce expenditure, purchase amount per transaction, delivery mode, and option choices. The proposed framework can simulate the changes in e-commerce demand and be used to evaluate the impacts of a range of policies and solutions. We specify the model parameters based on various sources of relevant information, integrate the model into an urban freight simulator, and conduct a demonstrative simulation for a prototypical North American city. The results of the analysis highlight the capability and applicability of the proposed modeling framework.

Subject Areas: Freight demand modeling; E-commerce; Agent-based simulation; Freight delivery; Urban freight

Availability: Sakai, T., Hara, Y., Seshadri, R., Alho, A.R., Hasnine, M.S., Jing, P., Chua, Z., and Ben-Akiva, M. (2022). "Household-based E-commerce Demand Modeling for an Agent-Based Urban Transportation Simulation Platform." *Transportation Planning and Technology*, *45*(2), pp. 179–201. https://doi.org/10.1080/03081060.2022.2084397

7.23. Title: The Application of Land Redevelopment and Traffic Congestion Control Strategy

Author(s): Wang, Y., Wu, B., and Li, L.

Abstract: This book proposes a series of traffic congestion control strategies for urban land redevelopment and gives three tools: an integrated land use and transportation model framework for urban land redevelopment, pre-exam method of traffic congestion during planning stage of land redevelopment, and traffic impact analysis system during implementation stage of land redevelopment. However, the effectiveness of specific strategies and tools still needs to be tested and perfected in practice.

Subject Areas: Traffic congestion control; Integrated land use; Transportation model framework; Urban land redevelopment; Traffic impact analysis

Availability: Wang, Y., Wu, B., and Li, L. (2022). *The Application of Land Redevelopment and Traffic Congestion Control Strategy*. Urban Redevelopment and Traffic Congestion Management Strategies, pp 253–284. Urban Sustainability. Springer, Singapore. https://doi.org/10.1007/978-981-19-1727-1_7

7.24. Title: How Should Vehicle Miles Traveled Displaced by E-Scooter Trips be Calculated?

Author(s): Meroux, D., Broaddus, A., Telenko, C., and Wen Chan, H.

Abstract: A dominant practice in assessing mode shift for scooter sharing is to survey scooter riders on what transportation mode they otherwise would have taken. Trip share displacing car modes and average scooter trip distance are common metrics used to support calculations like vehicle miles traveled (VMT) and emissions reductions. This practice assumes a 1:1 relationship between trip and mile replacement, implying no relationship between mode replaced and scooter trip distance. In our study, we test this assumption. An in-app end of trip survey was answered by nearly 12,000 e-scooter riders using Spin e-scooter sharing in four U.S. cities: San Francisco, Tampa, Washington D.C., and Portland. Trip GPS breadcrumb distance was linked to survey responses, enabling scooter distance traveled to be calculated by mode displaced. We calculate scooter distance share and average trip distance conditional on mode displaced for scooter trips that displaced personal car, taxi, and transportation network company trips as alternative metrics to trip share and average trip distance, respectively. To account for the effects of built environment, we cluster scooter trips on the U.S. Environmental Protection Agency National Walkability Index for trip start location. We find that across cities and walkability index clusters, the conventional trip share and average trip distance metrics consistently overestimate walk-mode shift and underestimate car VMT displacement by e-scooter use. To ensure an accurate representation of mode shift, we recommend that cities, operators, and researchers report average trip distance conditional on mode displaced or scooter distance share. The mode shift observed across the four cities in this study, for example, revealed that about one-third of the distance travelled by scooters displaced car VMT.

Subject Areas: Data and data science; Urban transportation data and information systems; Mode choice data; Sustainability and resilience; Transportation and sustainability; Sustainable mobility; Active modes

Availability: Meroux, D., Broaddus, A., Telenko, C., and Wen Chan, H. (2022). "How Should Vehicle Miles Traveled Displaced by E-Scooter Trips be Calculated?" *Transportation Research Record: Journal of the Transportation Research Board*, *2677*(1), pp. 356–368. https://doi.org/10.1177%2F03611981221099506

7.25. Title: Are Transportation Planning Views Shared by Engineering Students and the Public?

Author(s): Ralph, K., Klein, N.J., Thigpen, C., and Brown, A.

Abstract: We surveyed transportation students and the U.S. public to explore consensus and divergence in policy preferences. We find considerable agreement among planning students, which may be a strength—it is easier to pursue shared goals—or a weakness—too much consensus can lead to echo chambers and disconnection. Engineering students and the public shared some planner-preferred views (like expanding transit) but disagreed with planning students about the role of transportation and appropriate policy tools, especially road widening. Our results suggest that diverging policy preferences are, at least in part, a reflection of planning's signature pedagogy.

Subject Areas: Public opinion; Pedagogy; Echo chamber; False consensus effect; Transportation

Availability: Ralph, K., Klein, N.J., Thigpen, C., and Brown, A. (2022). "Are Transportation Planning Views Shared by Engineering Students and the Public?" *Journal of Planning Education and Research*. https://doi.org/10.1177%2F0739456X221097840

7.26. Title: Spatiotemporal Analysis of Activity-Travel Fragmentation Based on Spatial Clustering and Sequence Analysis

Author(s): Shi, H., Su, R., Xiao, J., and Goulias, K.G.

Abstract: In this study using data from the 2017 National Household Travel Survey in California from 26,078 survey participants, sequence analysis is used to estimate a fragmentation indicator of people's daily schedules. Then, spatial clustering is used to find groups of observations with similarly high or low fragmentation using the longitude and latitude of their residential locations. This is followed by a hierarchical sequence clustering within each spatial cluster to identify distinct patterns of time allocation. Using the Local Indicator of Spatial Association (LISA) we find a large portion (approximately 30 percent) of the sample with significant spatial clustering of fragmentation. We also find systematic and significant differences in membership to these clusters based on land use, county of residence, household and personal characteristics, and travel modes used. Sequence analysis pattern recognition within LISA spatial clusters shows systematically repeating time allocation patterns that include typical work and school schedules as well as staying at home patterns. However, each spatial LISA cluster is composed of different time allocation clusters. All this analysis taken together points out substantial and measurable heterogeneity in spatial clustering of fragmentation and the need for customized policy actions in different geographies.

Subject Areas: Spatial clustering; Activity-travel fragmentation; Sequence analysis; Travel survey

Availability: Shi, H., Su, R., Xiao, J., and Goulias, K.G. (2022). "Spatiotemporal Analysis of Activity-Travel Fragmentation Based on Spatial Clustering and Sequence Analysis." *Journal of Transport Geography*, *102*. https://doi.org/10.1016/j.jtrangeo.2022.103382

7.27. Title: Disentangling Social Capital – Understanding the Effect of Bonding and Bridging on Urban Activity Participation

Author(s): Tahlyan, D., Stathopoulos, A., and Maness, M.

Abstract: Social capital is a critical glue for economic and social development in urban areas. Yet, to effectively guide research and practice, there is a need for careful measurement of social capital and how it links to important aspects of urban system functions. This study is aimed at examining the multidimensional nature of social capital and the relationship between these dimensions and travel behavior. Prior research has shown connections between stand-alone social capital concepts, such as resources gathered via social networks, with specific aspects of travel behavior. In this work, we expand the definition of social capital to cover separate dimensions, modeled via multiple indicators. Specifically, we make use of over 1400 observations from the Pew Internet Networks and Community Survey dataset to build a Structural Equation Model dividing social capital into two latent dimensions: bonding and bridging to examine the relationship of both these dimensions with discretionary urban activity participation diversity and frequency. Moreover, broader measures of neighborhood and community engagement are included in the model to explain how such engagement can help with the accumulation of social capital. Our results indicate a positive but differential relationship between both social capital dimensions and activity participation. Further, the results also suggest an absence of correlation between bonding and bridging capital, strengthening the hypothesis that social capital is multi-dimensional. In terms of explaining the social capital accrual, we find that while community engagement is positively correlated to bridging capital, no evidence was found for a relationship between community engagement and bonding capital. Further, neighborhood engagement was not found to be associated with any of the social capital dimensions. This suggests that individuals predominantly rely on close-knit and stronger relationships for social/emotional support, while instead, community engagement significantly helps in the accumulation of bridging capital. The result from the study can be used by policy makers to improve transportation planning, management, and community well-being.

Subject Areas: Network capital; Structural equation modeling; Bonding capital; Bridging capital; Urban activity participation

Availability: Tahlyan, D., Stathopoulos, A., and Maness, M. (2022). "Disentangling Social Capital – Understanding the Effect of Bonding and Bridging on Urban Activity Participation." *Transportation Research Interdisciplinary Perspectives*, *15*. https://doi.org/10.1016/j.trip.2022.100629

7.28. Title: Developing A Tour-Based Trip Identification Algorithm Using Mobile Device Location Data

Author(s): Kabiri, A.

Abstract: This thesis presents a novel trip identification algorithm that supports travel behavior analysis based on mobile device location data. The proposed trip identification algorithm is applied to a large-scale Location-based Service (LBS) dataset consisting of the location points of a large representative sample of United States residents with over 40 million users in January 2020. Firstly, the proposed framework divides sightings into long-distance and short-distance home-based tours and then identifies the trips on each type of tour using different methods. Furthermore, the Maryland Statewide Household Travel Survey 2018/2019 and the National Household Travel Survey (NHTS) 2017 validate the derived trips. The results showed that several metrics of the trips from mobile device location data and travel surveys follow similar trends. In addition, the impact of coronavirus disease 2019 (COVID-19) on the travel behavior of the population is studied as a real-world application of the proposed algorithm.

Subject Areas: Mobile device location data; Trip identification algorithm; Urban planning; Transportation

Availability: Kabiri, A. (2022). *Developing A Tour-Based Trip Identification Algorithm Using Mobile Device Location Data*. Master's Thesis, University of Maryland, College Park, MD. https://drum.lib.umd.edu/handle/1903/28797

7.29. Title: Exploring Data Fusion Techniques to Estimate Network-Wide Bicycle Volumes

Author(s): Kothuri, S., Broach, J., McNeil, N., Hyun, K., Mattingly, S., Miah, M.M., Nordback, K., and Proulx, F.

Abstract: This research developed a method for evaluating and integrating emerging sources (Strava, StreetLight, and Bikeshare) of bicycle activity data with conventional demand data (permanent counts, short-duration counts) using traditional (Poisson) and advanced machine learning techniques. First, a literature review was conducted, along with cataloging and evaluating available third-party data sources and existing applications. Next, six sites (Boulder, Charlotte, Dallas, Portland, Bend, and Eugene) that represented a variety of contexts (urban, suburban) and geographical diversity were selected. Of these, Boulder, Charlotte and Dallas constituted the basic sites, where one year of data (i.e., 2019) was used for modeling. Portland, Bend, and Eugene in Oregon were considered enhanced sites, where three years of data (2017–2019) were used for model estimation. Demographic, network, count and emerging data were gathered for these sites. Using these data, Poisson and Random Forest models were estimated. The model estimation process was designed to allow for comparison of the relative accuracy and value added by different data sources and modeling techniques. Three sets of models were specified—All City Pooled, Oregon Pooled and city-specific models. In general, the three data sources (static, Strava, and StreetLight) appeared to be complementary to one another; that is, adding any two data sources together tended to outperform each data source on its own. Low-volume sites proved challenging, with the best-performing models still demonstrating considerable prediction error. City-specific models generally displayed better model fit and prediction performance. Using Strava or StreetLight counts to predict annual average daily bicycle traffic (AADBT) without static adjustment variables increased expected prediction error by a factor of about 1.4 (i.e., a 40% increase in %RMSPE). That rule of thumb figure of 1.4 times was only slightly lower when combining Strava plus StreetLight without static variables (1.3x). Tests of transferability showed that transferring the model specifications without re-estimating the model parameters resulted in 10–50% increase in error rate across models. Performance of machine learning models was comparable to count models. The findings from this study indicate that rather than replacing conventional bike data sources and count programs, big data sources like Strava and StreetLight actually make the old “small” data even more important.

Subject Areas: Bicycle volume; Machine learning; Crowdsource data; Urban transportation; Bicycle commuting

Availability: Kothuri, S., Broach, J., McNeil, N., Hyun, K., Mattingly, S., Miah, M.M., Nordback, K., and Proulx, F. (2022). *Exploring Data Fusion Techniques to Estimate Network-Wide Bicycle Volumes*. Final Report, NITC-RR-1269, Transportation Research and Education Center, Portland State University, Portland, OR. https://doi.org/10.15760/trec.273

7.30. Title: Joint Routing of Conventional and Range-Extended Electric Vehicles in a Large Metropolitan Network

Author(s): Subramanyam, A., Cokyasar, T., Larson, J., and Stinson, M.

Abstract: Range-extended electric vehicles combine the higher efficiency and environmental benefits of battery powered electric motors with the longer mileage and autonomy of conventional internal combustion engines. This combination is particularly advantageous for time-constrained delivery routing in dense urban areas, where battery recharging along routes can be too time-consuming to economically justify the use of all-electric vehicles. However, switching from electric to conventional fossil fuel modes also results in higher costs and emissions and lower efficiency. This paper analyzes this heterogeneous vehicle routing problem and describes two solution methods: an exact branch-price-and-cut algorithm and an iterated tabu search metaheuristic. From a methodological perspective, we find that the exact algorithm consistently obtains tight lower bounds that also serve to certify the metaheuristic solutions as near optimal. From a policy standpoint, we examine a large-scale real-world case study concerning parcel deliveries in the Chicago metropolitan area and quantify various operational metrics including energy costs and vehicle miles traveled. We find that by deploying roughly 20 percent of range-extended vehicles with a modest all-electric range of 33 miles, parcel distributors can save energy costs by up to 17 percent while incurring less than 0.5percent increase in vehicle miles traveled. Increasing the range to 60 miles further reduces costs by only 4 percent, which can alternatively be achieved by decreasing the average service time by 1 minute or increasing driver working time by 1 hour. Our study reveals several key areas of improvement on which vehicle manufacturers, distributors, and policy makers can focus their attention.

Subject Areas: Large-scale vehicle routing; Electric vehicles; Delivery planning; Optimization

Availability: Subramanyam, A., Cokyasar, T., Larson, J., and Stinson, M. (2022). *Joint Routing of Conventional and Range-Extended Electric Vehicles in a Large Metropolitan Network*. arXiv preprint, arXiv:2112.12769 [math.OC]. https://arxiv.org/abs/2112.12769

7.31. Title: Economic Analysis of Vehicle Infrastructure Cooperation for Driving Automation

Author(s): Vignon, D.A., Yin, Y., Bahrami, S., and Laberteaux, K.

Abstract: The current approach to driving automation has been primarily vehicle-centric. However, a vehicle-infrastructure cooperative approach, in which infrastructure and vehicles cooperate to perform the different driving tasks, may prevail in enabling automated driving. This paper conducts an economic analysis of vehicle infrastructure cooperation for automated driving. In doing so, we present a model that captures investment decisions in vehicle automation and infrastructure digitalization and their effect on travelers' purchase and travel decisions. Our analysis shows that, under certain conditions, equipping both infrastructure and vehicles is socially optimal. However, by analyzing strategic interactions between infrastructure support service providers and automakers, we show that lack of coordination between these two actors results in suboptimal investment in vehicle automation and infrastructure digitalization. Especially, when these two technologies are complementary, service providers are reluctant to invest in digital infrastructure and vehicle manufacturers tend to over equip their vehicles so as to avoid relying on infrastructure technology. Thus, we conclude by showing that better coordination between automakers and service providers—under the form of profit sharing—is welfare-improving and could potentially yield the socially optimal levels of automation and digitalization.

Subject Areas: Driving automation; Automated vehicles; Vehicle-infrastructure cooperation; Infrastructure; Digitalization

Availability: Vignon, D.A., Yin, Y., Bahrami, S., and Laberteaux, K. (2022). "Economic Analysis of Vehicle Infrastructure Cooperation for Driving Automation." *Transportation Research Part C: Emerging Technologies*, *142*. https://doi.org/10.1016/j.trc.2022.103757

7.32. Title: Virginia Residents Asked for Opinions About Transportation

Author(s): Thomas, P.

Abstract: Blog.

Subject Areas: Travel survey; Virginia Department of Transportation (VDOT); Virginia Department of Rail and Public Transportation (DRPT); Virginia Transportation Plan (VTrans); National Household Travel Survey (NHTS)

Availability: Thomas, P. (2022). "Virginia Residents Asked for Opinions About Transportation." *WDBJ7*, Gray Television, Inc. https://www.wdbj7.com/2022/07/07/virginia-residents-asked-opinions-about-transportation/

7.33. Title: Predicting Charge Consumption of Electric Vehicles Using Machine Learning

Author(s): Balaiah, G., Dhanasree, V.P., Jyothi, M., Varun, K., and Chowhan, D.

Abstract: Electric cars have to be the destiny approach of transportation in contemporary society, wherein the enterprise is prospering. A brand-new era is recruited every day, where electric cars are being driven for some reasons like pollution, growing fuel demand, international warming, and the promotion of environmentally pleasant modes of transportation. Electric vehicles require charging to operate, and therefore they use energy. Power consumption fluctuates depending on the road type, driving style, and distance traveled, but we must also include the user managing the vehicle, which affects the power consumption projection. Predictions based on additional data are more accurate than predictions based just on past charge data. We will make predictions based on current occurrences in the area. We will use algorithms to pre-process the data before training it. We will take into account the charging distance and time, the target variable, and the amount of energy consumed. Features such as acceleration, powertrain, and others will be used to study the behavior. We'll use decision trees and logistic regression and train some more algorithms. We will also implement a voting classifier to the ensemble with machine learning algorithms.

Subject Areas: Prediction; Electric vehicles; Charge; City; Transportation; Machine learning

Availability: Balaiah, G., Dhanasree, V.P., Jyothi, M., Varun, K., and Chowhan, D. (2022). "Predicting Charge Consumption of Electric Vehicles Using Machine Learning." *Journal of Algebraic Statistics*, *13*(3), pp. 2087–2095.
https://publishoa.com/index.php/journal/article/view/849

7.34. Title: Optimal Decentralized Coordinated Operation of Electric Vehicle Aggregators Enabling Vehicle to Grid Option Using Distributed Algorithm

Author(s): Lemeski, A.T., Ebrahimi, R., and Zakariazadeh, A.

Abstract: Electric vehicle (EV) aggregators play the role of intermediate entities between electric vehicles and the grid who can work independently or as the grid operator's agents within the electric network. For all the benefits they can provide through collaboration with other entities like the grid operator and distributed generator (DG), the uncoordinated action of EV aggregators can bring about undesired consequences such as high losses, voltage deviation, peak demand escalation and hence a huge inefficiency of the network operation. In this paper, a unique decentralized approach for the coordination of independent privately owned EV aggregators and distributed generators is proposed. In this framework, the objective functions representing the goals of the aggregators and generators seek higher profits or lower costs. The objectives also take into account the distribution system operator (DSO) requirements encompassing technical indices such as losses and bus voltages. Several EV-related uncertainties including the plug-in/plug-out times, the initial state of charge as well as the variations in the number of aggregators and distributed generators, techno-economical parameters of the grid such as the price and load variations and the conflicts of interest among the three parties contribute to the model complexity. For this purpose, a decentralized method based on the Fast Alternating Direction Method of Multipliers (FADMM) is employed to solve the model. The proposed approach is tested on two 33-bus and 69-bus distribution test networks comprising aggregators and DGs through different scenarios. The results demonstrate that, while retaining the privacy of different agents, the proposed algorithm guarantees the objectives of both aggregators and DGs through higher profits and in the meantime ensures the technical fulfillment for the grid operator. Finally, the effect of varying parameters on the personal and mutual objectives of the mentioned players is evaluated.

Subject Areas: Plug-in electric vehicle; Loss reduction; Fast Alternating Direction Method of Multipliers algorithm; Electric vehicles aggregator

Availability: Lemeski, A.T., Ebrahimi, R., and Zakariazadeh, A. (2022). "Optimal Decentralized Coordinated Operation of Electric Vehicle Aggregators Enabling Vehicle to Grid Option Using Distributed Algorithm." *Journal of Energy Storage*, *54*. https://doi.org/10.1016/j.est.2022.105213

7.35. Title: Likeness: A Toolkit for Connecting the Social Fabric of Place to Human Dynamics

Author(s): Tuccillo, J. and Gaboardi, J.

Abstract: The ability to produce richly attributed synthetic populations is key for understanding human dynamics, responding to emergencies, and preparing for future events, all while protecting individual privacy. The Likeness toolkit accomplishes these goals with a suite of Python packages: `pymedm/pymedm_legacy`, `livelike`, and `actlike`. This production process is initialized in `pymedm` (or `pymedm_legacy`) that utilizes census microdata records as the foundation on which disaggregated spatial allocation matrices are built. The next step, performed by `livelike`, is the generation of a fully autonomous agent population attributed with hundreds of demographic census variables. The agent population synthesized in `livelike` is then attributed with residential coordinates in `actlike` based on block assignment and, finally, allocated to an optimal daytime activity location via the street network. We present a case study in Knox County, Tennessee, synthesizing 30 populations of public K–12 school students & teachers and allocating them to schools. Validation of our results shows they are highly promising by replicating reported school enrollment and teacher capacity with a high degree of fidelity.

Subject Areas: Activity spaces; Agent-based modeling; Human dynamics; Population synthesis

Availability: Tuccillo, J. and Gaboardi, J. (2022). "Likeness: A Toolkit for Connecting the Social Fabric of Place to Human Dynamics." *Conference: 21st annual Scientific Computing with Python Conference (SciPy)*. https://www.osti.gov/biblio/1883844

7.36. Title: Data-Driven Low-Rank Tensor Approximation for Fast Grid Integration of Commercial EV Charging Stations Considering Demand Uncertainties

Author(s): Jiang, Y., Ortmeyer, T., Fan, M., and Ai, X.

Abstract: The high power demand and charging variation of commercial fast electric vehicle (EV) charging stations has the potential to significantly impact the operation of electric power distribution systems. To evaluate this impact, the engineering practice is to run power flow studies at peak load, leading to a conservative result, or implement computationally expensive quasi-static time-series simulations. To overcome these drawbacks, this paper proposes a computational approach based on low-rank tensor approximation (LRA) for fast grid impact studies on distribution grid operation caused by commercial EV charging stations with demand uncertainties. To this end, a stochastic transportation model is implemented to predict the potential charging profiles of EV stations based on vehicles' driving patterns, and the predicted charging demand is used to construct polynomial bases for the LRA algorithm. A methodology based on clustering approaches is proposed to strategically select the experimental samples for optimized determination of the coefficients, and the rank and degree of the LRA model are adaptively configured for improved performance. Test cases on a real-world utility feeder have demonstrated that the proposed approach is able to potentially reduce the time-series simulation time of distribution feeder circuits by around 99.99% while maintaining a high accuracy.

Subject Areas: Electric vehicle charging; Transportation; Computational modeling; Integrated circuit modeling; Uncertainty; Load modeling; Charging stations

Availability: Jiang, Y., Ortmeyer, T., Fan, M., and Ai, X. (2022). "Data-Driven Low-Rank Tensor Approximation for Fast Grid Integration of Commercial EV Charging Stations Considering Demand Uncertainties." *IEEE Transactions on Smart Grid (Early Access)*, *14*(1), pp. 517–529. https://doi.org/10.1109/TSG.2022.3191530

7.37. Title: Bi-Level Planning and Scheduling of Electric Vehicle Charging Stations for Peak Shaving and Congestion Management in Low Voltage Distribution Networks

Author(s): Prakash, K., Ali, M., Siddique, M.N.I., Karmaker, A.K., Macana, C.A., Dong, D., and Pota, H.R.

Abstract: Most existing algorithms for electric vehicle charging station (EVCS) planning and scheduling of electric vehicles (EVs) do not consider the uncertain behavior of EVs and distribution networks, including the EV arrival and departure times, user driving needs, and realistic residential load and generation profiles. This paper proposes a bi-level planning and operation framework that determines the optimal locations of EVCSs and scheduling of EVs to reduce peak load and network congestion in low voltage distribution networks by considering uncertain EV and distribution network behavior. Planning of EVCSs is performed to minimize voltage deviations and distribution network losses. The priority-based scheduling algorithm uses the vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technology to charge the EVs during high priority periods to meet the user requirements and discharge during low or medium priority periods to reduce the peak load and thermal overloading in distribution feeders. Based on an Australian scenario, the proposed method has been tested on the IEEE low voltage test feeder. Uncoordinated scheduling of EVs is also implemented and compared with the proposed strategy. The results show that installing EVCSs at the optimal locations can reduce the network losses and voltage deviations by 39.38% and 15.32%, respectively. It is also shown that the proposed scheduling of EVs can reduce the peak load of distribution substations and lower the network congestion without affecting the EV charging requirements. With a 55% penetration of EVs, the peak load and thermal overload in distribution lines are reduced by 20.53% and 5.88%, respectively.

Subject Areas: Congestion management; Control strategy; Electric vehicles; Network losses; Peak shaving; Voltage deviation

Availability: Prakash, K., Ali, M., Siddique, M.N.I., Karmaker, A.K., Macana, C.A., Dong, D., and Pota, H.R. (2022). “Bi-Level Planning and Scheduling of Electric Vehicle Charging Stations for Peak Shaving and Congestion Management in Low Voltage Distribution Networks.” *Computers and Electrical Engineering*, *102*. https://doi.org/10.1016/j.compeleceng.2022.108235

7.38. Title: Exploring Targeted Long-Distance Travel Survey Sampling Frame Approaches to Support Travel Survey Collection

Author(s): Fisher, M.P.

Abstract: Long-distance travel continues to grow in economic, environmental, and infrastructural importance. To inform policy, infrastructural funding, and travel demand forecasting, detailed travel survey findings are needed at the national level. However, the costs of running a full-scale national long-distance travel survey, both fiscally and temporally, have limited recent attempts. As such, survey data users have had to use older national survey data and then optimize their findings based on more recent, smaller-scale state travel surveys. These smaller-scale surveys have sample framing limitations, but while these limitations may be allowable given the immediate needs and scope associated with its original purpose, their utility for extrapolation and aggregation for broader use compared to the scope of national-level annual panel surveys is still fairly unknown.

This dissertation aims to identify how targeted sampling frame approaches can be used by national long-distance travel surveys. Having a full-sized, population-proportioned sample is always a tenet of good survey design, but the associated costs, especially for more niche subjects, can lead to an unwillingness to fully commit resources to survey deployment. This can lead to patchwork solutions to reduce costs such as with asking respondents for their long-distance travel habits over a very small timeframe or using regional survey findings to update national travel models. While these patchwork solutions offer potentially valid solutions, the actual impacts on data validity are practically unknown. This dissertation aims to fully explore these aspects, by not only exploring how targeted sampling frames might affect long-distance travel survey data accuracy, but also the best approaches for creating a targeted sample frame for the purposes of capturing nation-wide US long-distance travel.

Results suggest that the long-distance travel survey sampling frame can be targeted to reduce both fiscal and temporal costs considering seasonal variability trends, using targeted socio-demographic sampling, or using targeted geo-economic sampling. At the same time, these reductions can still provide statistically viable samples for socio-demographic groupings, travel volumes, mode splits, and purpose splits compared to full-scale national surveys like the 1995 American Travel Survey, 2001 National Household Travel Survey, and 2013 Longitudinal Survey of Overnight Travel.

Subject Areas: Long-Distance; Travel; Survey; Sampling

Availability: Fisher, M.P. (2022). *Exploring Targeted Long-Distance Travel Survey Sampling Frame Approaches to Support Travel Survey Collection*. Doctoral Dissertation, Auburn University, Auburn, AL. https://etd.auburn.edu/handle/10415/8417

7.39. Title: Inequality and the Future of Electric Mobility in 36 U.S. Cities: An Innovative Methodology and Comparative Assessment

Author(s): Romero-Lankao, P., Wilson, A., and Zimny-Schmitt, D.

Abstract: Electric vehicles are seen as one of the technological solutions to transition our transportation systems away from carbon, and cities offer unique opportunities to electrify transportation. To be equitable, however, this transition will not merely require technological innovations. Acknowledging socio-spatial inequalities and creating strategies to address them are critical—yet relatively underexplored—dimensions of the transportation transition. This paper integrates relevant literature into a micro-urban social typology (MUST) approach that uses agglomerative clustering techniques to examine, first, the factors and attributes defining transportation inequities within 36 U.S. cities, and, second, the implications of these inequities for policies that foster a more equitable transportation transition. By combining socio-spatial and transportation data, we identified five MUSTs: Wealthy, Urban Disadvantaged, Urban Renters, Middle-Class Homeowners, and Rural/Exurban. Rather than being tied to any particular indicator (e.g., homeownership), these MUSTs contain intersecting factors and features of inequities. We compare transportation and health outcomes across MUSTs, and the results suggest that user-centric strategies and public investments are necessary to foster true transportation equity. These must go beyond the electrification of private vehicles and should be tailored to the specific characteristics of each MUST. These could include electric carpooling for the rural/exurban MUSTs and electrification of transit for the urban disadvantaged and renter MUSTs. Our typology offers a critical next step toward informing transportation transition policies to target critical socio-demographic, economic, and techno-infrastructural factors.

Subject Areas: Equitable and just transitions; Cities; Transportation equity; Typologies; Electric vehicle adoption; Health risks

Availability: Romero-Lankao, P., Wilson, A., and Zimny-Schmitt, D. (2022). "Inequality and the Future of Electric Mobility in 36 U.S. Cities: An Innovative Methodology and Comparative Assessment." *Energy Research & Social Science*, *91*. https://doi.org/10.1016/j.erss.2022.102760

7.40. Title: Causality in Travel Mode Choice Modeling: A Novel Methodology That Combines Causal Discovery and Structural Equation Modeling

Author(s): Chauhan, R.S., Riis, C., Adhikari, S., Derrible, S., Zheleva, E., Choudhury, C.F., and Pereira, F.C.

Abstract: Causal discovery identifies causal relationships between variables in a dataset. This study investigates the potential of causal discovery in extracting causal connections from transportation behavioral data. To do so, four causal discovery algorithms are tested: Peter-Clark (PC), Fast Causal Inference (FCI), Fast Greedy Equivalence Search (FGES), and Linear Non-Gaussian Acyclic Models (LiNGAM). Their performances are compared to determine the most appropriate algorithm for travel choice modeling. Next, we propose a novel methodology to combine causal discovery with structural equation modeling (SEM) to model travel mode choice. This modeling approach can overcome some of the limitations of SEM, by combining both the strengths of causal discovery and SEM. The results show that LiNGAM best captures causality in transportation behavior modeling, among the four algorithms tested since the LiNGAM-based SEM achieved the lowest values of Chi-square, Root Mean Square Error of approximation (RMSEA), along with greater than 0.95 Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI), and Adjusted Goodness-of-Fit index (AGFI), Normed Fit Index (NFI), and Tucker-Lewis Index (TLI). The modeling results provide insights in causal relations leading to choosing private vehicles, public transit, or walking as a travel mode. The analyses are conducted on data from the 2017 National Household Travel Survey in the New York Metropolitan area.

Subject Areas: Causal Discovery; Structural Equation Modeling; Travel mode choice modeling

Availability: Chauhan, R.S., Riis, C., Adhikari, S., Derrible, S., Zheleva, E., Choudhury, C.F., and Pereira, F.C. (2022). *Causality in Travel Mode Choice Modeling: A Novel Methodology That Combines Causal Discovery and Structural Equation Modeling*. arXiv preprint, arXiv:2208.05624v1 [stat.AP]. https://arxiv.org/abs/2208.05624

7.41. Title: Estimating Bicycle and Pedestrian Ridership Using the Random Forest Algorithm

Author(s): Kamalapuram, S.

Abstract: For reasons related to traffic congestion, emissions, safety, physical activity and health, there has been an increased focus on active transportation modes, including cycling and walking, by transportation planners and policymakers in the United States. In this regard, estimating bicycle and pedestrian volumes is key to evaluating transportation systems, building new infrastructure, safety studies, and understanding the impact of policy changes. Researchers have used various methods to estimate these volumes but most of the studies are limited to a single city or include study locations only in urban areas. This study contributes to the existing literature by including study locations from rural areas and using unique explanatory variables from other tools such as the Strava Fitness app and the Bicycle Network Analysis (BNA) tool from PeopleforBikes. I built a set of models using the Random Forest algorithm to predict Annual Average Daily Bicycle Traffic (AADBT) at the street level and Annual Average Daily Pedestrian Traffic (AADPT) at the intersection level. The dependent variable in the bicycle models is the AADBT calculated using permanent counts from San Francisco and San Diego and short-term counts from Caltrans District 1 (including Del Norte, Mendocino, Humboldt, and Lake counties). The data from rural locations is limited to four counties in Northern California and thus I built separate models (urban, rural, and generalized: urban + rural) to account for the time and space limitations in the counts. The dependent variable in the pedestrian models is the AADPT calculated using annual average crossing volumes from 1,308 intersections in California. Unlike the bicycle count locations, pedestrian count locations are spread across various geographies and thus I developed a generalized pedestrian model that accounts for all neighborhood types.

Subject Areas: Active transportation; Traffic volume estimation; Rural areas; Random Forest algorithm

Availability: Kamalapuram, S. (2022). *Estimating Bicycle and Pedestrian Ridership Using the Random Forest Algorithm*. Master's Thesis, University of California, Davis, CA. https://escholarship.org/uc/item/1qj4f71g

7.42. Title: National Impacts of E-Commerce Growth: Development of a Spatial Demand Based Tool

Author(s): Jaller, M., Xiao, R., Dennis, S., Rivera-Royero, D., and Pahwa, A.

Abstract: This project aims to study the impacts of e-commerce on shopping behaviors and related externalities. The objectives are divided into five major tasks in this project. Methods used include Weighted Multinomial Logit (WMNL) models, time series forecasting, and Monte Carlo (MC) simulations. The American Time Use Survey (ATUS) and the National Household Travel Survey (NHTS) databases are used for identifying the independent and dependent variables for behavioral modeling. At the same time, we collected all MSA population data from the U.S. Census Bureau and combined the shares of each variable from ATUS to generate a synthesized population, which serves as input into the MC simulation framework together with the behavioral model. This simulation framework includes the generation of shopping travel parameters and the calculation of negative externalities. We do this to estimate e-commerce demand and impacts every decade until 2050. The results and analyses provide information that supports the generation of shopping travel and the estimations of a series of negative externalities using MC simulation, which includes shopping travel parameters, last-mile delivery parameters, and emission rate per person. For different parameters, a unique probability distribution or a regression relation is obtained for different MSAs, and this distribution is fed into the subsequent MC simulation. Finally, we simulated shopping behaviors for synthesized populations (until 2050) and to estimate the expected negative externalities. The MC simulation generates aggregate average vehicle miles traveled (VMT) and emissions (negative externalities) for different shopping activities in the planning years and different MSAs.

Subject Areas: E-commerce; Shopping behavior; Externalities; Forecast; Monte Carlo simulation

Availability: Jaller, M., Xiao, R., Dennis, S., Rivera-Royero, D., and Pahwa, A. (2022). *National Impacts of E-Commerce Growth: Development of a Spatial Demand Based Tool*. Final Research Report, UCD-ITS-RR-22-44, Institute of Transportation Studies, University of California, Davis, CA. https://escholarship.org/uc/item/46x4f1dr

7.43. Title: A Simulation Study of Passing Drivers' Responses to the Automated Truck-Mounted Attenuator System in Road Maintenance

Author(s): Li, Y., Wang, B., Li, W., and Qin, R.

Abstract: The Autonomous Truck-Mounted Attenuator (ATMA) system is a lead-follower vehicle system based on autonomous driving and connected vehicle technologies. The lead truck performs maintenance tasks on the road, and the unmanned follower truck is designed to improve the visibility of the moving work zone to passing vehicles and to protect workers and equipment. While the ATMA has been under testing by transportation maintenance and operations agencies in recent years, a simulator-based testing capability is a supplement, especially if human subjects are involved. This paper aims to discover how passing drivers perceive, understand, and react to the ATMA system in road maintenance accordingly. A driving simulator for ATMA studies is developed for collecting the driving data. Then, driving simulation experiments were performed, wherein a screen-based eye tracker collected sixteen subjects' gaze points and pupil diameters. Data analysis has evidenced the changes in the visual attention pattern of subjects when they were passing the ATMA. On average, the ATMA starts to attract subjects' attention from 500 ft behind the follower truck. Most (87.50%) understood the follower truck's protection purpose, and the majority (86.67%) reasoned the association between the two trucks. But still, many (43.75%) did not recognize that ATMA is a connected autonomous vehicle system. While all subjects safely changed lanes and attempted to pass the slow-moving ATMA, their inadequate understanding of ATMA is a potential risk, like cutting into the ATMA. Results implied that transportation maintenance and operations agencies should take this into consideration in establishing the deployment guidance.

Subject Areas: Moving Work Zone; Maintenance and Operations Management; Connected Autonomous Vehicles; Driving simulator; Eye tracking; Safety and Human Factors

Availability: Li, Y., Wang, B., Li, W., and Qin, R. (2022). *A Simulation Study of Passing Drivers' Responses to the Automated Truck-Mounted Attenuator System in Road Maintenance*. arXiv preprint, arXiv:2208.07303v1 [cs.RO]. https://arxiv.org/abs/2208.07303

7.44. Title: Is Long-Distance Travel Influenced by Regional Geography?: An Analysis of Tripmaking Between Sociogeographic Clusters of U.S. Counties

Author(s): Fisher, M., LaMondia, J.J., and Bricka, S.

Abstract: As long-distance travel volumes continue to grow, decision makers seek data to help manage the travel-related impacts. Household travel surveys offer the details necessary for developing policy-responsive forecasting models and other analyses, but more efficient sampling plans are needed to capture long-distance travel in a more cost-effective manner. To support the development of sampling approaches for long-distance surveys, the objectives of this study were to (a) develop a sociogeographic cluster classification system for stratifying U.S. counties and (b) measure differences in long-distance travel behavior across these county classifications. Using fuzzy clustering techniques, U.S. counties were successfully classified into sociogeographic clusters for the purpose of analyzing tripmaking behavior. We measured mean household total trip rates, trip rates by mode (air, vehicle, other), and trip rates by purpose (leisure, work, other) using the weighted 2001 National Household Travel Survey. The results indicated that households within each county cluster pursue (a) statistically similar long-distance trip rates with other households in their cluster and (b) statistically different trip rates from households in other clusters. The differences in household long-distance trip rates also extended to the census region level, meaning census regions as well as sociogeographic cluster assignment were significant predictors of long-distance trip rates. Therefore, rather than collect a long-distance travel survey from a sampling framework focused on being nationally representative, these results suggest we might target data collection from regional sociogeographic clusters.

Subject Areas: Long-distance travel; Sampling; Travel survey

Availability: Fisher, M., LaMondia, J.J., and Bricka, S. (2022). "Is Long-Distance Travel Influenced by Regional Geography?: An Analysis of Tripmaking Between Sociogeographic Clusters of U.S. Counties." *Transportation Research Record*. https://doi.org/10.1177/03611981221115429

7.45. Title: Using Panel Data Analysis to Evaluate How Individual Non-Pharmaceutical Interventions Affected Traffic in the U.S. During the First Three Months of the COVID Pandemic

Author(s): Motuba, D., Khan, M.A., Mirzazadeh, B., and Habib, M.F.

Abstract: In response to the COVID-19 pandemic, restrictive non-pharmaceutical policy interventions (NPIs), with the goals of reducing interactions and travel for people in different households, were introduced. In the U.S., each state had jurisdiction over the NPI policy imposed, resulting in myriad policy decisions. The aggregate impacts of these decisions are known; however, the individual impacts are not fully understood. We disaggregated the NPIs imposed during the first three months of the epidemic (1 March and 7 June 2020) using panel data regression analysis. Vehicular travel reduction as a proxy for NPI impacts on traffic was regressed against stay-at-home orders, business closures, school closures, and gathering bans. The results show that school closures and full closures of non-essential businesses were correlated with the largest impacts in reducing vehicle trips compared to when they were not in place. Stay-at-home orders had about half the impact of school closures compared to when they were not in place. Gathering bans had the least impact. In the U.S., decisions that target businesses were the most effective in reducing vehicle traffic. There was heterogeneity in how people responded to these restrictions. This study can be used in epidemiology models and inform decision-makers on policies that work best.

Subject Areas: Interventions policies; COVID-19 restrictions; Vehicle trip reduction; Heterogeneity; Panel data analysis

Availability: Motuba, D., Khan, M.A., Mirzazadeh, B., and Habib, M.F. (2022). "Using Panel Data Analysis to Evaluate How Individual Non-Pharmaceutical Interventions Affected Traffic in the U.S. During the First Three Months of the COVID Pandemic." *COVID*, *2*(9), pp. 1193–1206. https://doi.org/10.3390/covid2090086

7.46. Title: The Cost of Rate Caps: Evidence from Arkansas

Author(s): Lukongo, O.E.B. and Miller Jr., T.W.

Abstract: Regulated small-dollar installment lenders do not operate within Arkansas, but they do in all six states that border Arkansas. We can measure the effects of Arkansas' 17% interest rate cap because Arkansas residents obtain installment loans only from out-of-state lenders. On average, Arkansas residents borrow $1,051 at an annual percentage rate of 93%, when incorporating travel costs. Arkansas residents borrow at a rate of 90.4 loans per 10,000 people, compared to 524.5 per 10,000 for residents of the six bordering states. Residents in Arkansas counties that border other states hold 96.7% of out-of-state-supplied small-dollar installment loans. Statistical tests confirm that the interest rate cap affects residents in the interior counties of Arkansas more than it does residents in the perimeter counties.

Subject Areas: Arkansas; Small-dollar installment lenders; Interest rate cap; Interior counties; Perimeter counties

Availability: Lukongo, O.E.B. and Miller Jr., T.W. (2022). "The Cost of Rate Caps: Evidence from Arkansas." *Journal of Financial Research*, *45*(4), pp. 881–909. https://doi.org/10.1111/jfir.12301

7.47. Title: A Two-Lane Cellular Automaton Model to Evaluate the Bus Lane with Intermittent Priority

Author(s): Wu, D. and Han, X.

Abstract: Bus lanes with intermittent priority (BLIPs) are lanes where general traffic is required to give way to approaching buses. BLIPs can improve the reliability of bus services and help maximize the use of road resources. It can be seen as an innovative sharing mobility, such as carsharing, carpooling, and lane sharing. However, implementation of BLIPs has never been feasible until vehicle communications could accommodate the idea. Vehicle-to-vehicle (V2V) communications have broad application prospects in the deployment of BLIPs. This paper develops a two-lane cellular automaton (CA) model to simulate BLIPs and assesses the benefits of connected vehicles for bus operation. In the model, lane-changings are asymmetric with an improved mandatory BLIP lane-changing rule underlying. The effects of BLIPs are explored through numerical simulations, including BLIPs' impacts on neighboring lanes, travel time saving, fuel consumption, and the punctuality rate of buses. Analysis of traffic flow characteristics of corridors using BLIPs reveals that there is a strong connection among the bus departure interval, clear distance, and road capacity.

Subject Areas: Bus lanes with intermittent priority; Vehicle-to-vehicle communications; Two-lane cellular automaton; Traffic flow; Lane change

Availability: Wu, D. and Han, X. (2022). "A Two-Lane Cellular Automaton Model to Evaluate the Bus Lane with Intermittent Priority." *Journal of Advanced Transportation*. https://doi.org/10.1155/2022/9028212

7.48. Title: Investigating the Use of Machine Learning Methods in Direct Ridership Models for Bus Transit

Author(s): Sivakumar Nair, G., Mirzaei, A., and Ruiz-Juri, N.

Abstract: This test paper develops and tests 13 direct ridership models (DRMs) for transit sketch planning the Dallas–Fort Worth region. We explore both, machine learning modeling approaches (e.g., ridge regression and random forest) and traditional statistical models (e.g., linear regression and multiplicative regression). This effort provides a detailed description of modeling workflows and of the preprocessing of input data including general transit feed specification (GTFS), employment, socio-demographic, and ridership data. We also describe metrics to compare model performance; in our experiments the ridge regression framework using a Yeo-Johnson power transformation led to the most accurate predictions with an R2R2 of 0.88. The sensitivity of the DRM to errors in the service-related predictor variables is within acceptable limits with the root mean squared error (RMSE) increasing by less than 20% for a 25% error in any one of the input predictors. Our findings suggest that DRMs can be a powerful complement to the four-step planning process, providing an alternative that is easier to maintain and run, and which may lead to more accurate ridership estimates given the limitations of transit modeling in traditional regional models. To illustrate the benefits of DRMs, this effort describes the deployment of trained models using a web-based framework which allows practitioners to obtain ridership estimates by drawing prospective routes on a map and providing a small number of service attributes as input.

Subject Areas: Direct ridership models; Transit sketch planning; Machine learning modeling; Traditional statistical models; Modeling workflows

Availability: Sivakumar Nair, G., Mirzaei, A., and Ruiz-Juri, N. (2022). "Investigating the Use of Machine Learning Methods in Direct Ridership Models for Bus Transit." *Transportation Research Record: Journal of the Transportation Research Board*. https://doi.org/10.1177/03611981221117540

7.49. Title: Estimating Demand for Online Delivery Using Limited Historical Observations

Author(s): Mirzanezhad, M., Twumasi-Boakye, R., Broaddus, A., and Fabusuyi, T.

Abstract: Driven in part by the COVID-19 pandemic, the pace of online purchases for at-home delivery has accelerated significantly. However, responding to this development has been challenging given the lack of public data. The existing data may be infrequent, and a significant portion of data may be missing because of survey participant non-responses. This data paucity renders conventional predictive models unreliable. We address this shortcoming by developing algorithms for data imputation and synthetic demand estimation for future years without the actual ground truth data. We use 2017 Puget Sound Regional Council (PSRC) and National Household Travel Survey (NHTS) data and impute from the NHTS for the Seattle-Tacoma-Bellevue MSA where delivery data is relatively more frequent. Our imputation has the mean-squared error MSE ≈ 0.65 to NHTS with mean ≈ 1 and standard deviation ≈3.5 and provides a similarity matching between the two data sources' samples. Given the unavailability of NHTS data for 2021, we use the temporal fidelity of PSRC data sources (2017 and 2021) to project the resolution onto the NHTS providing a synthetic estimate of NHTS deliveries. Beyond the improved reliability of the estimates, we report explanatory variables that were relevant in determining the volume of deliveries. This work furthers existing methods in demand estimation for goods deliveries by maximizing available sparse data to generate reasonable estimates that could facilitate policy decisions.

Subject Areas: Delivery estimation; Travel survey data; Imputation

Availability: Mirzanezhad, M., Twumasi-Boakye, R., Broaddus, A., and Fabusuyi, T. (2022). *Estimating Demand for Online Delivery Using Limited Historical Observations*. arXiv preprint, arXiv:2209.01457v1 [stat.ME]. https://arxiv-export3.library.cornell.edu/abs/2209.01457

7.50. Title: Data-Driven Rolling Forecasting of Electric Vehicle Charging Load with Realtime Correction

Author(s): Xu, M., Guan, Y., and Che, L.

Abstract: The number of household electric vehicles (EVs) is increasing rapidly, and the charging load of electric vehicles has become a huge power consumption of the power grid that cannot be ignored. Accurate forecasting of electric vehicles is an important guarantee for the safe and stable operation of the power grid. However, conventional forecasting method is difficult to reflect the real situation of the forecasting day, and resulting in poor forecasting accuracy. Therefore, this paper proposes a data-driven rolling forecasting method of electric vehicle charging load. In detail, this paper constructs a neural network model for EVs' arrival time forecasting, and uses alternating direction multiplier method for model training to reduce the risk of falling into local optimization. On the basis, the model outputs are corrected in real time through mathematical methods according to the feedback information of the EVs which have arrived before the forecasting timepoint. The simulation results on the 2017 US National Household Travel Survey dataset show that the proposed method has better forecasting performance than the conventional method, and the utilization of feedback information is functional.

Subject Areas: Electric vehicles; Training; Simulation; Neural networks; Predictive models; Mathematical models; Real-time systems; Power grids

Availability: Xu, M., Guan, Y., and Che, L. (2022). "Data-Driven Rolling Forecasting of Electric Vehicle Charging Load with Realtime Correction." *2022 Power System and Green Energy Conference (PSGEC)*, pp. 164–168. https://doi.org/10.1109/PSGEC54663.2022.9881127

7.51. Title: Cigarette, Electronic Cigarette, and Marijuana Use Among Young Adults Under Policy Changes in California

Author(s): Meng, Y.-Y., Yu, Y., and Ponce, N.A.

Abstract: Introduction: Since 2016, California has implemented a series of policies, including prohibiting the sale of tobacco products and electronic cigarettes (e-cigarettes) to persons under 21, cigarette tax increase, and recreational marijuana legalization. The study aims to examine the use of cigarettes, e-cigarettes, and marijuana among young adults (ages 18–25) and their associations with other factors in the context of these policy changes.

Methods: We used the data from the California Health Interview Survey (CHIS) 2017–2018 to compare the rates of using cigarettes, e-cigarettes, and marijuana separately or any use of the three. Using CHIS 2018 data, weighted logistic regression models were used to examine associations of using cigarettes, e-cigarettes, and marijuana separately or any use of these products/substance with demo-socioeconomic factors, psychological distress, and use of each product/substances.

Results: Cigarette smoking remained flat while the use of e-cigarettes and marijuana escalated among young adults from 2017 to 2018. Using tobacco products increased the use of marijuana or vice versa among young adults. Severe psychological distress was significantly associated with cigarette use (adjusted odds ratio [AOR] = 4.06; 95% CI = 1.32, 12.55), marijuana use (AOR = 2.32; 95% CI = 1.10, 4.48), and any use (AOR = 4.11; 95% CI = 1.93, 8.77). Moderate psychological distress was also significantly associated with the use of these products/substance. Underage (ages 18–20) young adults had lower odds of using cigarettes than other young adults (ages 21–25).

Conclusions: Our findings highlight the importance of addressing the use of cigarettes, e-cigarettes, and marijuana simultaneously through policies to curtail tobacco and marijuana use among young adults.

Subject Areas: Tobacco; E-cigarette use; Marijuana use

Availability: Meng, Y.-Y., Yu, Y., and Ponce, N.A. (2022). "Cigarette, Electronic Cigarette, and Marijuana Use Among Young Adults Under Policy Changes in California." *Addictive Behaviors Reports*, *16*. https://doi.org/10.1016/j.abrep.2022.100459

7.52. Title: Feature Extraction, Cluster Analysis and Object Representation

Author(s): Yang, D. and Duan, Z.

Abstract: Although the data exist objectively, the perspective, the measurement method and the measurement scale used to extract characteristics from the data depend on the subjective perception of the researchers, thereby resulting in the possibility of sharp differences in obtained knowledge based on the same data. Since measurement system is closely related to fundamental conditions of the data, simply cramming big data into the traditional technical measurement concept often leads to incompatibility and may lose the important information contained in the data. Therefore, it is necessary to probe into feature extraction issues according to new data characteristics.

Subject Areas: Urban sustainability; feature extraction; Data characteristics

Availability: Yang, D. and Duan, Z. (2022). "Feature Extraction, Cluster Analysis and Object Representation." *Assessing Urban Transportation with Big Data Analysis*, pp. 137–186. https://link.springer.com/chapter/10.1007/978-981-19-3338-7_4

7.53. Title: A Method to Derive Small Area Estimates of Linked Commuting Trips by Mode from Open Source LODES and ACS data

Author(s): Credit, K. and Arnao, Z.

Abstract: This paper describes a fully customizable open source method to create linked origin-destination data on commuting flows by mode at the Census tract scale by combining LODES and ACS data from the US Census Bureau. With additional work, the method could be scaled to the entire US (with a small number of exceptions) for every year from 2002 to 2019. For demonstration purposes, the paper applies this method to 2015 commuting flows in Cook County, Illinois. At an aggregate scale, the results of this application show that commuting by all modes is dominated by travel to large regional employment centres. However, the pattern is more localised for the walking mode, and focused along corridors of mode-specific infrastructure investment for the cycling and transit modes, as might be expected. The auto and work from home modes demonstrate the most distributed pattern of travel, revealing more instances of commuting to regional sub-centres than the other modes.

Subject Areas: Travel behaviour; commuting; big data; transportation modelling; urban analytics

Availability: Credit, K. and Arnao, Z. (2022). "A Method to Derive Small Area Estimates of Linked Commuting Trips by Mode from Open Source LODES and ACS data." *Urban Analytics and City Science*. https://doi.org/10.1177/23998083221129614

7.54. Title: Mapping America's Activity Centers: The Building Blocks of Prosperous, Equitable, and Sustainable Regions

Author(s): Loh, T.H., Rowlands, D.W., Tomer, A., Kane, J., and Vey, J.

Abstract: In this report, we introduce a new methodology to locate and characterize *activity centers*: places within regions where economic, physical, social, and civic assets cluster at a clearly defined hyperlocal scale. We present a typology of activity centers, map their locations within the 110 U.S. metropolitan statistical areas (MSAs) with at least 500,000 residents using census block groups, and analyze those centers to help planners, real estate professionals, and elected leaders better understand how and why they matter.

Subject Areas: Activity centers; Metropolitan areas; Sustainable travel outcomes; Accessibility; Density; Real estate value

Availability: Loh, T.H., Rowlands, D.W., Tomer, A., Kane, J., and Vey, J. (2022). *Mapping America's Activity Centers: The Building Blocks of Prosperous, Equitable, and Sustainable Regions*. Report, Brookings Metro, Washington, D.C. https://www.brookings.edu/wp-content/uploads/2022/10/RegionallySigPlaces_FinalReport-1.pdf

7.55. Title: City Parks and Slow Streets: A Utility-Based Access and Equity Analysis

Author(s): Macfarlane, G., Voulgaris, C.T., and Tapia, T.

Abstract: During the spring and summer of 2020, cities across the world responded to the global COVID-19 pandemic by converting roadway facilities into open pedestrian spaces. These conversions improved access to public open space, but measuring the variation in that improvement among different populations requires clear definitions of access and methods for measuring it. In this study, we evaluate the change in a utility-based park accessibility measure resulting from street conversions in Alameda County, California. Our utility-based accessibility measure is constructed from a park activity location choice model we estimate using mobile device data—supplied by StreetLight Data, Inc.—representing trips to parks in that county. The estimated model reveals heterogeneity in inferred affinity for park attributes among different socio-demographic groups. We find, for example, that neighborhoods with more lower-income residents and those with more residents of color show a greater preference for park proximity while neighborhoods with higher incomes and those with more white residents show a greater preference for park size and amenities. We then apply this model to examine the accessibility benefits resulting from COVID-19 street conversions to create a set of small park-like open spaces; we find that this has been a pro-social policy in that Black, Hispanic, and low-income households receive a disproportionate share of the policy benefits, relative to the population distribution.

Subject Areas: Open space; Street conversions; California; Neighborhood socio-demographics; Accessibility, Passive data, Location choice, Parks

Availability: Macfarlane, G., Voulgaris, C.T., and Tapia, T. (2022). "City Parks and Slow Streets: A Utility-Based Access and Equity Analysis." *Journal of Transport and Land Use*, *15*(1), pp. 587–612. https://www.jtlu.org/index.php/jtlu/article/view/2009

7.56. Title: Federated Reinforcement Learning for Real-Time Electric Vehicle Charging and Discharging Control

Author(s): Zhang, Z., Jiang, Y., Shi, Y., Shi, Y., and Chen, W.

Abstract: With the recent advances in mobile energy storage technologies, electric vehicles (EVs) have become a crucial part of smart grids. When EVs participate in the demand response program, the charging cost can be significantly reduced by taking full advantage of the real-time pricing signals. However, many stochastic factors exist in the dynamic environment, bringing significant challenges to design an optimal charging/discharging control strategy. This paper develops an optimal EV charging/discharging control strategy for different EV users under dynamic environments to maximize EV users' benefits. We first formulate this problem as a Markov decision process (MDP). Then we consider EV users with different behaviors as agents in different environments. Furthermore, a horizontal federated reinforcement learning (HFRL)-based method is proposed to fit various users' behaviors and dynamic environments. This approach can learn an optimal charging/discharging control strategy without sharing users' profiles. Simulation results illustrate that the proposed real-time EV charging/discharging control strategy can perform well among various stochastic factors.

Subject Areas: Mobile energy storage; Electric vehicles; Real-time pricing signals; Markov decision process; Horizontal federated reinforcement learning; Charging/discharging control

Availability: Zhang, Z., Jiang, Y., Shi, Y., Shi, Y., and Chen, W. (2022). *Federated Reinforcement Learning for Real-Time Electric Vehicle Charging and Discharging Control*. arXiv preprint, arXiv:2210.01452v1 [eess.SY]. https://doi.org/10.48550/arXiv.2210.01452

7.57. Title: Lessons Learned About Electric Vehicle Consumers Who Rated the U.S. Federal Tax Credit "Extremely Important" in Enabling Their Purchase

Author(s): Williams, B.D.H. and Anderson, J.B.

Abstract: The U.S. federal tax credit (FTC) for electric vehicles (EVs) was phased out for GM and Tesla vehicles in 2019. To better understand the role the FTC played and inform incentive design, we do logistic regression using data from 6,391 recipients of California's EV rebate. We identify demographic, motivational, and other characteristics associated with consumers rating the FTC "Extremely Important" to making their EV purchase possible. A growing majority of consumers were found to be "FTC Extremes." Odds-increasing factors included younger age, non-white race/ethnicity, and importance given to fuel-cost savings, carpool-lane access, and charging availability. Notably not significant were income, residential solar, and the importance of environmental impacts. Evidence is discussed for recommendations including eliminating the need for sufficient tax liability to fully benefit, limiting eligible vehicle price, and moving incentives closer to the point of sale. Additional findings and recommendations are provided to inform incentive outreach and optimization.

Subject Areas: Incentive; Market development; Marketing; Policy; Promotion

Availability: Williams, B.D.H. and Anderson, J.B. (2022). *Lessons Learned About Electric Vehicle Consumers Who Rated the U.S. Federal Tax Credit "Extremely Important" in Enabling Their Purchase*. 35th International Electric Vehicle Symposium and Exhibition (EVS35), Oslo, Norway.
https://cleanvehiclerebate.org/sites/default/files/attachments/CVRP_Federal_EV_Tax_Credit_Lessons_Learned.pdf

7.58. Title: Economic-Environmental Convex Network-Constrained Decision-Making for Integrated Multi-Energy Distribution Systems Under Electrified Transportation Fleets

Author(s): Nasiri, N., Zeynali, S., Ravadanegh, S.N., and Kubler, S.

Abstract: Considering the high penetration rates of electrified transportation fleets, their impact on the integrated thermal/electrical/natural-gas multi-energy distribution systems (IMEDS) will be distinguishable. This study proposes a hybrid robust-stochastic convex optimization model for optimal scheduling of an IMEDS under the network constraints. Moreover, a high penetration level of smart plug-in hybrid electric vehicle (PHEV) fleets, as well as the renewable energy sources (RES) in the active electricity distribution system (AEDS) is regarded. A multi-objective optimization approach is taken to minimize the operation expenditures and the greenhouse gas emissions. The natural gas network (NGN) linepack storage capability along with the district heating network (DHN) thermal flexibility are formulated with the objective to enhance the flexibility and avoid overlapping in the peak demand of various energy forms under severe uncertainty conditions (e.g., considering uncertain input parameters such as RES production, electrical loads, natural gas loads, drivers' behaviour). To handle such uncertainty parameters, a scenario-based stochastic programming (SP) method is adopted, combined with robust optimization (RO) ambiguity sets, when dealing with volatilities of the market price. The network-constrained IMEDS was embodied by the standard IEEE 69-bus AEDS, 40-node NGN, 59-bus DHN systems. The proposed convex model is a second-order cone programming (SOCP) model, which was solved by the MOSEK solver. The functionality of the proposed method was confirmed through different case studies.

Subject Areas: Electric vehicles; Convex optimization; Second-order cone programming; Integrated multi-energy system; District heating network; Combined heat and power

Availability: Nasiri, N., Zeynali, S., Ravadanegh, S.N., and Kubler, S. (2022). "Economic-Environmental Convex Network-Constrained Decision-Making for Integrated Multi-Energy Distribution Systems Under Electrified Transportation Fleets." *Journal of Cleaner Production*, *379*(Part 1). https://doi.org/10.1016/j.jclepro.2022.134582

7.59. Title: Variables Appended to ABS Frames: Has Their Data Quality Improved?

Author(s): Roth, S., Caporaso, A., and DeMatteis, J.

Abstract: Address based sampling (ABS) has become current state-of-the-art methodology for conducting household surveys by mail, telephone or web in the United States. One potential advantage of ABS frames is that additional information about the sampled households can be appended and leveraged for data collection and analytic purposes. The appended data come from many sources and are of variable quality and completeness. The goals of this research were to evaluate data quality of demographic and socioeconomic variables provided for recent ABS samples from one vendor, and to examine their potential usefulness for sample design, including oversampling. We report on the completeness of the appended data as well as their concordance with data reported by respondents to two recent large ABS household surveys, one that invited households to complete the survey online and another that was mail only. Based on the quality assessment, we also examine the utility of the appended variables for oversampling. Our general conclusions are that the quality of select appended variables has improved such that the Hispanic origin, Hispanic surname, and presence of age group 65+ variables may be used to efficiently oversample these subgroups. However, this is not the case for oversampling other subgroups through appended variables for home tenure; those with head of household whose educational attainment is high school or less; low income households; households with children; presence of age groups 18–24, 25–34, and 35–64; or households based on the number of adults in the household.

Subject Areas: Address based sampling; Appended data; Survey quality

Availability: Roth, S., Caporaso, A., and DeMatteis, J. (2022). "Variables Appended to ABS Frames: Has Their Data Quality Improved?" *PLoS ONE*, *17*(11). https://doi.org/10.1371/journal.pone.0269110

7.60. Title: Human-Computer Interaction in Mobility Systems

Author(s): Krömker, H., Mayas, C., and Wienken, T.

Abstract: People's mobility is constantly increasing all over the world, and more and more transport systems are available. This is especially evident in urban transport systems that link individual transport with car and bike sharing or autonomous shuttles. This creates completely new challenges for human-computer interaction, as the complexity of mobility information and the management of intermodal travel becomes more and more sophisticated. A broad spectrum of travelers with different needs must be taken into account. To achieve the acceptance of these systems, human-computer interaction must be completely redesigned. In order to structure this complexity for HCI research, small modules for a theoretical basis have been developed step by step over the last 10 years, most of which were published for the first time at the HCI conferences. In many case studies, method sets and classifications were tested in order to get to know the challenges for HCI better and better. On the basis of case studies method sets and theoretical concepts have been developed. The contribution shows how these results were transferred into the holistic concept of the Mobility Experience.

Subject Areas: Mobility systems; Mobility experience; Transportation systems

Availability: Krömker, H., Mayas, C., and Wienken, T. (2022). "Human-Computer Interaction in Mobility Systems." *Duffy, V.G., Landry, S.J., Lee, J.D., Stanton, N. (eds) Human-Automation Interaction. Automation, Collaboration, & E-Services*, *11*, pp. 131–145. https://doi.org/10.1007/978-3-031-10784-9_7

7.61. Title: Evaluating the Comprehensive Development Level and Coordinated Relationships of Urban Multimodal Transportation: A Case Study of China's Major Cities

Author(s): Hu, B., Xu, A., and Dong, X.

Abstract: Urban multimodal transportation effectively meets the diversified travel demand of residents. However, it also generates extensive development problems such as traffic congestion, exhaust emissions and low operational efficiency. Therefore, there is an urgent need in urban sustainable development to achieve the coordinated and stable development of various modes of transportation. In this study, we took 36 major cities in China as the research object; measured the comprehensive development level of urban multimodal transportation; used the coupling coordination degree model (CCDM) to research the coordinated development relationship among buses, rail transit, and taxis; and clarified the shortcomings of the coordinated development of multimodal transportation. The results show that the comprehensive development of urban multimodal transportation in China has shown a significant upward trend from 2016 to 2020, with an average annual growth rate of about 7.36%. There are significant differences in the development levels of multimodal transportation in different cities. In addition, the relationship among buses, rail transit, and taxis in the major cities in China presents a state of uncoordinated development. Therefore, the relevant departments of cities should optimize the allocation of transportation resources, in terms of infrastructure construction and operation, according to these development levels and coordination of multimodal transportation.

Subject Areas: Multimodal transportation; Comprehensive development level; Coupling coordination relationship

Availability: Hu, B., Xu, A., and Dong, X. (2022). "Evaluating the Comprehensive Development Level and Coordinated Relationships of Urban Multimodal Transportation: A Case Study of China's Major Cities." *Land*, *11*(11). https://doi.org/10.3390/land11111949

7.62. Title: Response Willingness in Consecutive Travel Surveys: An Investigation Based on the National Household Travel Survey Using a Sample Selection Model

Author(s): Wang, X., Shaw, F.A., Mokhtarian, P.L., and Watkins, K.E.

Abstract: Declining survey response rates have increased the costs of travel survey recruitment. Recruiting respondents based on their expressed willingness to participate in future surveys, obtained from a preceding survey, is a potential solution but may exacerbate sample biases. In this study, we analyze the self-selection biases of survey respondents recruited from the 2017 U.S. National Household Travel Survey (NHTS), who had agreed to be contacted again for follow-up surveys. We apply a probit with sample selection (PSS) model to analyze (1) respondents' willingness to participate in a follow-up survey (the selection model) and (2) their actual response behavior once contacted (the outcome model). Results verify the existence of self-selection biases, which are related to survey burden, socio-demographic characteristics, travel behavior, and item non-response to sensitive variables. We find that age, homeownership, and medical conditions have opposing effects on respondents' willingness to participate and their actual survey participation. The PSS model is then validated using a hold-out sample and applied to the NHTS samples from various geographic regions to predict follow-up survey participation. Effect size indicators for differences between predicted and actual (population) distributions of select socio-demographic and travel-related variables suggest that the resulting samples may be most biased along age and education dimensions. Further, we summarized six model performance measures based on the PSS model structure. Overall, this study provides insight into self-selection biases in respondents recruited from preceding travel surveys. Model results can help researchers better understand and address such biases, while the nuanced application of various model measures lays a foundation for appropriate comparison across sample selection models.

Subject Areas: Self-selection bias; Nonresponse bias; Probit with sample selection model; National household travel survey; Model measurement; Sampling frame

Availability: Wang, X., Shaw, F.A., Mokhtarian, P.L., and Watkins, K.E. (2022). "Response Willingness in Consecutive Travel Surveys: An Investigation Based on the National Household Travel Survey Using a Sample Selection Model." *Transportation*. https://doi.org/10.1007/s11116-022-10312-w

7.63. Title: Mitigating Network Congestion by Integrating Transportation Network Companies and Urban Transit

Author(s): Sisiopiku, V. and Hadi, M.

Abstract: Transportation Network Companies (TNCs) like Uber and Lyft provide a transportation option that offers a higher level of availability, reliability, and convenience than traditional taxi and transit services. However, there are widespread concerns about their impacts on urban congestion and their threat to public transit and taxi services, some of which are affirmed by recent case studies. The research team developed and demonstrated novel methods for calibrating MATSim models using a regionally approved mode split behavioral model and real-world traffic counts; collecting and processing Uber trip-level data using crowdsourcing to address the lack of publicly available TNC data; and modeling ride-hailing, in addition to automobile and transit trips, in the same simulation testbed. Products of this research include: (a) a questionnaire survey for documenting awareness and use of TNC services in the Southeastern US; (b) a rigorously calibrated MATSim model of the Miami Beach area; and (c) a comprehensive digital twin model of the Birmingham region. The latter MATSim model successfully incorporates public transit and ride-hailing services into the Birmingham transportation network, in addition to private automobiles. Overall, this research work provides valuable contributions to the current body of knowledge related to multimodal modeling using an open-source large-scale agent-based transportation simulation platform. The findings of the case studies reported herein provide evidence on the benefits of adopting transit, TNC, and road pricing strategies in small- and medium-size urban settings and can assist transportation decision makers, urban planners, transit agencies, and TNC providers in their efforts to optimize their operations and serve the needs of the traveling public.

Subject Areas: Transportation Network Companies (TNCs); MATSim simulation modeling; Model calibration; Mode integration; Digital twin

Availability: Sisiopiku, V. and Hadi, M. (2022). *Mitigating Network Congestion by Integrating Transportation Network Companies and Urban Transit*. Report: STRIDE Project I2, U.S Department of Transportation/Office of Research, Development & Tech, Washington, D.C. https://rosap.ntl.bts.gov/view/dot/64763

7.64. Title: Statistical Modelling of Electric Vehicle Charging Behaviours

Author(s): Amara-Ouali, Y.

Abstract: The development of electric vehicles (EVs) is a major lever towards low-carbon transport. It comes with a growing number of charging infrastructures that can be used as flexible assets for the grid. To enable this smart-charging, an effective daily forecast of the charging behavior is necessary. In this context, the objective of this thesis is threefold: (a) to identify current modeling techniques and open data available, (b) to propose new EV charging methodologies to characterize their charging behaviours, and (c) to specify innovative techniques for daily peak load forecasting. The first chapter of the manuscript presents the industrial issues and introduces the modeling framework for EV charging. Chapter 2 is a review of state of the art EV load models as well as an exploration of 8 open charging session datasets. Chapter 3 offers a comparative study of 14 EV load and occupancy models on the 8 datasets presented in the previous chapter. Chapter 4 introduces a model for EV arrivals as a non-homogeneous Poisson process with additive spline and wavelet effects. Finally, Chapter 5 introduces a model for daily electrical peaks with a multi-resolution approach. We show that the approaches proposed in our work are competitive with the best existing alternatives by evaluating their performance on real-world data.

Subject Areas: Non-homogeneous Poisson process; Additive models; Multi-resolution analysis; Smart charging; Consumption peaks

Availability: Amara-Ouali, Y. (2022). *Statistical Modelling of Electric Vehicle Charging Behaviours*. Doctoral Thesis, Université Paris-Saclay, Paris, France. https://theses.hal.science/tel-03850949

7.65. Title: The 15-Minute City Quantified Using Mobility Data

Author(s): Abbiasov, T., Heine, C., Glaeser, E., Ratti, C., Sabouri, S., Salazar-Miranda, A., and Santi, P.

Abstract: Americans travel 7 to 9 miles on average for shopping and recreational activities, which is far longer than the 15-minute (walking) city advocated by ecologically oriented urban planners. This paper provides a comprehensive analysis of local trip behavior in US cities using GPS data on individual trips from 40 million mobile devices. We define local usage as the share of trips made within 15-minutes walking distance from home, and find that the median US city resident makes only 12% of their daily trips within such a short distance. We find that differences in access to local services can explain 80% of the variation in 15-minute usage across metropolitan areas and 74% of the variation in usage within metropolitan areas. Differences in historic zoning permissiveness within New York suggest a causal link between access and usage, and that less restrictive zoning rules, such as permitting more mixed-use development, would lead to shorter travel times. Finally, we document a strong correlation between local usage and experienced segregation for poorer, but not richer, urbanites, which suggests that 15-minute cities may also exacerbate the social isolation of marginalized communities.

Subject Areas: 15-minute city; Mobility; Sustainability; Land use policy; Walkability

Availability: Abbiasov, T., Heine, C., Glaeser, E., Ratti, C., Sabouri, S., Salazar-Miranda, A., and Santi, P. (2022). *The 15-Minute City Quantified Using Mobility Data*. arXiv preprint, arXiv:2211.14872v1 [physics.soc-ph]. https://arxiv.org/abs/2211.14872

7.66. Title: Transforming GPS Points to Daily Activities Using Simultaneously Optimized DBSCAN-TE Parameters

Author(s): Riches, G.M.

Abstract: With the recent upsurge in mental health concerns and ongoing isolation regulations brought about by the COVID-19 pandemic, it is important to understand how an individual's daily travel behavior can affect their mental health. Before finding any correlations to mental health, researchers must first have individual travel behavior information: an accurate number of activities and locations of those activities.

One way to obtain daily travel behavior information is through the interpretation of cellular Global Positioning System (GPS) data. Previous methods that interpret GPS data into travel behavior information have limitations. Specifically, rule-based algorithms are structured around subjective rule-based tests, clustering algorithms include only spatial parameters that are chosen sequentially or require further exploration, and imputation algorithms are sensitive to provided context (input parameters) and/or require lots of training data to validate the results of the algorithm.

Due to the lack of provided training data that would be required for an imputation algorithm, this thesis uses a previously adopted clustering method. The contribution of this thesis is a method to determine which spatial, entropy, and time parameters cause the clustering algorithm to give the most accurate travel behavior results. This optimal set of parameters was determined using a comparison of two non-linear optimization methods: simulated annealing and a limited-memory Broyden-Fletcher-Goldfarb-Shanno Bound (L-BFGS-B) optimizer. Determining the optimal parameters in this way addresses the limitations that typically come with clustering algorithms. First, entropy and time parameters are used, not just spatial parameters. Second, this thesis explores the entropy and time parameters, thus providing further exploration of them. Third, the parameters are chosen simultaneously, not sequentially, when using non-linear optimization.

Ultimately, simulated annealing optimization found the best set of clustering parameters leading to 91% clustering algorithm accuracy whereas L-BFGS-B optimization found parameters that were only able to produce a maximum of 79% accuracy. Using the most optimal set of parameters in the clustering algorithm, an entire set of GPS data can be interpreted to determine an individual's daily travel behavior. This resulting individual travel behavior sets the groundwork to answer the question of how individual travel behavior can affect mental health.

Using the most optimal set of parameters in the clustering algorithm, an entire set of GPS data can be interpreted to determine an individual's daily travel behavior. This resulting individual travel behavior sets the groundwork to answer the question of how individual travel behavior can affect mental health.

Subject Areas: Global Positioning System data; Imputation; Non-linear optimization; Individual travel behavior; Mental health; Clustering algorithm; Simulated annealing

Availability: Riches, G.M. (2022). *Transforming GPS Points to Daily Activities Using Simultaneously Optimized DBSCAN-TE Parameters*. Master's Thesis, Brigham Young University, Provo, UT.
https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=10764&context=etd

7.67. Title: Personalizing the Dichotomy of Fixed and Flexible Activities in Everyday Life: Deriving Prism Anchors from GPS-Enabled Survey Data

Author(s): Zhang, Y., Li, C., Song, Y., Chai, Y., and Fan, Y.

Abstract: Space–time prism is a fundamental concept in time geography that can model an individual's accessibility to resources under space–time constraints. A prism anchor is often defined by work, school, or home activity with a fixed location and schedule. Trips and other activities are relatively flexible and scheduled between prism anchors. This fixity-flexibility dichotomy may not capture the increasing complexity of human mobility behaviors or variations among individuals. Recent developments in location-aware technologies allow us to collect person-level mobility data with detailed space–time paths and contextual information. This article develops methods to extract prism anchors from these GPS-based survey data and examines whether home, work, and school activities can always be used to define prism anchors for everyone. To illustrate our methods, we use data collected in Minnesota and Beijing as two study cases. Results in both study cases suggest that not everyone has home, work, or school anchors, and people with the same socio-demographic background tend to have similar anchor types. By deriving home, work, and school anchors, we can better understand how a person's everyday schedules are governed by home, work, and school and refine person-based accessibility measures.

Subject Areas: Time geography; Space–time prism anchor; Travel behavior; GPS-enable survey data

Availability: Zhang, Y., Li, C., Song, Y., Chai, Y., and Fan, Y. (2022). "Personalizing the Dichotomy of Fixed and Flexible Activities in Everyday Life: Deriving Prism Anchors from GPS-Enabled Survey Data." *Transportation*. https://doi.org/10.1007/s11116-022-10352-2

7.68. Title: Data Driven Approaches for Understanding and Improving Urban Mobility

Author(s): Guo, Y.

Abstract: With the adoption of advanced information technologies, the transportation system keeps innovating. It now offers more travel options, becomes smarter, but meanwhile gets more complicated and imposes more challenges to researchers and practitioners. For example, demand responsive public transit operates according to user demand instead of traditional timetable based and fixed route services, which brings a lot of convenience to users. These emerging services also reshape the way people travel. With the popularity of ride sharing services such as Uber and Lyft, people are more accessible to vehicle use without an ownership. Given the increasing popularity of emerging services, it is important to understand it and manage with the aid of the latest algorithms.

The objective of this study is to explore different advanced data-driven methodologies that can be applied to identify the transportation "pain spots" in a city (e.g., areas' lack of transportation infrastructure or services), understand emerging transportation systems, and improve its services and equity performance.

Subject Areas: Shared mobility; Travel behavior; Transportation equity; Demand forecasting; Data driven modeling

Availability: Guo, Y. (2022). *Data Driven Approaches for Understanding and Improving Urban Mobility*. Doctoral Dissertation, University of South Florida, Tampa, FL. https://www.proquest.com/openview/bb3539996a646d80bfd6610fd9269163/1?pq-origsite=gscholar&cbl=18750&diss=y

7.69. Title: Equity in User-Fee Systems: Accounting for Locational Differences in Travel Demand

Author(s): Zolnik, E.

Abstract: User fees are an alternative source of revenue to fuel taxes. Unfortunately, public perception of inequity in user-fee systems complicates program implementation. The need for new sources of revenue to fund transportation in the United States means empirical research to explore the equity of user-fee systems is important. One version of equity of import to the public is the fairness of a fee for users in rural locations where travel demand is greater than in urban locations. The potential difference in the fees rural users incur versus the fees urban users incur due to differences in travel demand is the focus of the study. Specifically, the study answers a call in the equity literature to use disaggregated data to explore how locational differences in travel demand could impact user-fee systems. Adoption of a multi-level approach nests vehicles within households to estimate the magnitude of the rural–urban difference in travel demand. Analysis of a user-fee program in the State of Oregon provides modest empirical evidence for locational differences in travel demand. In terms of vehicle kilometers of travel (VKT), the rural–urban difference is only +14.44 kilometers. Results from a subsequent series of price scenarios show how to adjust a user-fee system to account for the modest rural–urban difference in VKT. Overall, results from the study suggest public perceptions of rural–urban differences in travel demand are not entirely without merit. However, adjustment of programs to implement user-fee systems could help solve modest inequity problems due to rural–urban differences in travel demand.

Subject Areas: User-fee system; Equity; Travel demand; Fuel economy; Geographic location

Availability: Zolnik, E. (2022). "Equity in User-Fee Systems: Accounting for Locational Differences in Travel Demand." *Journal of Rural and Community Development*, *17*(4). https://journals.brandonu.ca/jrcd/article/view/2023

7.70. Title: Rethinking VMT: Factors Affecting Household VMT Focusing on Differences Between ICEVs and EVs

Author(s): Kwon, K.

Abstract: This study examines factors affecting household vehicle miles traveled (VMT) with a focus on the differences between electric vehicles (EVs) and conventional internal combustion engine vehicles (ICEVs). This study mainly utilizes detailed individual-level data from the 2017 National Household Travel Survey-California Add-on (2017 NHTS-CA). We first classify households into three groups such as 1) households with only ICEVs, 2) households with only EVs, and 3) households with both ICEVs and EVs. We then employ OLS regression models to analyze the determinants of household VMT across three groups. Second, we focus on households with both ICEVs and EVs to look at the substitute patterns between ICEVs and EVs. We employ the Seemingly Unrelated Regression (SUR) model to analyze total household VMT and its distribution among ICEVs and EVs. Some key findings are as follows. First, households with only EVs tend to have lower household VMT than others. Second, available EV charging stations near residential locations lead to longer household VMT in households with only EVs. Third, employment density has different effects on household VMT by groups. For instance, high employment density leads to shorter household VMT in households with only ICEVs and with both ICEVs and EVs. On the other hand, high employment density reveals a statistically positive effect on household VMT in households with only EVs. Lastly, in households with both ICEVs and EVs, the share of EV VMT is likely to increase in total household VMT if EVs are used more for work trips and shopping/family errands.

Subject Areas: Vehicle miles traveled; Electric Vehicles; Conventional Internal Combustion Engine Vehicles; Seemingly Unrelated Regression

Availability: Kwon, K. (2022). *Rethinking VMT: Factors Affecting Household VMT Focusing on Differences Between ICEVs and EVs*. Preprint Research Article, Research Square, Durham, NC. https://www.researchsquare.com/article/rs-2395159/v1

7.71. Title: Evaluation of Scoring Methods for Prioritizing Pedestrian and Bicycle Projects

Author(s): Korostina, D.

Abstract: To increase the number of pedestrian and bicycle facilities and to grow the number of people using those facilities in Kentucky more such projects need to be implemented. The Strategic Highway Investment Formula for Tomorrow (SHIFT) is a data-driven approach that Kentucky uses for prioritizing projects in the state, but its focus is auto-centric. The purpose of this study was to develop and evaluate a prioritization scoring approach for pedestrian and bicycle projects that could be implemented into SHIFT. The study used the SHIFT–2022 pedestrian and bicycle projects to develop and evaluate different scoring scenarios. After scoring each project on its proposed project type and existing facilities, a composite score was developed for both pedestrian and bicycle projects. The sensitivity analysis examined the impact of the proposed scoring scenarios on pedestrian and/or bicycle projects as well as all projects considered at the regional level. Each scoring scenario affected the boost points allocated to each project by the Metropolitan Planning Organization and District. The results showed that the scenario that reduced each boost by 5 points and allocating them to the pedestrian and bicycle projects retained all pedestrian and bicycle projects in any scenario of project selection percentage. This scenario also had the largest number of projects that ranked higher than in the existing method with the greatest average rank change.

Subject Areas: Pedestrian and bicycle projects; Strategic Highway Investment Formula for Tomorrow (SHIFT); Project prioritization

Availability: Korostina, D. (2022). *Evaluation of Scoring Methods for Prioritizing Pedestrian and Bicycle Projects*. Master's Thesis, University of Kentucky, Lexington, KY. https://uknowledge.uky.edu/ce_etds/129

Chapter 8. Traffic Safety

8.1. Title: We Live and Die by The Sun: Motor Vehicle Fatalities and Circadian Timing in The USA 2001 to 2018

Author(s): Soca, R., Mounts, C., Hediger, L., and York, C.

Abstract: Background: Motor vehicle accidents continue to be one of the leading causes of morbidity and mortality across the world. The distribution of accidents during the 24-hour period exhibits a known pattern which includes three well-defined peaks during day, with circadian factors exerting significant influence. Time zones standardize time for large geographic areas and create misalignment between the natural position of the sun, or "solar" time, and the time imposed by the time zone, or "social" time. The light/dark cycle that is created by the sun is the main zeitgeber of the circadian system and it is unknown if this affects the pattern of accidents that is observed in different areas of a given time zone (Easter portion vs Western portion).

Methods: We analyzed public data from the Fatality Analysis Reporting System from 2001 to 2018 to compare the pattern of accidents from Eastern portions of the time zone to those from the Western portions.

Results: The accident curves on both sides of the time zones were shifted, or out of phase, showing a shift of approximately 45 min between accident patterns.

Conclusion: This shift in patterns suggests that solar time, rather than clock time, is the most important factor in the pattern of accidents.

Subject Areas: Circadian; Motor vehicle fatalities; Solar time**;** Fatality Analysis Reporting System

Availability: Soca, R., Mounts, C., Hediger, L., and York, C. (2022). "We Live and Die by The Sun: Motor Vehicle Fatalities and Circadian Timing in The USA 2001 to 2018." *Sleep and Breathing*, *26*, pp. 2009–2013. https://doi.org/10.1007/s11325-021-02550-6

8.2. Title: Reducing Informational Asymmetry Impacts Choices and Improves Safety: An Evaluation of Automobile Crash Tests

Author(s): Sheehan-Connor, D.

Abstract: Vehicle crash tests mitigate an informational market failure and provide substantial benefits to consumers. Consumers cannot accurately assess vehicle safety leading automakers to provide it suboptimally. Crash tests performed by the Insurance Institute for Highway Safety represent an attempt to mitigate this market failure. This paper presents evidence that automakers responded by producing safer vehicles and that consumers increased purchases of highly rated vehicles. A novel identification strategy using the year of vehicle redesign is used to evaluate the tests' safety impact. A lower-bound estimate of program benefits is $3000 per vehicle resulting in an annual reduction of 1650 fatalities.

Subject Areas: Asymmetric information; Automobile crash tests; Automobile insurance; Impact evaluation

Availability: Sheehan-Connor, D. (2022). "Reducing Informational Asymmetry Impacts Choices and Improves Safety: An Evaluation of Automobile Crash Tests." *Journal of Risk and Insurance*, *89*(3), pp. 697–723. https://doi.org/10.1111/jori.12375

8.3. Title: A Literature Review of Wheelchair Transportation Safety Relevant to Automated Vehicles

Author(s): Klinich, K.D., Manary, M.A., Orton, N.R., Boyle, K.J., and Hu, J.

Abstract: This literature review summarizes wheelchair transportation safety, focusing on areas pertinent to designing automated vehicles (AVs) so they can accommodate people who remain seated in their wheelchairs for travel. In these situations, it is necessary to secure the wheelchair to the vehicle and provide occupant protection with a Wheelchair Tiedown and Occupant Restraint System (WTORS). For this population to use AVs, a WTORS must be crashworthy for use in smaller vehicles, able to be used independently, and adaptable for a wide range of wheelchair types. Currently available WTORS do not have these characteristics, but a universal docking interface geometry and prototype automatic seatbelt donning systems have been developed. In the absence of government regulations that address this situation, RESNA and ISO have developed voluntary industry standards to define design and performance criteria to achieve occupant protection levels for wheelchair-seated passengers that are similar to those provided by conventional vehicle seats.

Subject Areas: Wheelchair; Automated vehicles; Standards; Occupant restraint; Wheelchair tiedowns

Availability: Klinich, K.D., Manary, M.A., Orton, N.R., Boyle, K.J., and Hu, J. (2022). "A Literature Review of Wheelchair Transportation Safety Relevant to Automated Vehicles." *International Journal of Environmental Research and Public Health*, *19*(3). https://doi.org/10.3390/ijerph19031633

8.4. Title: Pedestrian Fatalities in Darkness: What Do We Know, and What Can Be Done?

Author(s): Sanders, R.L., Schneider, R.J., and Proulx, F.R.

Abstract: An alarming, consistent increase in U.S. pedestrian fatalities since 2009 culminated in a 28-year high of 6,283 pedestrians killed in 2018. Yet these numbers obscure a second alarming trend: 75 percent of pedestrian fatalities occur in darkness, and nearly 90 percent of the increase in pedestrian fatalities from 2009 to 2018 occurred in darkness.

This paper examines data on pedestrian fatalities at the national level and pedestrian fatalities and serious injuries in California from 2012 to 2017 to better understand correlates of severe pedestrian injuries in darkness. Binary and multinomial logit models reveal that variables related to roadway design and operations (e.g., speed limits, number of lanes, roadway type, and presence of traffic control)—but not speeding—are significantly associated with the likelihood of a pedestrian fatality or serious injury occurring in darkness as compared to daylight. Critically, these factors—which were consistent for fatalities regardless of lighting presence and roadway type, with few exceptions—are all worse in darkness because they are negatively affected by a lack of visibility. Alcohol usage by drivers or pedestrians and sociodemographic characteristics were also positively associated with severe injuries in darkness.

Our findings urge an explicit consideration of pedestrian safety in darkness in all future design and retrofit decisions, and particularly on higher-speed, multi-lane roadways. Immediate solutions include roadway designs and policies that slow drivers, particularly at night, and that increase illumination and driver attention, such as through additional roadway lighting, high-visibility countermeasures and protected crossings, and adaptive lighting and detection technology for vehicles.

Subject Areas: Pedestrian; Darkness; Fatalities; Serious injuries; Severe injuries; Fatality Analysis Reporting System (FARS)

Availability: Sanders, R.L., Schneider, R.J., and Proulx, F.R. (2022). “Pedestrian Fatalities in Darkness: What Do We Know, and What Can Be Done?” *Transport Policy*, *120*, pp. 23–39 https://doi.org/10.1016/j.tranpol.2022.02.010

8.5. Title: Who Is More Likely to Get into Car Death Accidents – Men or Women?

Author(s): Buckfire Law.

Abstract: Blog.

Subject Areas: Car accident; Fatality; Gender; Driving behavior; Age

Availability: Buckfire Law. (2022). "Who Is More Likely to Get into Car Death Accidents – Men or Women?" *LawandCrime.com*. https://lawandcrime.com/sponsored/who-is-more-likely-to-get-into-car-death-accidents-men-or-women/

8.6. Title: Guardrails on Priced Lanes: Protecting Equity While Promoting Efficiency

Author(s): Manville, M., Pierce, G., and Graveline, B.

Abstract: Can congestion pricing be implemented in a way that protects vulnerable residents of California? This report examines that question from two perspectives. First, we empirically estimate the size of the vulnerable population likely to be impacted if congestion pricing were introduced on California's urban freeways. Our estimates suggest that 13 percent of households, as a result of their low-incomes and current travel habits, might be unduly burdened by a freeway tolling program in California. Second, we consider ways to mitigate these burdens. In particular, we compare freeway use to use of other metered network infrastructure, like electricity grids or water systems. We suggest that assistance programs from these utilities provide a useful model for protecting low-income drivers from road prices, and further note that policymakers would be less constrained in progressively redistributing congestion toll revenue than they would be in redistributing utility revenue.

Subject Areas: Traffic; Transportation finance; Equity

Availability: Manville, M., Pierce, G., and Graveline, B. (2022). *Guardrails on Priced Lanes: Protecting Equity While Promoting Efficiency*. Final Report, Institute of Transportation Studies, University of California, Los Angeles, CA.
https://escholarship.org/content/qt2rj35891/qt2rj35891.pdf

8.7. Title: The Prevalence and Excess Mortality Risk of Driving with Children

Author(s): Dunn, R.A., Tefft, N.W., and Romano, E.

Abstract: Introduction: The presence of passengers can affect the driving behavior of motor-vehicle operators. Child passengers present unique motivations to drive more safely, as well as opportunities to distract drivers. Because motor-vehicle crashes are an important cause of premature childhood mortality, this study assesses whether adult drivers with child passengers are more or less likely to cause a fatal crash.

Method: Data include fatal crashes involving one or two vehicles from 2007 to 2017 in the U.S. Fatality Analysis Reporting System. We apply methods developed by Levitt and Porter (2001) and Dunn and Tefft (2020)—the LPDT approach—to estimate the risk that adult drivers (21 years or older) with at least one child passenger (15 year or younger) cause a fatal crash relative to adults without child passengers.

Results: Childhood crash exposure when traveling with an adult driver is low: 0.78 percent of vehicle miles traveled by adults included a child passenger. Nevertheless, adult drivers with child passengers were significantly more likely to cause a fatal crash than adult drivers without child passengers. The estimated risk of causing a single-vehicle crash was 6.2 times higher among the full sample of adults, 7.2 times higher among female drivers, and 5.0 times higher among drivers 25–44 years old.

Conclusions: Despite their relatively low crash exposure, child passengers are associated with much greater risk of causing a fatal crash. Practical Applications: This study not only informs about the need to develop interventions to remind parents and adult drivers of the risks associated with driving children, but also reminds researchers about the enormous potential of the LPDT approach when applied to traffic safety issues.

Subject Areas: Child passenger; LPDT approach; Crash risk; Protective and risk factors; Fatality Analysis Reporting System

Availability: Dunn, R.A., Tefft, N.W., and Romano, E. (2022). "The Prevalence and Excess Mortality Risk of Driving with Children." *Journal of Safety Research*, *82*, pp. 176–183. https://doi.org/10.1016/j.jsr.2022.05.009

8.8. Title: Safety Analysis for Micromobility: Recommendations on Risk Metrics and Data Collection

Author(s): Karpinski, E., Bayles, E., and Sanders, T.

Abstract: Existing measures of road safety were primarily designed to evaluate motor vehicle crashes. Consequently, they are not well-suited for alternate or emerging modes of micromobile transportation, particularly the e-scooter, whose popularity has surged without a corresponding body of research on their safety. Effective safety analysis depends on complete, high-quality data capable of accounting for the relevant mode-specific dangers. The established criteria for measuring consequences and hazard exposure in risk metrics used for motor vehicles do not apply. Most road safety data sources and schemas have a similar motor vehicle-centric bias. This framing presents challenges when it comes to selecting and interpreting data about alternate modes of transportation like micromobility. This paper discusses a basic theory of risk metric selection and the purpose of transportation safety measures. It applies these ideas to the emerging mode of micromobility transportation and recommends appropriate criteria and limitations for each component of a metric. This paper also evaluates existing data sources and schemas to provide examples of bias and estimate the relative size of each issue. These considerations may serve as useful guidelines for further research in the area and help inform the requirements of data collection necessary to better answer questions of safety.

Subject Areas: Multimodal analysis; Pedestrians; Bicycles; Human factors; Bicycle transportation; Safety; Sustainability and resilience; Transportation and society; Equity in transportation; Micromobility and active transportation

Availability: Karpinski, E., Bayles, E., and Sanders, T. (2022). "Safety Analysis for Micromobility: Recommendations on Risk Metrics and Data Collection." *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(12), pp. 420–435. https://doi.org/10.1177%2F03611981221095523

8.9. Title: Disparities in Activity and Traffic Fatalities by Race/Ethnicity

Author(s): Raifman, M.A. and Choma, E.F.

Abstract: Introduction: Traffic fatalities remain a major public health challenge despite progress made during recent decades. This study develops exposure-based estimates of fatalities per mile traveled for pedestrians, cyclists, and light-duty vehicle occupants and describes disparities by race/ethnicity, including a subanalysis of fatality rates during darkness and in urban areas.

Methods: Estimates of person-miles traveled by mode and race/ethnicity group were derived from the 2017 National Household Travel Survey using replicate weights. Three-year average (2016–2018) traffic fatalities were measured by mode and race/ethnicity group with the U.S. Fatality Analysis Reporting System. Fatality rates per mile traveled and CIs were calculated for each subgroup as well as separately for trips occurring during darkness and in urban areas. Analysis was conducted in 2021–2022.

Results: Exposure to traffic fatality differs by race/ethnicity group and by mode, indicating that adjustment for differential exposure is needed when estimating disparities. The authors find that fatality rates per 100 million miles traveled are systematically higher for Black and Hispanic Americans for all modes and notably higher for vulnerable modes (e.g., Black Americans died at more than 4 times the rate for White Americans while cycling, 33.71 [95% CI: 21.84, 73.83] compared with 7.53 [95% CI: 6.64, 8.69], and more than 2 times the rate while walking, 40.92 [95% CI: 36.58, 46.44] compared with 18.77 [95% CI: 17.30, 20.51]). Previous estimates that do not adjust for differential exposure may underestimate disparities by race/ethnicity. Observed disparities remained when considering only urban areas and appear to be exacerbated during darkness.

Conclusions: Traffic fatalities are a substantial and preventable public health challenge in America. Black and Hispanic Americans have higher traffic fatality rates per mile traveled than White Americans across the transportation system, requiring urgent attention.

Subject Areas: Fatality rate; Race and ethnicity; Darkness; Urban area; Fatality Analysis Reporting System

Availability: Raifman, M.A. and Choma, E.F. (2022). "Disparities in Activity and Traffic Fatalities by Race/Ethnicity." *American Journal of Preventive Medicine*, *63*(2), pp. 160–167. https://doi.org/10.1016/j.amepre.2022.03.012

8.10. Title: Study: Black Cyclists Die 4.5x More Often Than White Cyclists

Author(s): Wilson, K.

Abstract: Blog.

Subject Areas: Cyclists and pedestrians; Fatality; Traffic violence disparities; Race and ethnicity

Availability: Wilson, K. (2022). "Study: Black Cyclists Die 4.5x More Often Than White Cyclists." *Streetblog USA*. https://usa.streetsblog.org/2022/06/14/study-black-cyclists-die-4-5x-more-often-than-white-riders/

8.11. Title: Data-Driven Operational and Safety Analysis of Emerging Shared Electric Scooter Systems

Author(s): Ma, Q.

Abstract: The rapid rise of shared electric scooter (e-scooter) systems offers many urban areas a new micro-mobility solution. The portable and flexible characteristics have made e-scooters a competitive mode for short-distance trips. Compared to other modes such as bikes, e-scooters allow riders to freely ride on different facilities such as streets, sidewalks, and bike lanes. However, sharing lanes with vehicles and other users tends to cause safety issues for riding e-scooters. Conventional methods are often not applicable for analyzing such safety issues because well-archived historical crash records are not commonly available for emerging e-scooters.

Perceiving the growth of such a micro-mobility mode, this study aimed to investigate e-scooter operations and safety by collecting, processing, and mining various unconventional data sources. First, origin–destination (OD) data were collected for e-scooters to analyze how e-scooters have been used in urban areas. The key factors that drive users to choose e-scooters over other options (i.e., shared bikes and taxis) were identified. Concerning user safety tied to the growing usage, we further assessed e-scooter user guidelines in urban areas in the U.S. Scoring models have been developed for evaluating the adopted guidelines. It was found that the areas with e-scooter systems have notable disparities in terms of the safety factors considered in the guidelines. Built upon the usage and policy analyses, this study also creatively collected news reports as an alternative data source for e-scooter safety analysis. Three-year news reports were collected for e-scooter-involved crashes in the U.S. The identified reports are typical crash events with great media impact. Many detailed variables such as location, time, riders' information, and crash type were mined. This offers a lens to highlight the macro-level crash issues confronted with e-scooters. Besides the macro-level safety analysis, we also conducted micro-level analysis of e-scooter riding risk. An all-in-one mobile sensing system has been developed using the Raspberry Pi platform with multiple sensors including GPS, LiDAR, and motion trackers. Naturalistic riding data such as vibration, speed, and location were collected simultaneously when riding e-scooters. Such mobile sensing technologies have been shown as an innovative way to help gather valuable data for quantifying riding risk. A demonstration on expanding the mobile sensing technologies was conducted to analyze the impact of wheel size and riding infrastructure on e-scooter riding experience. The quantitative analysis framework proposed in this study can be further extended for evaluating the quality of road infrastructure, which will be helpful for understanding the readiness of infrastructure for supporting the safe use of micro-mobility systems.

To sum up, this study contributes to the literature in several distinct ways. First, it has developed mode choice models for revealing the use of e-scooters among other existing competitive modes for connecting urban metro systems. Second, it has systematically assessed existing e-scooter user guidelines in the U.S. Moreover, it demonstrated the use of surrogate data sources (e.g., news reports) to assist safety studies in cases where there is no available crash data. Last but not least, it developed the mobile sensing system and evaluation framework for enabling naturalistic riding data collection and risk assessment, which helps evaluate riding behavior and infrastructure performance for supporting micro-mobility systems.

Subject Areas: Mobile sensing system; Evaluation framework; Riding behavior; Infrastructure performance; Micro-mobility systems

Availability: Ma, Q. (2022). *Data-Driven Operational and Safety Analysis of Emerging Shared Electric Scooter Systems*. Doctoral Dissertation, Old Dominion University, Norfolk, VA. https://digitalcommons.odu.edu/msve_etds/65/

8.12. Title: Pedestrian, Bicycle Safety Tips to Protect Kids Heading Back to School

Author(s): Wessel, J.

Abstract: Blog.

Subject Areas: Cyclists and pedestrians; Safety; Back to school

Availability: Wessel, J. (2022). "Pedestrian, Bicycle Safety Tips to Protect Kids Heading Back to School." *Arkansas Center for Health Improvement*. https://achi.net/newsroom/pedestrian-bicycle-safety-tips-to-protect-kids-heading-back-to-school/

8.13. Title: Estimated Contribution of Peak-Hours Non-Commercial Vehicle Traffic to Fatality Rates

Author(s): Tucker, A.

Abstract: This Traffic Safety Facts Research Note explores the relationship between the decline in vehicle miles traveled (VMT) associated with the COVID-19 pandemic and the increased fatality rate observed for 2020. It hypothesizes that the fatality rate relative to previous years is due in part to a decrease in peak-hours (i.e., 6–9 a.m., 3–6 p.m.) non-commercial vehicle traffic—that is, a decrease in commuting. To draw comparisons with 2020 the author use the most recent National Household Travel Survey, Fatality Analysis Reporting System, and FHWA VMT data to estimate separate peak and non-peak, non-commercial vehicle fatality rates for 2017. The estimated peak-hours non-commercial vehicle fatality rate for 2017 was .5 per 100m VMT, while the non-peak hours non-commercial fatality rate was 1.27 per 100m VMT. Excluding peak-hours non-commercial vehicle traffic, 2017 had an overall fatality rate of 1.48 per 100m VMT. The fatality rate for 2020 was 1.34 per 100m VMT. The author therefore concluded that decreased peak-hours non-commercial vehicle traffic associated with the COVID-19 pandemic, stay-at-home orders, and increases in remote working contributed to 2020's increased fatality rate relative to previous years.

Subject Areas: Traffic safety; Vehicle miles traveled; Fatality rate; Peak-hours; COVID-19

Availability: Tucker, A. (2022). *Estimated Contribution of Peak-Hours Non-Commercial Vehicle Traffic to Fatality Rates*. Traffic Safety Notes, Office of Behavioral Safety Research, National Highway Traffic Safety Administration, Washington, D.C. https://rosap.ntl.bts.gov/view/dot/63105

8.14. Title: Existence of the Safety-in-Numbers Effect in the Aspect of Injury Severity: A Macroscopic Analysis for Bicyclists and Pedestrians

Author(s): Lian, Y., Zhou, E., Lee, J., and Abdel-Aty, M.

Abstract: *Objective:* Several studies have confirmed the existence of a safety-in-numbers effect in relation to vulnerable road users. The safety-in-numbers effect refers to a phenomenon wherein the number of bicyclists/pedestrians on a road is higher, and consequently, the risk of each bicyclist/pedestrian being involved in a crash is lower. Nevertheless, the existence of the safety-in-numbers effect in the aspect of injury severity in traffic crashes has not yet been investigated. Thus, this study aimed to explore whether traffic injuries are more (less) severe with fewer (more) pedestrians/bicyclists at the county level.

Method: Using two fractional split multinomial logit models, the relationships between the number of bicyclists/pedestrians and the proportion of crashes involving bicyclists/pedestrians based on crash severity were investigated at the county level using crash data from Florida. In other words, we explored whether differing numbers of bicyclists/pedestrians could change the distribution of traffic injury severity levels.

Results: The modeling results clearly revealed a lower proportion of severe injuries caused to bicyclists/pedestrians at a higher level of daily bicycle/pedestrian flows, indicating existence of the safety-in-numbers effect. Several variables (e.g., the percentage of people aged 65 years and older, the percentage of commuters using public transportation, and the proportion of recreational land use) were found to have a significant effect on the distribution of traffic injury severity among bicyclists/pedestrians.

Conclusion: This study proves that a safety-in-numbers effect exists in the aspect of injury severity among bicyclists and pedestrians.

Practical applications: These findings are expected to provide recommendations for promoting the use of active transportation, which will improve the safety of vulnerable road users in the future.

Subject Areas: Safety-in-numbers; Injury severity; Bicyclists; Pedestrians; Fractional split multinomial logit model

Availability: Lian, Y., Zhou, E., Lee, J., and Abdel-Aty, M. (2022). "Existence of the Safety-in-Numbers Effect in the Aspect of Injury Severity: A Macroscopic Analysis for Bicyclists and Pedestrians." *Journal of Safety Research*, *83*, pp. 302–309. https://doi.org/10.1016/j.jsr.2022.09.004

8.15. Title: Investigating Safety in Numbers in Cycling After the Entry of Dock-Based Bikeshare Programs in Three U.S. Cities

Author(s): Dong, X., Hamidi, S., and Dumbaugh, E.

Abstract: This paper investigates the safety in numbers effect in cycling by comparing monthly bicycle crash trends before and after public bikeshare's launch in Philadelphia and Pittsburgh, PA, from 2010 to 2019, and in Portland, OR, from 2014 to 2019. To estimate the bicycle crash trend in each city, the authors conduct time series analysis with a regression discontinuity design using generalized linear quasi-Poisson models. The entries of dock-based public bikeshare programs signal an increase in biking activity on the road and serve as the point of discontinuity in the analysis. For each city, the analysis models pre- and post-bikeshare bicycle crash trends inside and outside bikeshare program's service area separately to compare crash trends at different biking activity levels within the same local context. Results show that before bikeshare, crash trends inside and outside service areas had similar patterns in Philadelphia and Portland while moving in opposite directions in Pittsburgh. The post-bikeshare crash trends differed across cities for both inside and outside of the service areas. The finding that bicycle crash trends changed in different patterns across the three cities indicates that there may be no single safety in numbers effect on bicycle crashes. The inconsistent patterns of bicycle crash trends within and across cities suggest confounding factors underlying the change in bicycle crashes.

Subject Areas: Traffic safety; Bicycle crash trend; Public bikeshare

Availability: Dong, X., Hamidi, S., and Dumbaugh, E. (2022). "Investigating Safety in Numbers in Cycling After the Entry of Dock-Based Bikeshare Programs in Three U.S. Cities." *Transportation Research Record: Journal of the Transportation Research Board*.
https://doi.org/10.1177/03611981221123803

8.16. Title: Light Where It Matters: IIHS Headlight Ratings Are Correlated with Nighttime Crash Rates

Author(s): Brumbelow, M.L.

Abstract: Introduction: Vehicle headlights are the primary means of providing visibility illumination for drivers at night, when crash rates are several times higher than during the day. Based on research indicating a wide range of headlight performance in the passenger vehicle fleet and the absence of a comprehensive and objective consumer evaluation program, the Insurance Institute for Highway Safety (IIHS) began testing and rating headlight systems in 2015. The purpose of this study was to examine the relationship between headlight visibility, as quantified by IIHS, and real-world crash occurrence.

Methods: Poisson regression was used to estimate the effects of the headlight rating and the underlying demerits on the rate of police-reported nighttime single-vehicle crashes per vehicle mile traveled.

Results: Results indicate that vehicles with better headlight visibility have lower nighttime crash rates after controlling for differences in daytime rates and other factors. A reduction of 10 visibility demerits, the equivalent of one overall rating band, was estimated to reduce the nighttime crash rate by 4.6% (95% CI: 2.1%–7.0%). While statistical significance was limited by small sample sizes, good-rated headlights were estimated to reduce crash rates by 12–29% relative to those with poor ratings for the different types of single-vehicle crashes studied. Among different components of the IIHS rating, the assessments of low and high beam curve visibility were associated with the greatest crash rate reductions.

Conclusions: This study demonstrates that the IIHS evaluation program encourages headlight designs that reduce the risk of nighttime single-vehicle crashes.

Practical applications: Headlight systems have a meaningful effect on nighttime crash rates. Drivers can reduce their crash risk by selecting a vehicle with one of the best designs.

Subject Areas: Headlights; Nighttime driving; Single-vehicle crashes; Consumer information

Availability: Brumbelow, M.L. (2022). "Light Where It Matters: IIHS Headlight Ratings Are Correlated with Nighttime Crash Rates." *Journal of Safety Research*, *83*, pp. 379–387. https://doi.org/10.1016/j.jsr.2022.09.013

8.17. Title: Comparison of Motor-Vehicle Involved E-Scooter Fatalities with Other Traffic Fatalities

Author(s): Karpinski, E., Bayles, E., Daigle, L., and Mantine, D.

Abstract: Introduction: Shared e-scooters are an emerging mode of transportation with many features that make their physical properties, behavior, and travel patterns unique. Safety concerns have been raised concerning their usage, but it is difficult to understand effective interventions with so little data available.

Methods: Using media and police reports, a crash dataset was developed of rented dockless e-scooter fatalities in crashes involving motor vehicles that occurred in the United States in 2018–2019 (n = 17) and the corresponding records from the National Highway Traffic Safety Administration data were identified. The dataset was used to perform a comparative analysis with other traffic fatalities during the same time period.

Results: Compared to fatalities from other modes of transportation, e-scooter fatality victims are younger and more likely male. More e-scooter fatalities occur at night than any other mode, except pedestrians. E-scooter users are comparatively as likely as other unmotorized vulnerable road users to be killed in a hit-and-run crash. While e-scooter fatalities had the highest proportion of alcohol involvement of any mode, this was not significantly higher than the rate seen in pedestrian and motorcyclist fatalities. E-scooter fatalities were more likely than pedestrian fatalities to be intersection-related, and to involve crosswalks or traffic signals.

Conclusions: E-scooter users share a mix of the same vulnerabilities as both pedestrians and cyclists. Although e-scooter fatalities are demographically most similar to motorcycle fatalities, crash circumstances share more similarities with pedestrian or cyclist fatalities. Other characteristics of e-scooter fatalities are notably distinct from other modes.

Practical Applications*:* E-scooter use must be understood by users and policymakers to be a distinct mode of transportation. This research highlights the similarities and differences between similar modes, like walking and cycling. By using this information on comparative risk, e-scooter riders and policymakers can take strategic action to minimize the number of fatal crashes.

Subject Areas: E-scooters; Micromobility; Transportation fatalities; Transportation safety

Availability: Karpinski, E., Bayles, E., Daigle, L., and Mantine, D. (2022). "Comparison of Motor-Vehicle Involved E-Scooter Fatalities with Other Traffic Fatalities." *Journal of Safety Research*. https://doi.org/10.1016/j.jsr.2022.10.008

8.18. Title: City-Oriented and Inclusive Bicycle-Vehicle Crash Frequency Modeling Through the Integration of Bicycle-Sharing System and Other Surrogates

Author(s): Kalambay, P. and Pulugurtha, S.S.

Abstract: This research explores a city-oriented and inclusive bicycle-vehicle crash frequency model through the integration of bicycle-sharing system and other surrogates pertaining to the built environment like road network, land use developments, and socio-demographic characteristics. Bicycle-vehicle crash data from 2016 to 2019, along with the road network, land use, and socio-demographic characteristics within a 1-mile radius of 62 randomly selected Capital Bikeshare (CaBi) stations (referred to as stations), was used to estimate and validate bicycle-vehicle crash frequency models (negative binomial regression models with log-link distribution) and assess the role of explanatory variables. The selected stations are geographically and fairly distributed in low-risk, moderate-risk, high-risk, and very high-risk areas while covering 99.8% of the total number of recorded bicycle-vehicle crashes. From such an inclusive approach, it was observed that bicyclists are more likely to be involved in crashes in commercial, mixed-use, and densely populated areas. In addition, they are more often involved in crashes in areas with more six-lane roads. Also, many bicycle-vehicle crashes have occurred at intersections. The nonexistence of bicycle crossings could explain this finding. The findings are substantial, and characteristics related to the built environment like road network (including vehicle and bicycle infrastructure), land use developments, and socio-demographics are good surrogates for traffic volume and bicycle count.

Subject Areas: Bicycle-sharing; Bicycle-vehicle crash; Crash frequency; Infrastructure; Bicycle lane; Capital Bikeshare

Availability: Kalambay, P. and Pulugurtha, S.S. (2022). "City-Oriented and Inclusive Bicycle-Vehicle Crash Frequency Modeling Through the Integration of Bicycle-Sharing System and Other Surrogates." *Transportation Research Interdisciplinary Perspectives*, *16*. https://doi.org/10.1016/j.trip.2022.100714

8.19. Title: A New Racial Disparity in Traffic Fatalities

Author(s): Chalfin, A. and Massenkoff, M.

Abstract: In 2015, for the first time in nearly forty years, the rate of motor vehicle fatalities for Black Americans exceeded that of white Americans. By 2020, the gap in death rates stood at 34%, accounting for approximately 4,000 excess deaths between 2014 and 2020. This disproportionate increase occurred in nearly all states, in rural as well as urban areas, and was shared by drivers of all ages and genders. We consider a variety of potential explanations for the emerging race gap including race-specific changes in time spent driving, the circumstances of driving, the quality of medical care for crash victims, decreases in other types of mortality, changes in policing, and risky driving behaviors such as speeding, driving without a seat belt and driving while intoxicated. We can rule out many of these factors as important contributors to the race gap, but find evidence for two of them. The first is opportunity: Relative to white Americans, Black Americans are spending more time in vehicles than they have in the past. Changes in time spent driving, while modest, likely explain an important share of the emergent race gap. The second is a relative increase in drug use, manifested by a quadrupling of the rate of overdose deaths among Black Americans after 2014. Increased drug use appears to have resulted in a concomitant increase in fatal crashes involving drivers under the influence of drugs. Finally, we consider whether the emerging race gap is explained by the so-called "Ferguson effect," the idea that police officers have pulled back from enforcement activity in recent years. On the one hand, traffic stops made by police officers do appear to have declined after 2014. However, the decline in traffic stops does not appear to be race-specific and there is little evidence of a broad increase in risky driving behaviors like speeding and driving without a seat belt.

Subject Areas: Racial disparity; Traffic fatalities; Driving behaviors

Availability: Chalfin, A. and Massenkoff, M. (2022). *A New Racial Disparity in Traffic Fatalities*. NBER Working Paper, No. w30636, SSRN, Rochester, NY. https://ssrn.com/abstract=4276098

8.20. Title: Risk Assessment and Mitigation of E-Scooter Crashes with Naturalistic Driving Data

Author(s): Prabu, A., Zhang, Z., Tian, R., Chien, S., Li, L., Chen, Y., and Sherony, R.

Abstract: Recently, e-scooter-involved crashes have increased significantly but little information is available about the behaviors of on-road e-scooter riders. Most existing e-scooter crash research was based on retrospectively descriptive media reports, emergency room patient records, and crash reports. This paper presents a naturalistic driving study with a focus on e-scooter and vehicle encounters. The goal is to quantitatively measure the behaviors of e-scooter riders in different encounters to help facilitate crash scenario modeling, baseline behavior modeling, and the potential future development of in-vehicle mitigation algorithms. The data was collected using an instrumented vehicle and an e-scooter rider wearable system, respectively. A three-step data analysis process is developed. First, semi-automatic data labeling extracts e-scooter rider images and non-rider human images in similar environments to train an e-scooter-rider classifier. Then, a multi-step scene reconstruction pipeline generates vehicle and e-scooter trajectories in all encounters. The final step is to model e-scooter rider behaviors and e-scooter-vehicle encounter scenarios. A total of 500 vehicle to e-scooter interactions are analyzed. The variables pertaining to the same are also discussed in this paper.

Subject Areas: E-Scooter crashes; Naturalistic driving study; Scenario modeling; Baseline behavior modeling; In-vehicle mitigation algorithms

Availability: Prabu, A., Zhang, Z., Tian, R., Chien, S., Li, L., Chen, Y., and Sherony, R. (2022). *Risk Assessment and Mitigation of E-Scooter Crashes with Naturalistic Driving Data*. arXiv preprint, arXiv:2212.12660 [eess.SY]. https://doi.org/10.48550/arXiv.2212.12660

Chapter 9. Transit Planning

9.1. Title: Investigating Travel Behavior in Transit-Oriented Development: Toward Sustainable and Multimodal Mobility

Author(s): Choi, Y.

Abstract: An extensive literature has shown that transit-oriented development residents (TOD) have lower automobile use and diverse travel modes due to easy access to transit, better walkability, and proximity to various amenities. While such benefits of TOD are generally expected, the degree to which TODs influence travel behavior is still debatable. Besides, TOD implementation differs by context, and not all transit areas are developed along TOD principles. This variation in transit areas leads to different impacts on transportation outcomes. Although different TOD typologies have been developed in past studies, they are limited to a particular city or region. The other ongoing debate in land use and travel behavior field is the emergence of new mobility services that enable users to utilize a mode of transport on an as-needed basis. Recent advances in information technologies have facilitated new mobility services that meet travelers' diverse needs, such as transportation network companies (TNCs), ridesharing, car sharing, bike sharing, microtransit, and shared autonomous vehicles. While new mobility services are expected to play an important role—either positive or negative—in planning how TODs can be implemented, the impacts and consequences of such services on traditional modes of transport such as public transit are still not well understood. In doing so, this dissertation investigates different modes of transportation in TOD areas by posing the following research questions: (1) do people walk more in transit-oriented developments? (2) are residents more multimodal in transit-oriented developments? and (3) what is the potential impact of new mobility services on public transit demand? For the first question, this dissertation addresses the effect of rail transit access on walking behavior in TOD areas. TODs are compared to other similar areas without rail transit access to determine whether people are more likely to walk in TODs for purposes other than transit use in Atlanta. The second question is addressed by identifying different TOD types on their impacts on residents' multimodal behavior to capture various conditions of existing TODs and their heterogeneous outcomes. This research identifies different types of 4,400 transit areas—a half-mile buffer area from rail station—in the U.S. and develops several analytic models to explain the multimodal traveler behavior in the 2017 NHTS. The third question examines the potential impacts of TNCs on transit demand in Chicago, with a particular focus on understanding heterogeneity in the effects by employing fixed effects panel regression models. By investigating various travel behavior around transit station areas, this dissertation provides insights on how TODs can be better implemented to promote sustainable and multimodal travel behavior.

Subject Areas: Transit oriented development; New mobility services; Multimodal travel behavior; Transit station areas

Availability: Choi, Y. (2021). *Investigating Travel Behavior in Transit-Oriented Development: Toward Sustainable and Multimodal Mobility*. Doctoral Dissertation, Georgia Institute of Technology, Atlanta, GA. https://smartech.gatech.edu/handle/1853/66155

9.2. Title: Examining the Association between Bus Transit Reliability and Ridership

Author(s): Jayanthi, S.L.

Abstract: The road infrastructure has not been developed at the rate of growing travel demand in many cities in the United States, mainly due to space and resource constraints. Practitioners are exploring means to increase public transportation ridership with economically efficient investment plans to cater the travel demand, reduce congestion, and contribute to sustainability. Despite these ongoing efforts, recent statistics indicate that public transportation ridership has decreased in many cities in the United States, and bus ridership alone fell by 5% in 2017 compared to the previous year. There is a need to research and identify factors that encourage the use of public transportation systems over other modes of transportation.

The research explaining the relationship between bus transit reliability and ridership is limited. The reliability of a bus transit system by bus stop type, time of the day, day of the week, and direction of travel may influence the ridership. In other words, it is not clear how bus transit reliability influences the ridership temporally and spatially at a bus stop level. Therefore, this research aims to examine the association between bus transit reliability and ridership from a bus user perspective at a bus stop level. The objectives of this research are: (1) to identify and better understand the bus transit reliability performance measure, (2) to analyze the relationship between bus transit reliability and ridership, by considering the time of the day, day of the week, and direction of travel, and (3) to research the effect of bus stop type (for example, transit center, bus stop near a light rail transit [LRT] station, transit centers near LRT etc.,) on bus transit reliability and ridership relationships.

Subject Areas: Transit Economic Equity Index; Non-peak- and peak-hour service; Accessibility

Availability: Jayanthi, S.L. (2021). *Examining the Association between Bus Transit Reliability and Ridership*. Master's Thesis, The University of North Carolina at Charlotte, Charlotte, NC. https://www.proquest.com/openview/0be0bf20f294918e9091ba449b0947ad/1?pq-origsite=gscholar&cbl=18750&diss=y

9.3. Title: The Effects of Covid-19 on Los Angeles Metro Bus Ridership

Author(s): Gleason, Q.

Abstract: In California, removing cars from the road by expanding transit ridership is lauded as a large part of climate change action. Buses and trains are the most efficient ways to move people and are a necessary element for mitigating traffic congestion. In addition, because the transit-dependent are overwhelmingly low-income, communities of color, a safe, reliable public transportation system is a social justice issue. In Los Angeles County, bus ridership was already declining before COVID-19. This research hopes to fill the gap on what ridership was lost due to the pandemic and how that loss varies spatially. Using station/stop-level Los Angeles County Metro bus ridership data aggregated into census block groups as the dependent variable, a Spatial Lag Regression and a Getis-Ord were performed. Built environment as well as demographic data was used to evaluate ridership between 2019 and 2020, considered pre and during pandemic. The results indicate that, in addition to land use diversity, percentage of persons of color, median household income, and median age, COVID-19 had a huge impact on Metro bus ridership. While most recent public transit expansion has focused on rail, bus and bus rapid transit would be a better avenue for creating an equitable transportation system for the riders that abandoned busses in much smaller numbers than their higher income, whiter counterparts. In the hot spot areas of Gateway Cities, Southbay, and Westside Central that generates 34.38 percent of ridership, the level of service was only 27.95 percent of total service studied. Boosting service to match ridership in those areas would serve Los Angeles County's most loyal and/or captive riders of public transportation. As the residents of these hot spots also match the profile of the essential worker, serving these residents would help to make Los Angeles more resilient in the next public health emergency.

Subject Areas: COVID-19; Transit ridership; Ridership decline; Los Angeles County; Rider demographics; E transportation system

Availability: Gleason, Q. (2021). *The Effects of Covid-19 on Los Angeles Metro Bus Ridership.* Master's Thesis, California State Polytechnic University, Pomona, CA. https://scholarworks.calstate.edu/downloads/jq085r35m

9.4. Title: What the Heck is a Choice Rider? A Theoretical Framework and Empirical Model

Author(s): Guerra, E.

Abstract: As local, state, and federal agencies began investing substantial resources into subsidizing transit in the 1960s and '70s, public documents argued that transit agencies should focus on attracting choice riders instead of dependent riders, who have no alternatives and use transit regardless of service quality. After six decades, the definitions, uses, and implications of the terms choice and dependent rider have remained consistent in the academic and professional literature. These definitions, however, lack a strong theoretical grounding or empirical evidence to support them. Using travel diary data from the Philadelphia region, I estimate discrete choice models to identify choice riders, who I define as those who have close to a 50 percent probability of choosing between a car or transit for a given trip. The Philadelphia region, which has a diverse range of transit users and transit services, is an ideal place to develop and fit an empirical model of choice ridership. Attributes assumed to be associated with dependent riders, such as lack of a car, low income, and being a racial or ethnic minority, are much more prevalent among choice riders than the general metropolitan population. Choice riders are also diverse, with a mix of racial backgrounds, income levels, educational attainment, and access to private cars. Transit dependency, by contrast, is rare. The lowest and highest income residents generally only choose transit when service quality is high, and transit is cost and time competitive with the car.

Subject Areas: Choice ridership; Transit; Dependency; Captivity; Mode choice

Availability: Guerra, E. (2022). "What the Heck is a Choice Rider? A Theoretical Framework and Empirical Model." *Journal of Transport and Land Use*, *15*(1), pp. 165–182. https://doi.org/10.5198/jtlu.2022.2096

9.5. Title: If Rush Hour Dies, Does Mass Transit Die with it?

Author(s): Grabar, H.

Abstract: Blog.

Subject Areas: Transit; Rush hour; Peak commuters

Availability: Grabar, H. (2021). "If Rush Hour Dies, Does Mass Transit Die with it?" *Slate*. https://slate.com/business/2021/02/mass-transit-subways-after-pandemic.html

9.6. Title: Achieving Access Equity: Undoing De Facto Discrimination in Public Transit

Author(s): Piccinini, G.

Abstract: This comment outlines a creative approach to addressing the problem of access inequity. Access inequity describes de facto discrimination in public access to travel and arises out of transit related access disparities to otherwise available social, economic, and educational opportunities. Access inequity thusly construed focuses on a person's access to opportunity both at a time and over time, impacting people not only individually, but also generationally. Such access disparities manifest in transit most often on public roadways, where private automobile transit is preferred over public transit. Because roadway transit dominates transit infrastructure, reliance on private transit as a policy choice inequitably excludes most non-driving commuters and unsustainably increases traffic density. The need to travel by car to travel in most areas lends to the ubiquity of the problem, and without adequate transit alternatives, access inequity continues.

This comment begins by providing background on the problem and setting the stage as to why New Jersey's public transit is ripe for reconsideration, focusing first on the powers unique to local governments in New Jersey, and second on the historical development of transit infrastructure in New Jersey. Section III addresses the problem's theoretical and historical antecedents to illustrate how access inequity offends the constitutionally protected freedom of movement and right to travel and stems from the effects of de jure discrimination in housing. Section IV examines the problem of access inequity on the roadways, and Section V proposes a long-term solution to the problem presented. The comment then concludes by noting the moral imperative behind vindicating the fundamental freedom of movement and right to travel to ensure equitable access to both travel as well as opportunity for all.

Subject Areas: Transit; Access inequity; Transit infrastructure; New Jersey

Availability: Piccinini, G. (2022). "Achieving Access Equity: Undoing De Facto Discrimination in Public Transit." *Seton Hall Legislative Journal*, *46*(1). https://scholarship.shu.edu/shlj/vol46/iss1/6

9.7. Title: A Structural Analysis of The Work Tour Behavior of Transit Commuters

Author(s): Rafiq, R. and McNally, M.G.

Abstract: Our knowledge of complex travel behavior associated with transit commuting is limited. While chaining activities into tours has been a frequent behavior of travelers in general, and in some cases of work commuters, it is unclear how successful public transit has been in providing the accessibility that is needed to link multiple activities, especially on work tours. To address this knowledge gap, a structural model was developed for transit commuters, which allows for the characterization of commuters based on the complexity of work tours and an assessment of the influence of household and person-level socio-demographic characteristics, built environment variables, and activity-travel demand on tour complexity. Using data from the 2017 National Household Travel Survey, this study's results suggested that married men with no children and high vehicle ownership living in low-density areas tend to make simple work tours while single women with children who live in high-density neighborhoods were more likely to make complex work tours. Also, white men with higher incomes and higher education living in denser areas were more likely to make complex tours with work-based sub-tours. Denser residential neighborhoods, flexible work schedules, and vehicle availability on work tours were observed to increase the propensity of making complex tours. The findings of this study can assist transit agencies or planning organizations in identifying transit commuters who have complex travel needs or whose circumstances hold potential to yield greater benefits from transit usage in work tours and thus to formulate policies directed at better work and non-work travel and activity linkages.

Subject Areas: Work trip; Complex tours; Trip chaining; Public transit; Commuters; Structural equation modeling; National Household Travel Survey

Availability: Rafiq, R. and McNally, M.G. (2022). "A Structural Analysis of The Work Tour Behavior of Transit Commuters." *Transportation Research Part A: Policy and Practice*, *160*, pp. 61–79. https://doi.org/10.1016/j.tra.2022.04.003

9.8. Title: Investigating the Relationship Between Access to Intercity Bus Transportation and Equity

Author(s): Javid, R. and Sadeghvaziri, E.

Abstract: Intercity bus transportation provides essential public transit service, mainly to long-distance passengers and residents of rural areas. Although the intercity bus system can be beneficial to increase equity by providing such services to low-income people from remote rural areas, it suffers from a problem. The problem is that the socio-demographic characteristics of those disadvantaged individuals are still not crystal clear. This study aims to examine the relationship between access to intercity bus transportation and the socio-demographic characteristics of the region. This study addresses these problems through data integration and multiple regression analysis using a combination of socio-demographic variables across the U.S. The results showed that changes in the percentages of households with zero vehicles and households with an income of less than $50,000 are significantly associated with changes in the access to intercity bus transportation, and different levels of income affect access to intercity bus transportation. Among the significant variables in the model, the number of intercity bus stops can be controlled by policymakers to optimize access to intercity bus transportation. The findings demonstrate the importance of public transit for low-income households and imply that increasing bus access could help shift the spatial distribution of poverty and create more equal and inclusive communities.

Subject Areas: Policy and organization; Executive management issues; Economics; Revenue; Finance; Transportation equity; Public transportation; Intercity bus

Availability: Javid, R. and Sadeghvaziri, E. (2022). "Investigating the Relationship Between Access to Intercity Bus Transportation and Equity." *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(9), pp. 711–719.
https://doi.org/10.1177%2F03611981221088218

9.9. Title: Accuracy and Uncertainty in Traffic and Transit Ridership Forecasts

Author(s): Hoque, J. M.

Abstract: Investments of public dollars on highway and transit infrastructure are influenced by the anticipated demands for highways and public transportations or traffic and transit ridership forecasts. The purpose of this study is to understand the accuracy of road traffic forecasts and transit ridership forecasts, to identify the factors that affect their accuracy, and to develop a method to estimate the uncertainty inherent in those forecasts. In addition, this research investigates the pre-pandemic decline in transit ridership across the U.S. metro areas since 2012 and its influence on the accuracy of transit forecasts.

The sample of 1,291 road projects from the United States and Europe compiled for this research shows that measured traffic is on average 6 percent lower than forecast volumes, with a mean absolute deviation of 17 percent from the forecast. Higher volume roads, higher functional classes, shorter time spans, and the use of travel models all improved accuracy. Unemployment rates also affected accuracy—traffic would be 1 percent greater than forecast on average, rather than 6 percent lower, if we adjust for higher unemployment during the post-recession years (2008–2014). Forecast accuracy was not consistent over time: more recent forecasts were more accurate, and the mean deviation changed direction. Similarly for 164 large-scale transit projects, the observed ridership was about 24.6 percent lower than forecasts on average. The accuracy depends on the mode, length of the project, year the forecast was produced as well as socioeconomic and demographic changes from the production to observation year.

In addition, we have found evidence of recent changes in transit demand to be affecting the transit ridership forecast accuracy. From 2012 to 2018, bus ridership decreased by almost 15 percent and rail ridership decreased by about 4 percent on average across the metropolitan areas in the United States. This decline is unexpected, because it coincided with the period of economic and demographic growth: indicators typically associated with rising transit ridership. We found that the advent of new mobility options in ride hailing services, bike, and scooter shares as well as declining gas prices and increasing transit fares have the highest impact on ridership decline. Adjusting the ridership forecasts for these factors in a hypothetical scenario saw an improved transit ridership forecast performance.

Despite the advances in modeling techniques and the availability of rich travel data over the years, expecting perfect forecasts (where observations are equal to the forecasts), may not be prudent because of its forward-facing nature. Forecasts need to convey their inherent uncertainty so that planners and policymakers can take that into account when they are making any decision about a project. The existing methods to quantify the uncertainty rely on flawed assumptions regarding input variability and interaction and are significantly resource intensive. An alternate method is one that considers the uncertainty inherent in the travel demand models themselves based on empirical evidence. In this research, I have developed a tool to quantify the uncertainty in traffic and transit ridership forecasts through a retrospective evaluation of the forecast accuracy from the two largest available databases of traffic and transit ridership forecasts. The factors associated with the accuracy and the recent decline in transit ridership lead the formulation of quantile regression as a new method to quantify the uncertainty in forecasts. Together with a consideration of decision intervals or

breakpoints where a project decision might change, such ranges can be used to quantify project risk and produce better forecasts.

Subject Areas: Travel demand forecast; Forecast accuracy; Uncertainty; Transit ridership decline; Quantile regression; Reference class forecasting

Availability: Hoque, J. M. (2022). *Accuracy and Uncertainty in Traffic and Transit Ridership Forecasts*. Doctoral Dissertation, University of Kentucky, Lexington, KY. https://uknowledge.uky.edu/ce_etds/118/

9.10. Title: Why Has Public Transit Ridership Declined in The United States?

Author(s): Erhardt, G.D., Hoque, J.M., Goyal, V., Berrebi, S., Brakewood, C., and Watkins, K.E.

Abstract: Between 2012 and 2018, bus ridership in the United States declined 15 percent and rail ridership declined 3 percent. These losses are widespread and in contrast to trends in other countries. Using data from 215 Metropolitan Statistical Areas (MSAs) prior to the COVID-19 pandemic, we identify the factors responsible for this decline and quantify the contribution of each. We show that expanded transit service and land-use changes increased ridership 4.7 percent on bus and 10.7 percent on rail. However, losses due to other factors exceed these gains. Ride-hailing is the biggest contributor to transit ridership decline over this period, reducing bus ridership by 10 percent. Ride-hailing's effect on rail varies by metropolitan area size: it has little effect on rail ridership in the largest metropolitan areas but decreases rail ridership 10 percent in mid-sized metropolitan areas. Lower gas prices and higher fares contribute to lower transit ridership, as do higher incomes, more teleworking and higher car ownership. By providing a clear understanding of the causes of transit ridership decline, our research provides the foundation on which communities can craft an effective response to the problem.

Subject Areas: Transit; Bus; Rail; Ride-hail; Transportation Network Companies

Availability: Erhardt, G.D., Hoque, J.M., Goyal, V., Berrebi, S., Brakewood, C., and Watkins, K.E. (2022). "Why Has Public Transit Ridership Declined in The United States?" *Transportation Research Part A: Policy and Practice, 161*, pp. 68–87. https://doi.org/10.1016/j.tra.2022.04.006

9.11. Title: Transit-Oriented Development or Development-Oriented Transit: Measuring the Effect of Proximity to LA Metro Rail on Residential Construction

Author(s): Dsida, C.

Abstract: The expansion of Los Angeles Metro's rail network in recent decades presents a meaningful opportunity to understand how land use and transportation planning interact. This relationship is critically important to planning decisions about both land use policy and major transportation infrastructure investments. Using multivariate logistic regression on parcel-level data, I explore the factors that influence where and when transit-oriented development occurs across the region. By examining temporal components of these interactions, I determine how different project milestones—plan approval, groundbreaking, or service start dates—correspond with changes in the built environment. There is some evidence that residential development is more likely to occur on parcels near newly constructed rail transit at all project phases, with the most significant effect visible following the start of construction. However, when considering whether the development that takes place is at densities high enough to support transit use, the results are less conclusive. These dynamics provide useful information for planning practice about whether barriers to transit-oriented development exist in Greater Los Angeles, or alternatively, for evaluating choices related to rail rapid transit route selection.

Subject Areas: Los Angeles; Rail network; Land use; Transportation planning; Multivariate logistic regression; Residential development; Transit use

Availability: Dsida, C. (2022). *Transit-Oriented Development or Development-Oriented Transit: Measuring the Effect of Proximity to LA Metro Rail on Residential Construction*. Master's Thesis, Harvard Graduate School of Design, Cambridge, MA. https://dash.harvard.edu/handle/1/37371651

9.12. Title: Transit and Active Transportation Use for Non-Commute Travel Among Portland Transit-Oriented Development Residents

Author(s): Dill, J. and McNeil, N.

Abstract: Transit-oriented development (TOD) seeks to promote non-single occupancy vehicle travel by placing dense residential and mixed-use buildings near high-capacity, high-frequency transit. Most research to date on the impact of TODs on travel behavior has focused on commute trips; however, many trips are for nonwork purposes, and a sizable portion of the population does not commute to work. This study utilizes a set of surveys, conducted between 2005 and 2019 in the Portland OR region to assess factors associated with whether or not, and how often, TOD residents walk, bike, or take transit for home-based nonwork trips. Findings show that about 20 percent of TOD residents take transit for nonwork trips at least once per week, while 65 percent walk or bike for such trips. Attitudes and housing preferences are important factors in predicting whether and how frequently TOD residents walk, bicycle, or take transit for non-work trips. TOD residents make more non-work trips on transit when there is better transit access, and they walk and bicycle for more of these trips when street connectivity is higher. Lower access to a personal vehicle is also an important factor in non-work travel.

Subject Areas: Planning and analysis; Land use and multiuse; Attitudes/attitudinal data; Behavior analysis; Public transportation; Transit-oriented development; Sustainability and resilience; Transportation and sustainability

Availability: Dill, J. and McNeil, N. (2022). "Transit and Active Transportation Use for Non-Commute Travel Among Portland Transit-Oriented Development Residents." *Transportation Research Record: Journal of the Transportation Research Board*, *2677*(1), pp. 151–168. https://doi.org/10.1177%2F03611981221098391

9.13. Title: Exploiting Floating Car Data to Derive the Shifting Potential to Electric Micromobility

Author(s): Nigro, M., Castiglione, M., Colasanti, F.M., Vincentis, R.D., Valenti, G., Liberto, C., and Comi, A.

Abstract: Electric micromobility systems such as e-bikes and e-scooters represent sustainable mobility options especially for specific classes of travelled distances. Moreover, the coverage and accessibility of transit services can be expanded through the implementation and promotion of these systems. Therefore, transport engineering is dealing with the development of new tools to support the forecast of the potential demand both for door-to-door trips and its integration with transit. With respect to these incoming research challenges, the paper proposes a methodology to investigate private mobility through floating car data (FCD) to identify the potential demand that can be shifted from cars to electric micromobility (e-micromobility) systems while also exploring the opportunity to increase transit usage. The benefits of such methodology have been evaluated on a real large test case, i.e., Rome (Italy), through an FCD dataset of about 240,000 monitored vehicles. The developed methodology is parametric and, thus, it can be easily transferred to other city contexts taking into consideration the compatibility of the local network infrastructures and the micromobility solutions. In Rome, it was estimated that the potential demand for e-micromobility can reach a maximum value of about 20 percent of weekday trips, while about 10 percent of the morning peak trips could potentially be interested in a multimodal trip (i.e., mass transit services and e-micromobility for the access/egress). Results can be adopted by local authorities, transport companies and electric mobility providers to optimize infrastructural measures or the location of shared e-scooters and e-bikes to increase potential e-micromobility demand, as well as to increase the number of multimodal mobility options.

Subject Areas: Micromobility; Sustainable travel modes; E-scooters; E-bikes; Floating car data; Modal shift; Transit network coverage

Availability: Nigro, M., Castiglione, M., Colasanti, F.M., Vincentis, R.D., Valenti, G., Liberto, C., and Comi, A. (2022). “Exploiting Floating Car Data to Derive the Shifting Potential to Electric Micromobility.” *Transportation Research Part A: Policy and Practice*, *157*, pp. 78–93. https://doi.org/10.1016/j.tra.2022.01.008

9.14. Title: Community Transportation Needs and Willingness to Use Shared Micromobility: A Case Study of Fort Smith, Arkansas

Author(s): Kammerer, A.M.

Abstract: Shared micromobility is utilized in "targeted service areas with the usage generally intended for short trips such as 'first- and last-mile' connections to complete trips made via other modes, including transit" (Price et al., 2021). In the United States, this practice has especially taken off with the implementation of sharing-based systems. This is evidenced by ridership numbers in the United States growing from 84 million riders nationwide in 2018 to 136 million riders in 2019 (NACTO, 2020). Users often use their smart phone or another similar device to unlock the vehicle after paying a fee on the device through their credit card. While many people use these scooters or bikes as a novelty or purely for entertainment, "21% [of] adults would consider using e-scooters when available" (Mitra, 2020). The growing market for micromobility could result in changes in the way that the public commutes to their destination. E-scooters and bikes have potential to provide users the "last mile" of transportation. This, for instance, could be seen as a quarter-mile walk from the bus stop to a person's place of employment. In urban areas, racial minorities and low-income users are almost twice as likely to use public transit (Anderson, 2016). Due to this growing market, it is important to analyze the ways low-income citizens will also be able to use scooter and bicycle sharing in cities in the United States. Low-income users have less access to mobile phones (Pew Research Center, 2021). Additionally, 7.1 million Americans do not have access to a bank account (FDIC, 2020). Both of these factors combine into a possible user gap for low-income citizens regarding shared micromobility services. Utilizing data from users and cities, will assist municipalities and companies alike so they can implement micromobility in cities so that low-income communities can also take part. From implementation to public transit, to Sunday joy rides, micromobility has a chance to grow into a 2 mainstay in American cities. If this is the case, it is important that all people can utilize the system for effective public transportation. This thesis examines the transportation needs of citizens of low-income communities in Fort Smith, Arkansas. This thesis is developed in conjunction with an NSF sponsored research project called SMILIES: Shared MicromobIlity for affordable accessible Housing. SMILIES seeks to better link affordable housing and workplaces through shared micromobility by developing strategy for decision making. This thesis develops the survey that will be used in SMILIES to view the opinions of potential low-income users in the Fort Smith, Arkansas area.

Subject Areas: Shared micromobility; E-scooter; Low-income household; Transportation; Transit

Availability: Kammerer, A.M. (2022). *Community Transportation Needs and Willingness to Use Shared Micromobility: A Case Study of Fort Smith, Arkansas*. Civil Engineering Undergraduate Honors Thesis, University of Arkansas, Fayetteville, AR. https://scholarworks.uark.edu/cveguht/75

9.15. Title: Analyzing the Impacts of a Successful Diffusion of Shared E-Scooters and Other Micromobility Devices and Efficient Management Strategies for Successful Operations in Illinois

Author(s): Mohammadian, A., Rahimi, E., Javadinasr, M., Shamshiripour, A., Davatgari, A., Allahyari, A., and Brown, T.

Abstract: Active transportation can play an important role in promoting more physically active and positive public health outcomes. While walking and biking provide significant physical health benefits, their modal share remains low. As a new form of micromobility service, shared e-scooters can enhance the suite of options available in cities to promote active transportation and fill in the gaps when walking or biking are not preferred. Although e-scooters show potential as a mode of transportation, it is unclear whether people will adopt the technology for everyday use. Furthermore, shared micromobility (e.g., electric scooters) is gaining attention as a complementary mode to public transit and is expected to offer a solution to access/egress for public transit. However, few studies have analyzed integrated usage of shared e-scooters and public transit systems while using panel data to measure spatial and temporal characteristics. This study aims to examine the adoption and frequency of shared e-scooter usage and provide policy implementation. To do so, the researchers launched a survey in the Chicago region in late 2020 and collected a rich data set that includes residents' sociodemographic details and frequency of shared e-scooter use. To characterize the frequency, the researchers used an ordered probit structure. The findings show that respondents who are male, low income, Millennials and Generation Z, or do not have a vehicle are associated with a higher frequency of shared e-scooter use. Furthermore, this study utilizes shared e-scooter trips for a 35-day measurement period from 10 shared e-scooter operators in Chicago, where the researchers used a random-parameter negative binomial modeling approach to analyze panel effects. The findings highlight the critical role of spatial and temporal characteristics in the integration of shared e-scooters with transit.

Subject Areas: Transportation; Micromobility; Shared e-scooter; Public transit; Survey

Availability: Mohammadian, A., Rahimi, E., Javadinasr, M., Shamshiripour, A., Davatgari, A., Allahyari, A., and Brown, T. (2022). *Analyzing the Impacts of a Successful Diffusion of Shared E-Scooters and Other Micromobility Devices and Efficient Management Strategies for Successful Operations in Illinois*. Final Report, FHWA-ICT-22-006, Illinois Center for Transportation, University of Illinois at Urbana-Champaign, Urbana, IL. https://doi.org/10.36501/0197-9191/22-006

9.16. Title: Try Transit! Lessons Learned from Metrolink Riders to Incentivize a Post-Pandemic Mode Shift to Commuter Rail

Author(s): Owen, E.

Abstract: The COVID-19 pandemic has left future travel to work behavior uncertain since most office employees have not yet returned to commuting to five days per week. This uncertainty underscores the precarious future of American commuter rail, with existing rail service narrowly focused on connecting suburbs to downtown employment centers. The goal of this project is to answer the following question: What factors motivate travelers to switch from driving alone to riding commuter rail? The recommendations of this study were informed by a literature review, two surveys conducted with existing and potential Metrolink riders, and a review of other commuter rail agencies' pandemic ridership and recovery efforts. Research focused on how to incentivize mode shift through a behavioral science perspective has provided ideas that broadly fall into three categories: "try transit" exposure programs; technologies that are either gamification-based apps or trip planning tools that provide information and rewards to people considering transit usage; and targeted marketing campaigns to attract new riders. Survey participants from this study reflected higher engagement and interest in Metrolink among low-income households, older riders, lapsed riders, people who have never used Metrolink, and riders mostly interested in using service for leisure trips. The surveys provided insights about the criteria that existing and potential Metrolink riders consider when choosing commuter rail, including feeling secure from crime, convenient train schedules, cleanliness onboard trains, and on-time performance. Metrolink riders expressed the need for increased access to real-time information, more transit connections offered at stations, and more affordable fare options. Other commuter rail agencies such as Caltrain, BART, Long Island Railroad, NJ Transit, and Metra all have found similar ridership trends and offer ideas for service improvement, marketing campaigns, and mode shift incentives that Metrolink should consider.

Subject Areas: Transit; COVID-19; Commute travel; Transit ridership; California

Availability: Owen, E. (2022). *Try Transit! Lessons Learned from Metrolink Riders to Incentivize a Post-Pandemic Mode Shift to Commuter Rail*. Capstone Projects, Institute of Transportation Studies, University of California, CA. https://escholarship.org/uc/item/4x04003s

9.17. Title: Exploring the Nonlinear Effects of Ridesharing on Public Transit Usage: A Case Study of San Diego

Author(s): Zhang, Z., Zhai, G., Xie, K., and Xiao, F.

Abstract: The emergence of ridesharing services might complement or substitute public transit systems, leading to intricate relationships between the two services. However, limited studies focused on the non-linear effects of ridesharing use frequency on public transit usage. Therefore, this paper investigated such non-linear effects using the hierarchical negative binomial generalized additive model (HNBGAM), with the latest publicly available National Household Travel Survey (NHTS) dataset. The negative binomial and hierarchical negative binomial generalized linear models were also developed for comparison with the HNBGAM. The NHTS data involved travel information of 928 ridesharing users within 98 census tracts in San Diego. Two-level hierarchy (individual and census tract level) was constructed in the HNBGAM. In addition, the smooth function of the HNBGAM could help identify the non-linear effects of ridesharing use frequencies on public transit usage. Demographic factors (age, gender, race, household size, etc.) and built environment factors (e.g., population density, worker density, percentage of rental houses, and house unit density) were also considered in the modeling process. The findings revealed a negligible impact on public transit usage for occasional ridesharing use (from one to eleven times per month), a complementary effect for regular ridesharing use (from eleven to thirty-two times per month), and a substitution effect for active ridesharing use (more than thirty-two times per month). Understanding such non-linear relationships could help policymakers make more informed decisions to avoid the over-substitution of public transit usage and better complement the public transport system.

Subject Areas: Spatial dependence; Multilevel; Generalized additive models; Nonlinear effects; Ridesharing use frequency

Availability: Zhang, Z., Zhai, G., Xie, K., and Xiao, F. (2022). "Exploring the Nonlinear Effects of Ridesharing on Public Transit Usage: A Case Study of San Diego." *Journal of Transport Geography*, *104*. https://doi.org/10.1016/j.jtrangeo.2022.103449

9.18. Title: Evaluating Modal Mismatch Through Lens of Equity in the San Francisco Bay Area

Author(s): Han, M.

Abstract: The last few years, a variety of social and political movements around the world have spotlighted the equity issues in many areas. It gains the momentum and provides the opportunity for everyone including scholars to engage in the conversation of this particular topic. Although the term "equity" is multi-disciplinary and widely used, it shares a common meaning that benefits and risks are distributed proportionally among different groups of people in a way favoring those in disadvantage due to social, historic, geographic, or other influencing factors (Pereira et al., 2017; Litman, 2021).

In the field of transportation planning, equity is an essential component in most plans or strategies (Karner & Niemeier, 2013). It is multi-dimensional in considering mobility and accessibility, safety, traffic-related pollution, health, and other system and individual goals (Creger et al., 2018). Among these different perspectives, our main focus of this study is accessibility which is the most representative indicator of transportation system's main function—to move people around and to provide access to opportunities by various means (Geurs & van Wee, 2004).

Most studies discussing transportation equity did not pay enough attention to the difference between equality and equity and often used them interchangeably. The lack of clarity of concepts directly results in the confusion of methods used to assess equity or equality. In order to operationalize equity analysis, we synthesized two main equity principles—basic needs and equitable difference—and developed a 6-step framework based on a variety of social and philosophical theories regarding equity as well as multiple studies that incorporated equity principles in accessibility-related analysis. We selected one of the most transit-rich regions in the U.S.—the San Francisco Bay Area—as our study area.

Three inter-related indexes were created, including the transit demand index, the modal mismatch index, and the modal equity index. These indexes revealed how the modal accessibility gap is distributed in relation to transit demand across the region. In addition to the index development, we identified statistically significant socioeconomic variables either individually or collectively that are associated with transit users and places with high levels of transit services with many interesting and contradictory findings. We also used spatial analysis methods to understand the underlying spatial patterns of modal mismatch. With these methodological and theoretical work, we demonstrated the need to think differently and to provide an alternative about transit planning and how to design the system through lens of equity.

Subject Areas: Transit planning; Equity; Equality; San Francisco Bay Area; Modal mismatch; Modal accessibility

Availability: Han, M. (2022). *Evaluating Modal Mismatch Through Lens of Equity in the San Francisco Bay Area*. Doctoral Dissertation, University of Florida, Gainesville, FL. https://www.proquest.com/openview/41fd415eb747f25a3c97d65ef002f04a/1.pdf?pq-origsite=gscholar&cbl=18750&diss=y

9.19. Title: Public Transportation at a Crossroads – Transportation Network Companies, COVID-19, and Transit Ridership

Author(s): Khatun, F.

Abstract: Public transportation in the U.S., including in California, was declining before COVID-19, and the pandemic made a bad situation much worse. In this dissertation, I analyze data from the 2009 and 2017 National Household Travel Surveys and from a California survey administered in May 2021 by IPSOS using both discrete choice (cross-nested logit and generalized ordered logit) and quasi-experimental (propensity score matching) tools first to investigate how Transportation Network Companies (TNCs) (e.g., Uber and Lyft) impacted transit ridership before COVID-19, before analyzing how COVID-19 affected transit and other modes. In Chapter 2, my results for the U.S. show that individuals/households who use either public transit or TNCs share socio-economic characteristics, reside in similar areas, and differ from individuals/households who use neither public transit nor TNCs. In addition, individuals/households who use both public transit and TNCs tend to be Millennials or belong to Generation Z, with a higher income, more education, no children, and fewer vehicles than drivers. In Chapter 3, I quantify the impact of TNCs on household transit use by comparing travel for households from the 2017 NHTS (who had access to both transit and TNCs) matched with households from the 2009 NHTS (who only had access to transit) using propensity score matching. Overall, I find a 22% drop for weekdays (1.6 fewer daily transit trips by each household) and a 15% decrease for weekends (1.4 fewer daily transit trips by each household). In Chapter 4, I analyze how Californians changed transportation modes due to COVID-19 and explore their intentions to use different modes after COVID-19. I find that driving but especially transit and TNCs could see substantial drops in popularity after the pandemic. Many Hispanics, African Americans, Asians, lower-income people, and people who would like to telecommute more intend to use transit less. Key obstacles to a resurgence of transit after COVID-19 are insufficient reach and frequency, shortcomings that are especially important to younger adults, people with more education, and affluent households ("choice riders"). My findings highlight the danger of public transit entering into outsourcing agreements with TNCs, neglecting captive riders, and exposing choice riders to TNCs.

Subject Areas: Public transportation; COVID-19; California; Transit ridership; Transportation Network Companies; Demographics

Availability: Khatun, F. (2022). *Public Transportation at a Crossroads – Transportation Network Companies, COVID-19, and Transit Ridership*. Doctoral Dissertation, University of California, Irvine, CA. https://escholarship.org/uc/item/1rf256h5

9.20. Title: Pandemic Transit: Examining Transit Use Changes and Equity Implications in Boston, Houston, and Los Angeles

Author(s): Paul, J. and Taylor, B.D.

Abstract: While the COVID-19 pandemic upended many aspects of life as we knew it, its effects on U.S. public transit were especially dramatic. Many former transit commuters began to work from home or switched to traveling via private vehicles. But for those who continued to work outside the home and could not drive—who were more likely low-income and Black or Hispanic—transit remained an important means of mobility. However, most transit agencies reduced service during the first year of the pandemic, reflecting reduced ridership demand, increasing costs, and uncertain budgets. To analyze the effects of the pandemic on transit systems and their users, we examine bus ridership changes by neighborhood in Boston, Houston, and Los Angeles from 2019 to 2020. Combining aggregated stop-level boarding data, passenger surveys, and census data, we identify associations between shifting travel patterns and neighborhoods. We find that early in the pandemic, neighborhoods with more poor and non-white households lost proportionally fewer riders; however, this gap between high- and low-ridership-loss neighborhoods shrank as the pandemic wore on. We also model ridership change controlling for multiple factors. Ridership in Houston and LA generally outperformed Boston, with built environment and demographic factors accounting for some of the observed differences. Neighborhoods with high shares of Hispanic and African American residents retained more riders in the pandemic, while those with higher levels of auto access and with more workers able to work from home lost more riders, all else equal. We conclude that transit's social service role elevated during the pandemic, and that serving travelers in disadvantaged neighborhoods will likely remain paramount emerging from it.

Subject Areas: Public transit; Ridership; COVID-19; Equity; Neighborhoods

Availability: Paul, J. and Taylor, B.D. (2022). "Pandemic Transit: Examining Transit Use Changes and Equity Implications in Boston, Houston, and Los Angeles." *Transportation*. https://doi.org/10.1007/s11116-022-10345-1

9.21. Title: Public Transportation, Transportation Network Companies (TNCs), and Active Modes

Author(s): Saphores, J.-D. and Khatun, F.

Abstract: To better understand how TNCs likely impacted transit ridership before Covid-19, investigate how Covid-19 affected other modes, and elicit obstacles to a resurgence of transit after the pandemic, we analyzed data from the 2017 National Household Travel Survey, and from an IPSOS survey administered in May 2021 for this project. Our Results show that TNCs are attracting younger, more affluent, and better educated urban households, many of whom are also served by transit. Lower-income households who reside in core urban areas served by transit are less likely to switch to TNCs. Our analysis suggests that driving but especially transit and TNCs, could see substantial drops in popularity after the pandemic ends or moves to the background like the flu. Many Hispanics, Asians, and women intend to use transit less. Although walking and biking should increase, many Hispanics, African Americans, and Asians plan on walking/biking less. Key obstacles to a resurgence of transit include insufficient reach and frequency. African Americans and Asians have lingering health concerns, and women are more likely to worry about personal safety. In addition to addressing these concerns, effective transit policies need to be integrated into a comprehensive framework designed to achieve California's social and environmental goals.

Subject Areas: Transportation Network Companies; Public transportation; Transit; Travel behavior; Ride share; Modes; Travel patterns; COVID-19

Availability: Saphores, J.-D. and Khatun, F. (2022). *Public Transportation, Transportation Network Companies (TNCs), and Active Modes*. Final report, PSR-19-34-TO-035, University of Southern California, Los Angeles, CA. https://www.metrans.org/assets/research/psr-19-34_to-035_saphores_final-report.pdf

9.22. Title: Rural Transit Fact Book, 2022

Author(s): Mattson, J. and Mistry, D.

Abstract: Public transportation plays a fundamental role in the livability of communities of all sizes. The *Rural Transit Fact Book* provides information on transit service availability and cost to help the transit industry in the United States provide efficient and effective service to meet rural community mobility needs. Financial and operating statistics can be used by agency managers, local decision makers, state directors, the Federal Transit Administration (FTA), and lawmakers to assist in policy making, planning, managing operations, and evaluating performance.

The *Rural Transit Fact Book* serves as a national resource for statistics and information on rural transit in America. This publication includes rural demographic and travel behavior data as well as financial and operating statistics for agencies receiving Section 5311 funding. In addition to national-level data, statistics are presented by state, FTA region, tribe, and mode, as well as other agency characteristics.

The rural transit data presented in this report were obtained from the National Transit Database (NTD). The 2011 edition of the *Rural Transit Fact Book* was the first published by SURTC/SURCOM and included NTD data for 2007–2009. Since 2011, updates have been made to the book to provide updated data. The 2022 edition includes 2020 data from the NTD as well as additional data from the American Community Survey and National Household Travel Survey.

As noted, this publication presents data for transit providers receiving Section 5311 Non-Urbanized Area Formula Program funding. This program provides funding to states to support public transportation in rural areas with populations of less than 50,000. Several rural transit providers also receive funding under the Section 5310, Enhanced Mobility of Seniors and Individuals with Disabilities, program. However, nationwide data for 5310 services are not available, as providers are not required to report such data to the NTD. Therefore, rural transit providers not funded by the 5311 program but receiving funding from Section 5310 are not included in this report. Also excluded from the report are providers that receive strictly non-federal funding and those receiving both Section 5311 funds and Section 5307 Urbanized Area Formula Program funding and report their data in the urban NTD.

Subject Areas: Transit service availability; Mobility in rural community; 5311 Non-Urbanized Area Formula Program; Rural demographic; Travel behavior; Operating statistics

Availability: Mattson, J. and Mistry, D. (2022). *Rural Transit Fact Book, 2022*. North Dakota State University, Fargo, ND. https://www.ugpti.org/resources/reports/downloads/surtcom22-11.pdf

Chapter 10. Travel Behavior

10.1. Title: An Exploratory Analysis of Alternative Travel Behaviors of Ride-Hailing Users

Author(s): Rafiq, R. and McNally, M.G.

Abstract: The emergence of ride-hailing, technology-enabled on-demand services such as Uber and Lyft, has arguably impacted the daily travel behavior of users. This study analyzes the travel behavior of ride-hailing users first from conventional person- and trip-based perspectives and then from an activity-based approach that uses tours and activity patterns as basic units of analysis. While tours by definition are more easily identified and classified, daily patterns theoretically better represent overall travel behavior but are simultaneously more difficult to explain. We thus consider basic descriptive analyses for tours and a more elaborate approach, Latent Class Analysis, to describe pattern behavior. The empirical results for tours using data from the 2017 National Household Travel Survey show that 76 percent of ride-hailing tours can be represented by five dominant tour types with non-work tours being the most frequent. The Latent Class model suggests that the ride-hailing users can be divided into four distinct classes, each with a representative activity-travel pattern defining ride-hailing usage. Class 1 was composed of younger, employed people who used ride-hailing to commute to work. Single, older individuals comprised Class 2 and used ride-hailing for midday maintenance activities. Class 3 represented younger, employed individuals who used ride-hailing for discretionary purposes in the evening. Last, Class 4 members used ride-hailing for mode change purposes. Since each identified class has different activity-travel patterns, they will show different responses to policy directives. The results can assist ride-hailing operators in addressing evolving travel needs as users respond to various policy constraints.

Subject Areas: Ride-hailing; Activity-travel pattern; Tour; Trip chaining; Latent class analysis; National Household Travel Survey

Availability: Rafiq, R. and McNally, M.G. (2022). "An Exploratory Analysis of Alternative Travel Behaviors of Ride-Hailing Users." *Transportation*. https://doi.org/10.1007/s11116-021-10254-9

10.2. Title: Human Movement Patterns of Different Racial-Ethnic and Economic Groups in U.S. Top 50 Populated Cities: What Can Social Media Tell Us About Isolation?

Author(s): Wu, M. and Huang, Q.

Abstract: Many studies have proven that human movement patterns are strongly impacted by individual socioeconomic and demographic background. While many efforts have been made on exploring the influences of age and gender on movement patterns using social media, this study aims to analyze and compare the movement patterns among different racial-ethnic and economic groups using social media (i.e., geotagged tweets) from the U.S. top 50 populated cities. Results show that there are significant differences in number of activity zones and median travel distance across cities and demographic groups, and that power-laws tend to be captured in both spatial and demographic aspects. Additionally, the analysis of outbound-city travels demonstrates that some cities have slightly stronger interaction with others, and that economically disadvantaged populations and racial-ethnic minorities are more restricted in long distance travels, indicating that their spatial mobility is more limited to the local scale. Lastly, an economically segregated movement pattern is discovered—upper-class neighborhoods are mostly visited by the upper-class, while lower-class neighborhoods are mainly accessed by the lower-class—but some racial-ethnic groups can diversify this segregated pattern in the local scale.

Subject Areas: Segregation; Isolation; Human mobility; Social media; User profile inference

Availability: Wu, M. and Huang, Q. (2022). "Human Movement Patterns of Different Racial-Ethnic and Economic Groups in U.S. Top 50 Populated Cities: What Can Social Media Tell Us About Isolation?" *Annals of GIS*, *28*, pp. 161–183. https://doi.org/10.1080/19475683.2022.2026471

10.3. Title: Exploring the Role of Ride-Hailing in Trip Chains

Author(s): Ahmed, T. and Hyland, M.

Abstract: Ride-hailing can potentially provide a variety of benefits to individuals who need to chain several activities together within a single trip chain, relative to other travel modes. Using household travel diary/survey data, the goal of this study is to assess the role ride-hailing currently plays within trip chains. Specifically, the study aims to determine, within trip chains, who uses ride-hailing services, for what trip/activity purposes, and to/from what types of areas, as well as the characteristics of trip chains that involve ride-hailing segments. To meet these objectives, the study estimates a binary logit model using 2017 National Household Travel Survey data, where the dependent variable denotes the inclusion of at least one ride-hailing trip within a trip chain. Similar to the non-trip-chaining ride-hailing literature, this study indicates that trip chains with ride-hailing legs are positively associated with travelers who are younger, live in high-income households, frequently use transit, and reside in high-density areas. However, this study includes novel findings indicating statistically significant relationships between ride-hailing and trip chains that end in healthcare and social/recreational activities. Moreover, trip chains with ride-hailing tend to have fewer stops and longer activity durations than trip chains without ride-hailing. This study also includes nested logit choice models, wherein the dependent variable denotes the primary mode (ride-hailing, transit, personal vehicle, or non-motorized transport) of a trip chain. These model results provide additional insights into the role of ride-hailing within trip chains, as they allow for cross-mode comparisons. The paper discusses the potential transportation planning and policy implications of the model results as well as future research directions.

Subject Areas: Shared mobility; Travel behavior; Activities; Ridesourcing; Trip chain; Logit choice models

Availability: Ahmed, T. and Hyland, M. (2022). “Exploring the Role of Ride-Hailing in Trip Chains.” *Transportation*. https://doi.org/10.1007/s11116-022-10269-w

10.4. Title: Analysis of the Negative Impact of Economic Development Process

Author(s): Shi, M.

Abstract: Rapid economic development is generally regarded as positive. One of the most obvious performance indicators is GDP. But GDP mainly measures market production and cannot be regarded as a measure of economic well-being. When we see GDP growth, we should not blindly rejoice, but see the hidden dangers and problems behind it. These issues mainly revolve around people's lives and affect people's level of happiness and quality of life. This essay mainly discusses the negative effects of economic development from three perspectives: regional economy, health, and environment. Then this essay focus on the negative impact of the blooming E-commerce economy caused by the rapid development of the Internet in recent years.

Subject Areas: Economic growth; Body health; Environment; E-commerce economic

Availability: Shi, M. (2021). "Analysis of the Negative Impact of Economic Development Process." *Scientific Journal of Economics and Management Research*, *3*(8).
http://www.sjemr.org/download/SJEMR-3-8-9-13.pdf

10.5. Title: Private Autonomous Vehicles and Their Impacts on Near-Activity Location Travel Patterns: Integrated Mode Choice and Parking Assignment Model

Author(s): Bahk, Y., Hyland, M.F., and An, S.

Abstract: The goal of this study was to analyze the impact of private autonomous vehicles (PAVs), specifically their near-activity location travel patterns, on vehicle miles traveled (VMT). The study proposes an integrated mode choice and simulation-based parking assignment model, along with an iterative solution approach, to analyze the impacts of PAVs on VMT, mode choice, parking lot usage, and other system performance measures. The dynamic simulation-based parking assignment model determines the parking location choice of each traveler as a function of the spatial–temporal demand for parking from the mode choice model, whereas the multinomial logit mode choice model determines mode splits based on the costs and service quality of each travel mode coming, in part, from the parking assignment model. The paper presents a case study to illustrate the power of the modeling framework. The case study varies the percentage of persons with a private vehicle (PV) who own a PAV versus a private conventional vehicle (PCV). The results indicated that PAV owners traveled an extra 0.11 to 1.51 mi compared with PCV owners on average, and the PV mode share was significantly higher for PAV owners. Therefore, as PCVs are converted into PAVs in the future, the results indicate substantial increases in VMT near activity destinations. However, the results also indicated that adjusting parking fees and redistributing parking lot capacities could reduce VMT. The significant increase in VMT from PAVs implies that planners should develop policies to reduce PAV deadheading miles near activity locations, as the automated era comes closer.

Subject Areas: Planning and analysis; Mathematical modeling; Simulation modeling; Systems modeling; Transportation supply; Impact analysis; Mode choices

Availability: Bahk, Y., Hyland, M.F., and An, S. (2022). "Private Autonomous Vehicles and Their Impacts on Near-Activity Location Travel Patterns: Integrated Mode Choice and Parking Assignment Model." *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(7), pp. 276–295. https://doi.org/10.1177%2F03611981221077982

10.6. Title: Commute Distance and Jobs-Housing Fit

Author(s): Blumenberg, E. and Siddiq, F.

Abstract: Anecdotal evidence suggests that the affordable housing crisis is forcing households to seek lower cost housing in the outer reaches of major metropolitan areas, helping to explain recent increases in commute distance. To test this relationship, we use spatial regression to examine the relationship between the availability of affordable housing in close proximity to jobs (jobs-housing fit) and commute distance in the Los Angeles metropolitan area. The analysis draws on 2015 Longitudinal Employer-Household Dynamics (LEHD) Origin–Destination Employment Statistics (LODES) by workplace supplemented with data from the 2013–2017 5-Year American Community Survey on affordable housing units. We find substantial variation in jobs-housing fit across Los Angeles neighborhoods. The imbalance is greatest in higher-income neighborhoods located along the coast and in Orange County, south of Los Angeles. Controlling for other determinants of commute distance, a higher ratio of jobs to affordable housing is associated with longer distance commutes. To address growing commute distances, policymakers must greatly expand and protect the supply of long-term rental housing particularly in job-rich neighborhoods.

Subject Areas: Commuting; Low-wage workers; Affordable housing; Residential location

Availability: Blumenberg, E. and Siddiq, F. (2022). "Commute Distance and Jobs-Housing Fit." *Transportation*. https://doi.org/10.1007/s11116-022-10264-1

10.7. Title: Results of the First Large-Scale Survey of Transportation Network Companies Use in the Bay Area

Author(s): Bradley, M., Greene, E., Sana, B., Cooper, D., Castiglione, J., Israel, S., and Coy, C.

Abstract: Transportation network companies (TNCs) such as Uber and Lyft have grown tremendously over the last decade, particularly in the San Francisco Bay Area. Nonetheless, relatively little publicly available data exist about the users of these services, their travel behaviors, volume of use, the times and locations of TNC trips, and how TNC services are affecting transportation system performance overall. This paper describes the methods and descriptive results of the first large-scale smartphone-based TNC user survey conducted in the California Bay Area in the fall 2018 and spring of 2019.

Subject Areas: Planning and analysis; Traveler behavior and values; Emerging; Public transportation; Innovative public transportation services and technologies; Transportation network companies

Availability: Bradley, M., Greene, E., Sana, B., Cooper, D., Castiglione, J., Israel, S., and Coy, C. (2022). "Results of the First Large-Scale Survey of Transportation Network Companies Use in the Bay Area." *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(7), pp. 13–23. https://doi.org/10.1177%2F03611981221076441

10.8. Title: Evaluating the Effects of Complete Streets on Mode Choice, A Case Study in the Baltimore-Washington Area

Author(s): Erdogan, S., Cirillo, C., Nasri, A., Bas, J.V., Al-Khasawne, M.B., and Nejad, M.M.

Abstract: The goal of this project is to enhance regional travel demand modeling capability of MDOT SHA by developing data-driven mode choice models that incorporates bicycling and walking among the modes so that impacts of Complete Street projects and plans can be forecasted in the future. To accomplish the project goals and objectives, a Stated Choice Experiment (SCE) in which respondents are asked to evaluate different alternatives (including walking, biking and other) characterized by attributes related to trips made in a CS context is completed. The data set is used to estimate discrete choice models to explain the preferences for bike and walk modes in a CS context. Considering the implementation of the model in MSTM, we estimated the models by income and trip purposes consistent with MSTM, and we calculated both direct and cross elasticities from the coefficients obtained. We utilized calculated elasticities to update motorized-share table input used in MSTM where each modeling zones are assigned an average LTS value. We developed an Excel spread-sheet tool to update the motorized share input to MSTM and tested it on two scenarios. The scenario results demonstrated that the methods and tools we developed in this project can successfully reflect the potential impacts of CS within a statewide transportation model, i.e., MSTM, albeit requiring further refinement and validation.

Subject Areas: Complete streets; Mode choice; Mode shift; Nonmotorized transportation; Benefits evaluation; Demand modeling; Estimation; Level-of-stress; Stated-choice experiment

Availability: Erdogan, S., Cirillo, C., Nasri, A., Bas, J.V., Al-Khasawne, M.B., and Nejad, M.M. (2021). *Evaluating the Effects of Complete Streets on Mode Choice, A Case Study in the Baltimore-Washington Area*. Final Report, University of Maryland, College Park, MD. https://www.roads.maryland.gov/OPR_Research/MD-21-SHA-5-25-CompleteStreets-Report.pdf

10.9. Title: Nonlinear Relationships between Vehicle Ownership and Household Travel Characteristics and Built Environment Attributes in the US Using the XGBT Algorithm

Author(s): Ma, T., Aghaabbasi, M., Ali, M., Zainol, R., Jan, A., Mohamed, A.M., and Mohamed, A.

Abstract: In the United States, several studies have looked at the association between automobile ownership and sociodemographic factors and built environment qualities, but few have looked at household travel characteristics. Their interactions and nonlinear linkages are frequently overlooked in existing studies. Utilizing the 2017 U.S. National Household Travel Survey, the authors employed an extreme gradient boosting tree model to evaluate the nonlinear and interaction impacts of household travel characteristics and built environment factors on vehicle ownership in three states of the United States (California, Missouri, and Kansas) that are different in population size. To develop these models, three main XGBT parameters, including the number of trees, maximal depth, and minimum rows, were optimized using a grid search technique. In California, the predictability of vehicle ownership was driven by household travel characteristics (cumulative importance: 0.62). Predictions for vehicle ownership in Missouri and Kansas were dominantly influenced by sociodemographic factors (cumulative importance: 0.53 and 0.55, respectively). In all states, the authors found that the number of drivers in a household plays a vital role in the vehicle ownership decisions of households. Regarding the built environment attributes, deficiencies in cycling infrastructure were the most prominent attribute in predicting household vehicle ownership in California. This variable, however, has threshold connections with vehicle ownership, but the magnitude of these relationships is small. The outcomes imply that improving the condition of cycling infrastructure will help reduce the number of vehicles. In addition, incentives that encourage the households' drivers not to buy new vehicles are helpful. The outcomes of this study might aid policymakers in developing policies that encourage sustainable vehicle ownership in the United States.

Subject Areas: Sustainable vehicle ownership; Nonlinear relationships; Built environment; XGBT

Availability: Ma, T., Aghaabbasi, M., Ali, M., Zainol, R., Jan, A., Mohamed, A.M., and Mohamed, A. (2022). "Nonlinear Relationships between Vehicle Ownership and Household Travel Characteristics and Built Environment Attributes in the US Using the XGBT Algorithm." *Sustainability*, *14*(6). https://doi.org/10.3390/su14063395

10.10. Title: How Sustainable Is People's Travel to Reach Public Transit Stations to Go to Work? A Machine Learning Approach to Reveal Complex Relationships

Author(s): Tang, P., Aghaabbasi, M., Ali, M., Jan, A., Mohamed, A.M., and Mohamed, A.

Abstract: Several previous studies examined the variables of public-transit-related walking and privately owned vehicles (POVs) to go to work. However, most studies neglect the possible nonlinear relationships between these variables and other potential variables. Using the 2017 U.S. National Household Travel Survey, we employ the Bayesian Network algorithm to evaluate the non-linear and interaction impacts of health condition attributes, work trip attributes, work attributes, and individual and household attributes on walking and privately owned vehicles to reach public transit stations to go to work in California. The authors found that the trip time to public transit stations is the most important factor in individuals' walking decision to reach public transit stations. Additionally, it was found that this factor was mediated by population density. For the POV model, the population density was identified as the most important factor and was mediated by travel time to work. These findings suggest that encouraging individuals to walk to public transit stations to go to work in California may be accomplished by adopting planning practices that support dense urban growth and, as a result, reduce trip times to transit stations.

Subject Areas: Sustainable travel to public transit stations; Complex relationship; Bayesian network algorithm; Work trip

Availability: Tang, P., Aghaabbasi, M., Ali, M., Jan, A., Mohamed, A.M., and Mohamed, A. (2022). "How Sustainable Is People's Travel to Reach Public Transit Stations to Go to Work? A Machine Learning Approach to Reveal Complex Relationships." *Sustainability*, *14*(7). https://doi.org/10.3390/su14073989

10.11. Title: Time on the Road and the Price of Gasoline: Evidence from ATUS and NHTS

Author(s): Alberini, A., Di Cosmo, V., and Horvath, M.

Abstract: What happens when motor fuel prices rise? In the United States, the National Household Travel Survey (NHTS) collects information about car ownership and use, and travel during a typical day, for over 100,000 households. It is conducted only once every 8 years, and does not include a longitudinal component, making it difficult to observe drivers' adjustments to changing gasoline prices. We experiment with combining the 2017 NHTS with eight waves of the American Time Use Survey (ATUS), which tracks trips, time spent traveling, and other characteristics of each trip. We find that the two datasets document remarkably similar behaviors—whether we use the eight waves of the ATUS or limit the comparison to the period when the two surveys overlap (April 2016 to April 2017). They also document similar responsiveness to prices—at least for the decision to take a car or a public transit trip. By contrast, minutes on the road and miles in the NHTS appear to be strongly responsive to gasoline prices, whereas minutes on the road from the ATUS are unrelated to fuel prices, despite the much greater price variation therein. This has important consequences when calculating the emissions reductions that can be expected when the price of gasoline rises. The results are robust to extensive checks and efforts to reduce measurement error in gasoline prices.

Subject Areas: Driving behavior; Vehicle Miles Traveled; Gasoline price; CO_2 emissions; Measurement error

Availability: Alberini, A., Di Cosmo, V., and Horvath, M. (2022). *Time on the Road and the Price of Gasoline: Evidence from ATUS and NHTS*. USAEE Working Paper No. 22–543, SSRN, Rochester, NY. https://dx.doi.org/10.2139/ssrn.4071943

10.12. Title: What Makes You Hold on to That Old Car? Joint Insights from Machine Learning and Multinomial Logit on Vehicle-level Transaction Decisions

Author(s): Jin, L. et al.

Abstract: What makes you hold on to that old car? While the vast majority of the household vehicles are still powered by conventional internal combustion engines, the progress of adopting emerging vehicle technologies will critically depend on how soon the existing vehicles are transacted out of the household fleet. Leveraging a nationally representative longitudinal data set, the Panel Study of Income Dynamics, this study examines how household decisions to dispose of or replace a given vehicle are: (1) influenced by the vehicle's attributes, (2) mediated by households' concurrent sociodemographic and economic attributes, and (3) triggered by key life cycle events. Coupled with a newly developed machine learning interpretation tool, TreeExplainer, we demonstrate an innovative use of machine learning models to augment traditional logit modeling to both generate behavioral insights and improve model performance. We find the two gradient-boosting-based methods, CatBoost and LightGBM, are the best performing machine learning models for this problem. The multinomial logistic model can achieve similar performance levels after its model specification is informed by TreeExplainer. Both machine learning and multinomial logit models suggest that while older vehicles are more likely to be disposed of or replaced than newer ones, such probability decreases as the vehicles serve the family longer. Pickup trucks and sport utility vehicles are less likely to be disposed of or replaced than cars, and leased vehicles are more likely to be transacted than owned vehicles. We find that married families, families with higher education levels, homeowners, and older families tend to keep their vehicles longer. Life events such as childbirth, residential relocation, and change of household composition and income are found to increase vehicle disposal and/or replacement. We provide additional insights on the timing of vehicle replacement or disposal, in particular, the presence of children and childbirth events are more strongly associated with vehicle replacement among younger parents.

Subject Areas: Travel behavior; Vehicle transaction; Life events; Mobility biography; Longitudinal data; Machine learning; Shapley Additive exPlanation TreeExplainer; Multinomial logit

Availability: Jin, L. et al. (2022). *What Makes You Hold on to That Old Car? Joint Insights from Machine Learning and Multinomial Logit on Vehicle-level Transaction Decisions*. arXiv preprint, arXiv:2205.06622 [stat.AP]. https://arxiv.org/abs/2205.06622

10.13. Title: Effects of Trip-Level Characteristics on Autonomous Vehicle Ownership: A U.S. Analysis

Author(s): Tu, Y., Jabbari, P., Khan, N.A., and MacKenzie, D.

Abstract: We examined how trip-level characteristics may influence autonomous vehicle ownership decisions. Using 639 stated preference survey responses in the U.S., we developed an integrated choice and latent variable model linking trip- and consumer-level characteristics to AV ownership choices. Results suggested parking cost, travel cost and travel time are important predictors for vehicle ownership at the trip-level; and monthly payment, car ownership importance and autonomous vehicle safety perceptions are significant predictors at the consumer-level. By examining elasticities of vehicle ownership market shares, we found while consumer-level characteristics have the most prominent effect on vehicle ownership decisions, trip-level characteristics have a small but measurable effect. Among trip-level characteristics, parking cost has the largest impact on vehicle ownership decisions, followed by travel cost of ridehailing (both conventional and autonomous), and transit travel time. Finally, we simulated future vehicle ownership decisions under three policy scenarios by leveraging trip- and consumer-level characteristics.

Subject Areas: Autonomous vehicle; Vehicle ownership; Integrated choice and latent variable model; Trip-level characteristics

Availability: Tu, Y., Jabbari, P., Khan, N.A., and MacKenzie, D. (2022). "Effects of Trip-Level Characteristics on Autonomous Vehicle Ownership: A U.S. Analysis." *Transportation Research Part D: Transport and Environment*, *108*. https://doi.org/10.1016/j.trd.2022.103321

10.14. Title: Investigating Potential Electric Micromobility Demand in the City of Rome, Italy

Author(s): Nigro, M., Castiglione, M., Colasanti, F.M., Vincentis, R.D., Liberto, C., Valenti, G., and Comi, A.

Abstract: Recent electric micromobility solutions can represent a sustainable transport alternative in urban environments. Indeed, these can be adopted as a substitute of car, especially for specific distance classes, as well as they can increase accessibility to transit services. Aiming to investigate the potential demand that can be moved from private cars to environment-friendly micromobility modes (e.g., e-scooters and e-bikes), a methodology based on exploiting data by probe vehicles is presented. To test its goodness, it is applied to the city of Rome (Italy) with challenging results.

Subject Areas: Micromobility; Probe vehicles; Floating car data; E-bikes; E-scooters

Availability: Nigro, M., Castiglione, M., Colasanti, F.M., Vincentis, R.D., Liberto, C., Valenti, G., and Comi, A. (2022). "Investigating Potential Electric Micromobility Demand in the City of Rome, Italy." *Transportation Research Procedia*, *62*, pp. 401–407. https://doi.org/10.1016/j.trpro.2022.02.050

10.15. Title: Inequality in Activity Participation: Multidimensional Disadvantages and Daily Trips by Trip Purpose and Trip Day

Author(s): Wang, S., Kim, J.J., and Xu, Y.

Abstract: This paper investigated how daily trips are associated with multi-dimensional disadvantages in demographic characteristics, socioeconomic status, transportation barriers, and internet use based on the 2017 U.S. National Household Travel Survey. We examined how these disadvantages affected weekday and weekend trips for work, recreation, and social participation purposes. Accounting for transit services and walkability at the metropolitan area level, the results of multi-level ordered and binomial logistic regression revealed that although the disadvantages were negatively associated with the likelihood of making any trips, their associations varied by the type of disadvantages, trip purpose, and trip day. Having a lower income was associated with a higher likelihood of making a weekday social participation trip and a weekend work trip. No internet use was more consistently related to a lower likelihood of making any weekday trips. A lack of car ownership was negatively associated with social participation trips, and the perceived financial burden of trips was negatively related to recreational trips. We discuss policy implications for reducing the effects of these disadvantages on trip likelihood.

Subject Areas: Disadvantages; Out-of-home activity; Social exclusion; Travel behavior; Transportation equity

Availability: Wang, S., Kim, J.J., and Xu, Y. (2022). "Inequality in Activity Participation: Multidimensional Disadvantages and Daily Trips by Trip Purpose and Trip Day." *Travel Behaviour and Society*, *29*, pp. 211–223. https://doi.org/10.1016/j.tbs.2022.06.013

10.16. Title: Long-Distance Travel Impacts of COVID-19 Across the United States

Author(s): Huang, Y., Zuniga-Garcia, N., and Kockelman, K.

Abstract: Using over a thousand Americans' population-weighted responses to a long-distance travel survey, this paper examines reductions in trips over 75 miles (one-way) in 2020, during the pandemic, versus behaviors in 2019. Negative binomial models of trip counts suggest that people aged 25 to 64 took 0.20 fewer annual long-distance business trips during the pandemic, but people aged 65 and older took 0.45 fewer business and 0.57 fewer non-business long-distance trips, on average. Household income was not a key predictor for long-distance non-business-trip-making during the pandemic, but was important in predicting long-distance trip rates for business purposes (both before and during the pandemic) and for non-business trips pre-pandemic.

Subject Areas: Long-distance travel; Travel behavior; Travel survey; COVID-19

Availability: Huang, Y., Zuniga-Garcia, N., and Kockelman, K. (2022). "Long-Distance Travel Impacts of COVID-19 Across the United States." *Findings*. https://findingspress.org/article/36454-long-distance-travel-impacts-of-covid-19-across-the-united-states

10.17. Title: Investigating Attitudinal and Behavioral Changes in U.S. Households Before, During, and After the COVID-19 Pandemic

Author(s): Salon, D. et al.

Abstract: Human behavior is notoriously difficult to change, but a disruption of the magnitude of the COVID-19 pandemic has the potential to bring about long-term behavioral changes. During the pandemic, people have been forced to experience new ways of interacting, working, learning, shopping, traveling, and eating meals. A critical question going forward is how these experiences have actually changed preferences and habits in ways that might persist after the pandemic ends. Many observers have suggested theories about what the future will bring, but concrete evidence has been lacking. We present evidence on how much US adults expect their own post-pandemic choices to differ from their pre-pandemic lifestyles in the areas of telecommuting, restaurant patronage, air travel, online shopping, transit use, car commuting, uptake of walking and biking, and home location. The analysis is based on a nationally representative survey dataset collected between July and October 2020. Key findings include that the "new normal" will feature a doubling of telecommuting, reduced air travel, and improved quality of life for some.

Subject Areas: Remote work; Telecommuting; Disruption; Survey; COVID-19

Availability: Salon, D. et al. (2022). *Investigating Attitudinal and Behavioral Changes in U.S. Households Before, During, and After the COVID-19 Pandemic*. Research Report, School of Sustainable Engineering and the Built Environment, Arizona State University Tempe, AZ. https://rosap.ntl.bts.gov/view/dot/62812

10.18. Title: Analysis and Modeling of Changes in Online Shopping Behavior Due to Covid-19 Pandemic: A Florida Case Study

Author(s): Adibfar, A., Gulhare, S., Srinivasan, S., and Costin, A.

Abstract: The emergence of eCommerce and online shopping commenced a new episode in human life and changed trading patterns. Online shopping provided access to a broader range of products and facilitated their delivery, which increased demand. To respond to the increased demand, more heavy commercial vehicles need to be on the roads to deliver orders. This is while the road infrastructure is not ready for such a swift shift, and most roads and bridges were planned and constructed during the 19s when online shopping was not coined yet. The continued increase of heavy vehicles on roads can intensify the deterioration of roads and structures such as bridges. Therefore, there is a significant need for an update on new shopping trends, especially changes in people's behavior due to the ongoing Covid-19 pandemic, and to assess if the pandemic permanently changed the trends of in-store and online shopping. This study first examines the NHTS 2017 data to find the attributes that are significant to online shoppers' behavior. Then a survey is developed to scrutinize Covid-19 effects on the online shopping behavior of users before, during, and after the Covid-19 pandemic. 206 records of data are interpreted through descriptive analysis and discrete choice modeling of users' responses to find the most significant attributes affecting their online shopping behavior. The findings of discrete choice modeling and descriptive analysis support that people tend to go back to stores after the pandemic. The findings of this study show that online and in-store shopping would be balanced after the pandemic and would pursue their normal trends as they were before the pandemic. Based on the findings of this study, it is hard to state that online shopping can vanish in-store shopping due to Covid-19. People still need to go to stores to fulfill their needs for the joy of shopping, interactions with other people, and touching the products they would like to buy. Therefore, transportation stakeholders need to pay special attention to both in-store and online shopping for their planning and operation management of ground transportation infrastructure.

Subject Areas: Long-distance travel; Travel behavior; Travel survey; COVID-19

Availability: Adibfar, A., Gulhare, S., Srinivasan, S., and Costin, A. (2022). "Analysis and Modeling of Changes in Online Shopping Behavior Due to Covid-19 Pandemic: A Florida Case Study." *Transport Policy*, *126*, pp. 162–176. https://doi.org/10.1016/j.tranpol.2022.07.003

10.19. Title: Impacts of the COVID-19 Pandemic on Telecommuting and Travel

Author(s): McNally, M.G., Rafiq, R., and Uddin, Y.S.

Abstract: This chapter examines changes in telecommuting and the resulting activity-travel behavior during the COVID-19 pandemic, with a particular focus on California. A geographical approach was taken to "zoom in" to the county level and to major regions in California and to "zoom out" to comparable states (New York, Texas, Florida). Nearly one-third of the domestic workforce worked from home during the pandemic, a rate almost six times higher than the pre-pandemic level. At least one member from 35% of U.S. households replaced in-person work with telework; these individuals tended to belong to higher income, White, and Asian households. Workplace visits have continued to remain below pre-pandemic levels, but visits to non-work locations initially declined but gradually increased over the first nine months of the pandemic. During this period, the total number of trips in all distance categories except long-distance travel decreased considerably. Among the selected states, California experienced a higher reduction in both work and non-workplace visits and the state's urban counties had higher reductions in workplace visits than rural counties. The findings of this study provide insights to improve our understanding of the impact of telecommuting on travel behavior during the pandemic.

Subject Areas: Telecommute; Activity-travel behavior; COVID-19; California; Workplace

Availability: McNally, M.G., Rafiq, R., and Uddin, Y.S. (2022). "Impacts of the COVID-19 Pandemic on Telecommuting and Travel." *Pandemic in the Metropolis*, *Springer Tracts on Transportation and Traffic*, *20*, pp. 217–232. https://link.springer.com/chapter/10.1007/978-3-031-00148-2_14

10.20. Title: Can I Borrow [for] Your Car? Income, Race, and Automobile Debt in California

Author(s): Blumenberg, E., Siddiq, F., Speroni, S., and Wasserman, J.L.

Abstract: The COVID-19 crisis elevated the importance of private vehicles. The pandemic drove riders off public transit and spawned additional car-based activities such as drive-through testing and vaccinations and curbside pick-ups. Yet millions of low-income and non-white households do not own vehicles. This chapter draws on a unique credit panel dataset to examine automobile debt and delinquency in California. In particular, we examine whether automobile debt patterns during the pandemic differed from those during and coming out of the Great Recession (December 2007–June 2009). We also analyze the response to the COVID-19 recession across neighborhoods by income and race. Similar to the situation during the Great Recession, we find that the number of automobile loans per borrower declined. While the automobile debt burden (the ratio between total automobile debt and aggregate income) also declined, it fell far less during the pandemic than during the Great Recession. Moreover, automobile loan delinquencies spiked during the Great Recession but instead continued to drop during the pandemic. Finally, the COVID-19 crisis affected consumers differently by both race and income. Automobile debt burden rose in low-income, Latino/a, and Black neighborhoods, a pattern that preceded but continued unabated during the pandemic. The findings suggest that COVID-19 relief may have helped some families manage their automobile-related expenditures. However, other factors, such as increasing automobile prices, likely contributed to growing debt burdens, a potential source of financial distress.

Subject Areas: Private vehicles; Automobile debt; COVID-19; Household income

Availability: Blumenberg, E., Siddiq, F., Speroni, S., and Wasserman, J.L. (2022). "Can I Borrow [for] Your Car? Income, Race, and Automobile Debt in California." *Pandemic in the Metropolis*, *Springer Tracts on Transportation and Traffic*, *20*, pp. 19–23.
https://link.springer.com/chapter/10.1007/978-3-031-00148-2_2

10.21. Title: Households with Constrained Off-Street Parking Drive Fewer Miles

Author(s): Currans, K.M., Abou-Zeid, G., McCahill, C., Iroz-Elardo, N., Clifton, K.J., Handy, S., and Pineda, I.

Abstract: Parking supply is one of the most neglected elements of the built environment in travel behavior research, despite evidence linking parking with vehicle use. As transportation impacts of new development are increasingly measured by vehicle miles traveled (VMT), explicitly connecting parking characteristics with vehicle travel is necessary to better inform transportation and land use policy. In this paper, we begin to address this research gap and explore the relationship between constrained parking and household VMT. Utilizing the 2017 National Household Travel Survey (NHTS) California add-on sample, we estimate residential parking constraint for households in Los Angeles County. Then, we develop a two-level model framework. Level 1 (Cost) models estimate travel costs, represented by vehicle ownership as a function of parking constraints, the built environment, and demographics. Level 2 (Demand) models regress household-level total and home-based-work VMT on predicted vehicle ownership, controlling for temporal and environmental characteristics. To further explore the relationship between parking and VMT by place type, we applied Level 1 and Level 2 models to develop a suite of scenarios for typical households in Los Angeles County. Our findings support the hypothesis that the built environment (including parking) influences VMT through travel costs (vehicle ownership). Results from scenarios analysis reveal constrained on-site residential parking (<1 parking space per dwelling unit), accounts for an approximate 10–23 percentage-point decrease in VMT within each place type. Finally, implications for practice and future research are presented.

Subject Areas: Parking; Vehicle miles traveled; Development-level; Transportation impact analyses; Vehicle ownership

Availability: Currans, K.M., Abou-Zeid, G., McCahill, C., Iroz-Elardo, N., Clifton, K.J., Handy, S., and Pineda, I. (2022). "Households with Constrained Off-Street Parking Drive Fewer Miles." *Transportation*. https://doi.org/10.1007/s11116-022-10306-8

10.22. Title: Longitudinal and Spatial Analysis of Americans' Travel Distances Following COVID-19

Author(s): Chen, K. and Steiner, R.

Abstract: Travel has become less common due to COVID-19. While prior research has discussed recent travel changes for Americans in multiple ways, few have examined the adjusted travel that has been sustained since March 2021. In addition, little is known about changes in Americans' travel patterns in trips by distance.

In this research, we asked two questions: 1) How have the numbers of trips by distance changed since 2019? and 2) What are the geospatial patterns of the changes? Data from mid-March to mid-September 2021 indicates a 7% decrease in the number of trips and a 14.5% increase in people staying home. People traveled less except for those in the middle U.S. states, from North Dakota to Texas, as vertically aligned. Staying home more seemed to occur mainly in the South. Trips between 50 and 500 miles increased nationwide. COVID-19 has had different levels of impact on trips of different distance ranges.

Subject Areas: Pandemic; Consistency; Travel behavior; Distance; Geospatial

Availability: Chen, K. and Steiner, R. (2022). "Longitudinal and Spatial Analysis of Americans' Travel Distances Following COVID-19." *Transportation Research Part D: Transport and Environment*, *110*. https://doi.org/10.1016%2Fj.trd.2022.103414

10.23. Title: Behavioral Intention to Ride in an AV and Implications on Mode Choice Decisions, Energy Use and Emissions

Author(s): Gkritza, K., Gkartzonikas, C., Losada-Rojas, L.L., and Zhang, Z.

Abstract: The objective of this project is to examine the potential effects of high-level vehicle automation on energy demand and greenhouse gas (GHG) emissions from vehicles. To achieve this, improved projections of future travel demand and patterns of autonomous vehicles (AVs) were obtained using a stated preference survey distributed in Indianapolis, Indiana, and the associated energy consumption and carbon intensity levels were estimated. Also, a two-stage simulation framework based on an agent-based model was proposed. Different scenarios were designed to examine the impact of the size and composition of fleets of AVs offering single-passenger rides, on GHG emissions, air pollutants, and energy consumption.

Subject Areas: Autonomous vehicles; Behavioral experiments; Energy demand; Greenhouse gas emissions; Intention to ride in AVs

Availability: Gkritza, K., Gkartzonikas, C., Losada-Rojas, L.L., and Zhang, Z. (2022). *Behavioral Intention to Ride in an AV and Implications on Mode Choice Decisions, Energy Use and Emissions*. Final Report, Center for Connected and Automated Transportation, Purdue University, West Lafayette, IN. http://dx.doi.org/10.5703/1288284317569

10.24. Title: Ridesharing, Active Travel Behavior, and Personal Health: Implications for Shared Autonomous Vehicles

Author(s): Gkritza, K. and Losada-Rojas, L.L.

Abstract: Autonomous vehicles (AVs) could have both positive and negative impacts on public health. The most notable benefits relate to reduction in crashes and pollutant emissions. Conversely, AVs can limit opportunities for active travel and associated health benefits. If the adoption of the AV or shared AV technology is not adequately designed, it could likely lead to increases in vehicle-miles traveled (VMT). This may decrease physical activity and aggravate air pollution, and in turn, exacerbate non-communicable diseases, which are nowadays responsible for two-thirds of deaths globally. This study evaluates the relationship between ridesharing (as a proxy for shared travel behavior) and active travel behavior (often measured as the number of trips made by walking or biking) and identifies personal health-related outcomes associated with the adoption of AVs. The study also discusses the built environment settings that are more likely to surround early adopters of AVs. Two metropolitan statistical areas served as case studies. A variety of strategies are recommended to maximize the benefits of SAV technology and mitigate any adverse impacts that this technology may bring.

Subject Areas: Autonomous vehicles; Ridesharing; Shared autonomous vehicles; Adoption; Public health; Active travel; Disadvantaged population

Availability: Gkritza, K. and Losada-Rojas, L.L. (2022). *Ridesharing, Active Travel Behavior, and Personal Health: Implications for Shared Autonomous Vehicles*. Technical Report, Center for Connected and Automated Transportation, Purdue University, West Lafayette, IN. http://dx.doi.org/10.5703/1288284317570

10.25. Title: Interaction Between Information and Communication Technologies and Travel Behavior: Using Behavioral Data to Explore Correlates of the COVID-19 Pandemic

Author(s): Patwary, A.L. and Khattak, A.J.

Abstract: The COVID-19 pandemic has highlighted the importance of information and communication technologies (ICTs) in providing virtual engagement. Planners and engineers must determine whether cities will see reductions in travel demand, given the increasing use of ICTs. Notably, ICTs facilitate online shopping and working from home (WFH). Generally, online shopping may lead to fewer shopping trips; similarly, WFH may reduce work-related trips. However, more WFH has the potential to generate other non-work trips, including shopping trips. To find answers and explore interdependencies, this study integrates pre-pandemic behavioral data with during-pandemic travel data. In our framework, WFH and online shopping are considered together. By harnessing the pre-pandemic 2017 National Household Travel Survey data, this study jointly analyzes the relationships between shopping trips, online shopping, and WFH with a conditional mixed process model that can address unobserved endogeneity and selection bias. The results suggest that, before the pandemic, online shopping was associated with fewer in-person shopping trips while WFH was associated with more shopping trips. The role of socio-demographic, locational, and travel-related factors is also explored. The during-pandemic data and analysis capture how COVID-19 affected travel behavior. Results show that the relationships among the key variables found in the pre-pandemic data are similar but differ in magnitude from during the pandemic. WFH increased from 12% to 61% during COVID-19, admittedly an unusual situation. In the next "new normal," planners may improve travel demand models by treating WFH explicitly as an alternative to traveling to work in the trip generation and time of day models.

Subject Areas: Planning and analysis; Applications; Communications/communications technology; E-shopping; Information and communication technologies; Technology; Telecommuting

Availability: Patwary, A.L. and Khattak, A.J. (2022). "Interaction Between Information and Communication Technologies and Travel Behavior: Using Behavioral Data to Explore Correlates of the COVID-19 Pandemic." *Transportation Research Record: Journal of the Transportation Research Board*. https://doi.org/10.1177%2F03611981221116626

10.26. Title: Impacts of Teleworking and Online Shopping on Travel: A Tour-Based Analysis

Author(s): Shah, H., Carrel, A.L., and Le, H.T.K.

Abstract: Large-scale adoption of telemobility, such as teleworking and online shopping, has affected travel patterns significantly. The impacts of teleworking and online shopping on travel have been studied separately and with trip-level analyses, thereby ignoring tour complexity, trip chaining, and activity scheduling. We aim to address this gap by investigating the interactions between online shopping, teleworking, and travel at a tour level, considering trip chaining and the importance of the activities involved. We classify tours into mandatory (e.g., travel for work, school), maintenance (e.g., travel for grocery shopping, appointments, errands), and discretionary (e.g., travel for non-grocery shopping, leisure, religious activities) tours according to the primary activity purpose. We then estimate a structural equation model using a one-week activity-travel diary from the 2019 Puget Sound Regional Travel Study. The results indicate that teleworking reduced mandatory and maintenance tours while increasing online shopping. Mandatory tours were negatively associated with both maintenance tours and online shopping, whereas the number of maintenance tours was positively associated with the number of discretionary tours. We did not find a statistically significant relationship between online shopping, maintenance tours, and discretionary tours. Overall, this study offers new insights into the effect of teleworking and online shopping on travel, with potential implications for travel demand modeling and management, as well as for the design of travel surveys that take such virtual activities into account.

Subject Areas: Travel behavior; Tour-based model; Information and communication technology; Telemobility; Structural equation model; Survey methods

Availability: Shah, H., Carrel, A.L., and Le, H.T.K. (2022). "Impacts of Teleworking and Online Shopping on Travel: A Tour-Based Analysis." *Transportation*. https://doi.org/10.1007/s11116-022-10321-9

10.27. Title: Characteristics of Everyday Leisure Trips by Car in Sweden—Implications for Sustainability Measures

Author(s): Strömblad, E., Winslott Hiselius, L., Smidfelt Rosqvist, L., and Svensson, H.

Abstract: In search for measures to reduce greenhouse gas emissions from transport, insights into the characteristics of all sorts of trips and specifically trips by car are needed. This paper focuses on everyday leisure trips for social and recreational purposes. Travel behaviour for these purposes is analysed considering individual and household factors as well as properties of the trip, based on Swedish national travel survey data. The analysis reveals that everyday leisure trips are often of joint character and that the average distance travelled per person and day increases with, for example, income, cohabitation, children in the household and residence in rural areas. The result also shows that the studied characteristics vary between studied trip purposes, influencing the sustainability potential of a reduction in car use and suggested measures. For instance, the largest share of passenger mileage comes from social trips, whereas trips for exercise and outdoor life have the largest share of car trips below 5 km. Several characteristics indicate difficulties in transferring trips by car to, for example, bicycle or public transport due to convenience, economy, start times, and company. The study indicates that there is a need to take a broader view of the effective potential.

Subject Areas: Leisure travel; Travel behaviour; Passenger transport; Car mileage; Climate change

Availability: Strömblad, E., Winslott Hiselius, L., Smidfelt Rosqvist, L., and Svensson, H. (2022). "Characteristics of Everyday Leisure Trips by Car in Sweden—Implications for Sustainability Measures." *Promet*, *34*(4), pp. 657–672. https://doi.org/10.7307/ptt.v34i4.4039

10.28. Title: Do Telecommuters Make Fewer Trips? An Analysis of Telecommuting Travel Behavior in Urban and Rural Communities in the USA

Author(s): Reilly, P.J. and Tawfik, A.M.

Abstract: Many believe that telecommuting could be a solution for some of the significant adverse impacts of our transportation systems, e.g., traffic congestion, greenhouse gas and air pollution emissions, and energy consumption. Observations may have further strengthened this belief during the first year of the COVID-19 Pandemic, where streets were deserted and clean air and wildlife returned to urban areas. Accordingly, this study investigates the legitimacy of this belief. The NHTS 2017 data set was used to examine the travel activity of commuting workers against telecommuters. Workers were classified into one of five telecommute classes based on primary work location, telecommute engagement, logged trips, and option to telecommute: home-based workers (those who work predominantly from home), primary and ancillary telecommuters (those who telecommute), passive telecommuters (those who have the option to telecommute), and non-telecommuters. The various forms of telecommuting were found to significantly impact average daily trip counts and average daily trip miles produced in both urban and rural contexts. Contrary to the possibly traditional belief, telecommuters made more trips per day and traveled longer distances per day compared to non-telecommuters. Additionally, the study investigated the differences in trip rates by trip purpose for each of the five telecommuting classes. The analysis revealed that while home-based work (HBW) trips for primary telecommuters decreased significantly, all other trip purposes increased (in number and distance) and in a higher manner than the decrease of the HBW trips. These findings indicate that telecommuting is likely to increase total VMT and associated negative impacts and should inform relevant transportation policies.

Subject Areas: Telecommuting travel; Urban and rural communities; Trip distance; Trip purpose; Vehicle miles of travel

Availability: Reilly, P.J. and Tawfik, A.M. (2022). "Do Telecommuters Make Fewer Trips? An Analysis of Telecommuting Travel Behavior in Urban and Rural Communities in the USA." *International Conference on Transportation and Development 2022*. https://doi.org/10.1061/9780784484340.006

10.29. Title: Car Dependency & Alternative Travel Behavior at the ASU Campus

Author(s): Klomp, R.

Abstract: American metropolitan university campuses have been identified as major trip generators that create many negative externalities such as emissions, nuisance, and congestion as these trips are mostly made by car due to their embeddedness in the American culture. Therefore, a modal shift towards more sustainable modes is encouraged to counter these negativities. This paper aims to gain insight into the level of car dependency and the intention to make use of alternative transport modes among students, faculty, and staff who travel to the Arizona State University's Tempe campus. To research the travel behavior and geographical patterns of these campus attendees, the main research question is as follows: "What is the role of proximity to campus and public transport and the effect of individual characteristics on car dependency and alternative transport mode use intentions for student, faculty, and staff travel to the Arizona State University's Tempe campus in the Phoenix Metropolitan Area?" In doing so, an extensive dataset of the university's Parking & Transit Services includes whether an individual has purchased a campus parking permit or public transportation pass, or has registered a bike combined with their address. Through QGIS mapping of all campus respondents, the results show that those possessing a parking permit are widespread across the Phoenix metropolitan area while individuals that have a bike registration are clustered around the center points of downtown Tempe or campus and downtown Phoenix. The importance of the geographic location of individuals, as well as their proximities and distances from campus and public transport stops, appear to be useful predictors of whether people have a parking permit, bike registration, and/or public transportation pass and opt to have monomodal or multimodal travel intention and behavior towards the ASU campus. Individuals with a public transport pass appear to be located in the downtown areas and along the Phoenix-Mesa railway with no visible clustering around bus stops. Besides, logistic regressions analyses were utilized to identify that the university groups of higher educated, males, those living near a train station, and individuals within half an hour distance driving tend to be less dependent on the car and pursue other forms of transportation. The same conclusions apply to multimodal users who are also for the majority located close to campus. To stimulate changes to the current travel behavior of university affiliates, new policies and infrastructural investments are needed to switch from car-dependent commute to alternative transport that is more sustainable in the long-term while targeting the entire Phoenix Metropolitan Area and those groups that tend to use the car more as opposed to others.

Subject Areas: Car dependency; ASU Tempe campus; Alternative and multimodal transport users; Geographical patterns

Availability: Klomp, R. (2022). *Car Dependency & Alternative Travel Behavior at the ASU Campus*. Master's Thesis, Rijksuniversiteit Groningen, Netherlands & Arizona State University, Tempe, AZ. https://frw.studenttheses.ub.rug.nl/4034/

10.30. Title: Employment Deconcentration and Spatial Dispersion in Metropolitan Areas: Consequences for Commuting Patterns

Author(s): Hipp, J.R., Lee, S., Kim, J.H., and Forthun, B.

Abstract: There is interest in understanding which characteristics of metropolitan areas impact the length of time or distance residents spend commuting. We utilize two measures recently introduced to the urban literature capturing distinct dimensions of employment decentralization—the level of employment deconcentration and employment spatial dispersion in metropolitan areas—to assess how they are related to commuting patterns across metropolitan areas. These two measures of urban/metropolitan spatial structure avoid challenges in identifying "job centers" and allow for a more systematic investigation of how employment decentralization affects commuting patterns. Furthermore, we detect key differences for the implications of these measures for commuting across 329 US metropolitan regions based on their population size. We find that greater employment deconcentration in very small MSAs is associated with longer commute times and distances, whereas greater employment deconcentration in large or very large MSAs is associated with shorter commutes. And whereas spatial dispersion is not related to commute times in very small MSAs, greater spatial dispersion is associated with longer commutes in very large MSAs. This study also shows that the spatial pattern of employment in regions, captured by these new measures, is associated with the proportion of very short and very long duration commutes.

Subject Areas: Metropolitan regions; Employment deconcentration; Urban scale; Commuting patterns; Spatial dispersion

Availability: Hipp, J.R., Lee, S., Kim, J.H., and Forthun, B. (2022). "Employment Deconcentration and Spatial Dispersion in Metropolitan Areas: Consequences for Commuting Patterns." *Cities*, *131*. https://doi.org/10.1016/j.cities.2022.103947

10.31. Title: Is Private-Schooling Problematic for Transportation? Evidence from Southeast Queensland, Australia

Author(s): Yan, Y., Burke, M., Leung, A., and McBroom, J.

Abstract: School travel behaviors are associated with children's health and well-being, traffic congestion, and sustainability. Australia has seen a steady rise in the number of car-passenger trips made by children to school, and a decline in walking-to-school. Australia differs from most nations in that it has one of the highest rates of private schooling in the world at around 34%, supported by high levels of Commonwealth Government funding. Little is known about the effects this has on travel behavior and whether it is a factor in Australia's high rates of chauffeuring. This paper looks at journeys-toschool in South-East Queensland. Two research questions were posed: i) How do students in private and public schools travel to school, including mode shares and median trip-distances by mode?; and ii) Is there any relationship between school type and mode choice, when controlling for key demographic and land use variables? Advanced geo-spatial matching allocated all trips made to schools in the 2017–2019 South East Queensland Travel Survey to either public or private schools. The resulting dataset included 2600 public school students' trips to school and 1117 private school students' trips to school. The public and private schools' commuting travel behavior was then examined. Private motor vehicle is the most frequently chosen mode for travelling to school across the two groups (72.3% for public and 74.6% for private). The proportion of students walking/biking to school is 2.3 times greater for public than for private schools (16.8% vs. 7.3%) even though those two groups share the same median trip distance value in active travel. For all other travel modes (automobile, public transportation and school bus), median trip distances are greater for private school students than private school students. Multinomial logistic regression modelling suggests that private school students are less likely to walk/cycle to school than public school students when controlling for key demographics and schools' urban form characteristics. Private schools appear to disproportionately contribute to traffic congestion. Australia should consider amending its school policy frameworks to help address these concerns.

Subject Areas: Journeys-to-school; Private school; Public school; Urban form; Travel behavior difference

Availability: Yan, Y., Burke, M., Leung, A., and McBroom, J. (2022). "Is Private-Schooling Problematic for Transportation? Evidence from Southeast Queensland, Australia." *Journal of Transport and Land Use*, *15*(1), pp. 567–585. https://doi.org/10.5198/jtlu.2022.1874

10.32. Title: Charging Drivers by the Gallon vs. the Mile: An Equity Analysis by Geography and Income in California

Author(s): Speroni, S., Agrawal, A.W., Manville, M., and Taylor, B.D.

Abstract: This study used data from the 2017 National Household Travel Survey California Add-On sample to explore how replacing the current state vehicle fuel tax with a flat-per-mile-rate road-user charge (RUC) would affect costs for different kinds of households. We first estimated how household vehicle fuel efficiency, mileage, and fuel tax expenditures vary by geography (rural vs. urban) and by income. These findings were then used to estimate how much different types of households pay in the current per-gallon state fuel tax, what they would pay if the state were to replace fuel taxes with a flat-rate road-usage charge (RUC) that would generate revenues similar to the current state fuel tax (2.52¢ per mile driven), and the difference in household expenditures between the fuel tax and RUC.

We find that rural households tend to drive more miles and own less fuel-efficient vehicles than urban ones, so they pay comparatively more in fuel tax and would pay more with the RUC as well. However, this rural/urban variation is less for the RUC than the fuel tax, so moving to a flat-rate RUC would redistribute some of the overall tax burden from rural households (that drive more miles in fuel-thirsty vehicles) to urban households (that drive fewer miles in more fuel-efficient vehicles). Transitioning from the fuel tax to RUC would also generally shift the fuel tax burden from lower-income to higher-income households, with one exception: Expenditures would rise for low-income urban households. However, the variation in the tax incidence between the gas tax and RUC is quite modest, amounting to less than one dollar per week for both urban and rural households at all income levels.

Subject Areas: Mileage-based user fees; Fuel taxes; Travel costs; Social equity; Travel behavior

Availability: Speroni, S., Agrawal, A.W., Manville, M., and Taylor, B.D. (2022). *Charging Drivers by the Gallon vs. the Mile: An Equity Analysis by Geography and Income in California*. Final Report, CA-MTI-2238, Mineta Transportation Institute, San José State University, San José, CA. https://transweb.sjsu.edu/sites/default/files/2238-Agrawal-Equity-Analysis-Road-User-Charge.pdf

10.33. Title: The Long-Term Effects of COVID-19 on Travel Behavior in the United States: A Panel Study on Work from Home, Mode Choice, Online Shopping, and Air Travel

Author(s): Javadinasr, M. et al.

Abstract: A critical challenge facing transportation planners is to identify the type and the extent of changes in people's activity-travel behavior in the post-Covid-19 pandemic world. In this study, we investigate the travel behavior evolution by analyzing a longitudinal two-wave panel survey data conducted in the United States from April 2020 to May 2021. Encompassing nearly 3,000 respondents across different states, we explored the effects of the pandemic on four major categories of work from home, travel mode choice, online shopping, and air travel. We utilized descriptive and econometric measures, including random effects ordered probit models, to shed light on the pandemic-induced changes and the underlying factors affecting the future of mobility in the post-pandemic world. Upon concrete evidence, our findings substantiate significant observed (i.e., during the pandemic) and expected (i.e., after the pandemic) changes in people's habits and preferences. According to our results, 48% of the respondents anticipate having the option to WFH after the pandemic, which indicates an approximately 30% increase compared to the pre-pandemic period. In the post-pandemic period, auto and transit commuters are expected to be 9% and 31% less than pre-pandemic, respectively. A considerable rise in hybrid work and grocery online shopping is expected. Moreover, 41% of pre-covid business travelers expect to have fewer flights (after the pandemic) while only 8% anticipate more, compared to the pre-pandemic.

Subject Areas: Transportation; Telecommute; Online Shopping; Transit; Air Travel; Pandemic

Availability: Javadinasr, M. et al. (2022). "The Long-Term Effects of COVID-19 on Travel Behavior in the United States: A Panel Study on Work from Home, Mode Choice, Online Shopping, and Air Travel." *Transportation Research Part F: Traffic Psychology and Behaviour*, *90*, pp. 466–484. https://doi.org/10.1016/j.trf.2022.09.019

10.34. Title: Tracking the State and Behavior of People in Response to COVID-19 Through the Fusion of Multiple Longitudinal Data Streams

Author(s): Bouzaghrane, M.A. et al.

Abstract: The changing nature of the COVID-19 pandemic has highlighted the importance of comprehensively considering its impacts and considering changes over time. Most COVID-19 related research addresses narrowly focused research questions and is therefore limited in addressing the complexities created by the interrelated impacts of the pandemic. Such research generally makes use of only one of either 1) actively collected data such as surveys, or 2) passively collected data from sources such as mobile phones or retail transactions. While a few studies make use of both actively and passively collected data, only one other study collects it longitudinally. Here we describe a rich panel dataset of active and passive data from U.S. residents collected between August 2020 and July 2021. Active data includes a repeated survey measuring travel behavior, compliance with COVID-19 mandates, physical health, economic well-being, vaccination status, and other factors. Passively collected data consists of all locations visited by study participants, taken from smartphone GPS data. We also closely tracked COVID-19 policies across counties of residence throughout the study period. Such a dataset allows important research questions to be answered—for example, to determine the factors underlying the heterogeneous behavioral responses to COVID-19 restrictions imposed by local governments. Better information about such responses is critical to our ability to understand the societal and economic impacts of this and future pandemics. The development of this data infrastructure can also help researchers explore new frontiers in behavioral science. The article explains how this approach fills gaps in COVID-19 related data collection; describes the study design and data collection procedures; presents key demographic characteristics of study participants; and shows how fusing different data streams helps uncover behavioral insights. The data are available to other researchers wishing to collaborate on future studies.

Subject Areas: COVID-19; Travel Behavior; Data Collection; Longitudinal data; POI Data

Availability: Bouzaghrane, M.A. et al. (2022). *Tracking the State and Behavior of People in Response to COVID-19 Through the Fusion of Multiple Longitudinal Data Streams*. arXiv preprint, arXiv:2209.11805v2 [cs.CY]. https://arxiv.org/abs/2209.11805

10.35. Title: A Qualitative Case Study Examining Individuals' Perceptions of Mode Choice and the Possibility to Reduce Car Mileage for Everyday Leisure Trips

Author(s): Strömblad, E., Hiselius, L.W., Rosqvist, L.S., and Svensson, H.

Abstract: In the transition to more sustainable travel behaviour, there is a need to reduce car mileage for all sorts of trips including everyday leisure trips for social and recreational purposes. In this case study, qualitative interviews were conducted to improve and deepen the understanding of transport mode choice for such trips. The analyses of factors affecting mode choice for everyday leisure purposes and how individuals reason about reducing car mileage for leisure trips reveal that factors matter to different extents depending on types of persons and trips. The interviewees' descriptions of how reducing car mileage would be more or less possible resulted in the identification of four typologies, based on the two dimensions willingness to change and perception of feasibility. A segmentation based on these four typologies demonstrates that all kinds of measures are needed and helps identify policy measures that are relevant for and accepted by different groups of people. For example, the results imply that for the group with high willingness to change and low perception of feasibility a combination of soft and infrastructure "pull" measures is appropriate, whereas the group with low willingness to change and high perception of feasibility needs a combination of both "pull" and "push" measures.

Subject Areas: Everyday leisure travel; Social and recreational trips; Mode choice; TBP; COM-B; Policy measures

Availability: Strömblad, E., Hiselius, L.W., Rosqvist, L.S., and Svensson, H. (2022). "A Qualitative Case Study Examining Individuals' Perceptions of Mode Choice and the Possibility to Reduce Car Mileage for Everyday Leisure Trips." *Case Studies on Transport Policy*, *10*(4), pp. 2183–2194. https://doi.org/10.1016/j.cstp.2022.09.013

10.36. Title: Travel Behavior on Vacation: Transport Mode Choice of Tourists at Destinations

Author(s): Bursa, B., Mailer, M., and Axhausen, K.W.

Abstract: Tourist travel contributes greatly to transport problems in highly attractive tourist areas. Despite that, local travel behavior of visitors at the destination has hardly been investigated so far. To fill this gap, we used data from a bespoke travel-activity survey conducted in the Austrian Alps to develop models of transport mode choice of tourists during their vacation stays at the resorts. The outcomes reveal significant effects of inter alia, travel time, travel cost, travel party composition, trip purpose, respondent's level of fitness, their knowledge about long-distance travel to the destination and mobility options at the destination, and selected weather elements. Tourists are found to be very inelastic to changes in travel cost, while more responsive to changes in travel time. The paper delivers unique evidence that can advance transport policy design and thus contribute to more sustainable travel at tourist destinations.

Subject Areas: Tourist travel behavior; Tourist mobility; Intra-destination; Sustainable tourism; Transport mode choice; Logit model

Availability: Bursa, B., Mailer, M., and Axhausen, K.W. (2022). "Travel Behavior on Vacation: Transport Mode Choice of Tourists at Destinations." *Transportation Research Part A: Policy and Practice*, *166*, pp. 234–261. https://doi.org/10.1016/j.tra.2022.09.018

10.37. Title: "Would It Be Weird to Live Here Without a Car?": Using Social Media to Understand Car Ownership Decisions

Author(s): Iacobucci, E.

Abstract: Transportation practitioners and scholars increasingly view car-free mobility as an essential component of a sustainable, healthy, and safe transportation future. In the United States, however, strikingly few households—only around 9%—do not own cars. Moreover, most zero-vehicle individuals—around 80%—are without vehicles due to constraint (e.g., because they cannot afford one), while a much smaller fraction—around 20%—are car-free because they can meet their mobility needs without one. This latter group is of interest to transportation researchers and practitioners, given the imperative to reduce driving and its associated negative externalities. In this paper, I examine factors that contribute to individuals' decisions to live car-free. This research is based on 430 comments posted on the social content-sharing website Reddit, in which commenters shared their first-hand experiences related to the prospect of going car-free. These comments were obtained from 46 threads situated in seven different US cities, focusing specifically on car ownership decisions. Commenters described accessible neighborhoods as foundational to decisions to forego a vehicle. While such conditions were typically necessary, however, they sometimes were not sufficient to foster car-free choices. Costs of car ownership, especially parking costs, were often the deciding factor for commenters who opted not to have a car. Finally, inconveniences related to car ownership and travel, like traffic-related stress, were discussed as benefits of living car-free. In sum, the observed individual decisions about car ownership tend to consist of people balancing supportive conditions for non-car travel against costs of and constraints on car-travel.

Subject Areas: Car ownership; Reddit; Automobile dependence; Car-free; Content analysis

Availability: Iacobucci, E. (2022). "'Would It Be Weird to Live Here Without a Car?': Using Social Media to Understand Car Ownership Decisions." *Transportation*. https://doi.org/10.1007/s11116-022-10340-6

10.38. Title: Impacts of Micromobility on Car Displacement with Evidence from a Natural Experiment and Geofencing Policy

Author(s): Asensio, O.I., Apablaza, C.Z., Lawson, M.C., Chen, E.W., and Horner, S.J.

Abstract: Micromobility, such as electric scooters and electric bikes—an estimated US$300 billion global market by 2030—will accelerate electrification efforts and fundamentally change urban mobility patterns. However, the impacts of micromobility adoption on traffic congestion and sustainability remain unclear. Here we leverage advances in mobile geofencing and high-resolution data to study the effects of a policy intervention, which unexpectedly banned the use of scooters during evening hours with remote shutdown, guaranteeing near perfect compliance. We test theories of habit discontinuity to provide statistical identification for whether micromobility users substitute scooters for cars. Evidence from a natural experiment in a major US city shows increases in travel time of 9–11% for daily commuting and 37% for large events. Given the growing popularity of restrictions on the use of micromobility devices globally, cities should expect to see trade-offs between micromobility restrictions designed to promote public safety and increased emissions associated with heightened congestion.

Subject Areas: Civil engineering; Energy policy; Sustainability; Technology

Availability: Asensio, O.I., Apablaza, C.Z., Lawson, M.C., Chen, E.W., and Horner, S.J. (2022). "Impacts of Micromobility on Car Displacement with Evidence from a Natural Experiment and Geofencing Policy." *Nature Energy*, *7*, pp. 1100–1108. https://doi.org/10.1038/s41560-022-01135-1

10.39. Title: Traffic Related Activity Pattern of Chinese Adults: A Nation-Wide Population Based Survey

Author(s): Jiang, N. et al.

Abstract: Background: Traffic-related air pollutants lead to increased risks of many diseases. Understanding travel patterns and influencing factors are important for mitigating traffic exposures. However, there is a lack of national large-scale research.

Objective: This study aimed to evaluate the daily travel patterns of Chinese adults and provide basic data for traffic exposure and health risk research.

Methods: We conducted the first nation-wide survey of travel patterns of adults (aged 18 and older) in China during 2011–2012. We conducted a cross-sectional study based on a nationally representative sample of 91,121 adults from 31 provinces in China. We characterized typical travel patterns by cluster analysis and identified the associated factors of each pattern using multiple logistic regression and generalized linear regression models.

Results: We found 115 typical daily travel patterns of Chinese adults and the top 11 accounted for 94% of the population. The interaction of age, urban and rural areas, income levels, gender, educational levels, city population and temperature affect people's choice of travel patterns. The average travel time of Chinese adults is 45 ± 40 min/day, with the longest travel time by the combination of walking and car (70 min/day). Gender has the largest effect on travel time ($B = -8.94$, 95% CI: −8.95, −8.93), followed by city GDP ($B = -4.23$, 95% CI: −4.23, −4.22), urban and rural areas ($B = -3.62$, 95% CI: −3.63, −3.61), age ($B = -2.21$, 95% CI: −2.21, −2.2), educational levels ($B = -1.53$, 95% CI: −1.53, −1.52), city area ($B = -1.4$, 95% CI: −1.4, −1.39) and temperature ($B = 1.21$, 95% CI: 1.2, 1.21).

Significance: This study was the first nation-wide study on traffic activity patterns in China, which provides basic data for traffic exposure and health risk research and provides the basis for the state to formulate transportation-related policies.

Subject Areas: Travel pattern; Travel time; Adults; Traffic-related air pollution

Availability: Jiang, N. et al. (2022). "Traffic Related Activity Pattern of Chinese Adults: A Nation-Wide Population Based Survey." *Journal of Exposure Science & Environmental Epidemiology*. https://doi.org/10.1038/s41370-022-00469-y

10.40. Title: Exploring the Endogenous Effects Among Car Dependency, Work Arrangement Choice, and Daily Travel Using the 2017 NHTS Data

Author(s): Asgari, H. and Jin, X.

Abstract: The paper presents an effort in investigating the cause-effect relationships among telecommuting, car dependency, and trip making behavior. Data from the 2017 National Household Travel Survey (NHTS) was used to develop a structural equations model (with latent constructs) to examine the endogenous effects between the decision to telework, the degree of car dependency, and the number of daily trips. Using confirmatory factor analysis, car dependency was measured by vehicle ownership, annual mileage, and car use frequency. The model provided interesting insights. Car dependency had a negative (both direct and total) impact on telework, an inference that confirms the role of car dependency as a resistant factor against alternative work arrangements and potentially any other new tech-based policies. In the opposite direction and surprisingly, telework encouraged car dependency, which might indicate that teleworkers tended to utilize the relaxed temporal-spatial constraints for non-work trips, and they were unlikely to give up private vehicle ownership simply because of their option to telecommute. Second, number of daily trips tended to increase the probability to telework, confirming the positive endogenous role of daily activity patterns on work arrangement decisions in a daily framework. Lastly, the significant negative impact of telework on daily trips was positively mediated through car dependency, leading to a smaller negative total impact on daily trips. Our study confirms that the association between telework and trip generation is quite a complex and multi-faceted relationship, leaving the argument regarding whether or not telework increases the number of daily trips as a debatable topic that calls for further exploration.

Subject Areas: Telework; Car dependency; Daily travel; Structural equations model; Endogeneity

Availability: Asgari, H. and Jin, X. (2022). "Exploring the Endogenous Effects Among Car Dependency, Work Arrangement Choice, and Daily Travel Using the 2017 NHTS Data." *International Journal of Transportation Science and Technology*. https://doi.org/10.1016/j.ijtst.2022.10.003

10.41. Title: Work from Home Behaviors Among U.S. Urban and Rural Residents

Author(s): Paul, J.

Abstract: Rates of working from home (WFH) have grown quickly over the last two decades, yet the option to do so varies by job sector and education level. Due to the advantages associated with WFH, equity concerns have arisen regarding the types of workers still required to commute. While previous studies have identified relationships between socioeconomic status and WFH access, few researchers have addressed the role of residential location. This paper uses pre-pandemic survey data to identify differences in WFH behaviors among U.S. rural and non-rural workers. To isolate the independent effect of residential location, this analysis uses binomial logistic and multinomial logistic regressions of 2017 travel data. Compared to urbanites, rural people prefer to work from home but less frequently can do so, all else equal. Findings on ethnicity, education, household structure, and professional employment also suggest distinct associations with WFH access by urban/rural residence. Understanding WFH behaviors among people facing accessibility disadvantages— including rural residents—remains a critical task for researchers. The decline of the commute may be the most remarkable emerging trend in travel behavior. This may disadvantage people who cannot WFH, and rural residents may thus face new employment challenges and travel burdens. Efforts to support rural workers should prioritize access to technology infrastructure and jobs that can be done virtually.

Subject Areas: Rural transportation; Work from home; Travel behavior; Telework; Commuting

Availability: Paul, J. (2022). "Work from Home Behaviors Among U.S. Urban and Rural Residents." *Journal of Rural Studies*, *96*, pp. 101–111. https://doi.org/10.1016/j.jrurstud.2022.10.017

10.42. Title: Who Bears the Cost of Congestion: Evidence from 2017 NHTS—A Distributional Analysis of Congestion Cost in the U.S.

Author(s): Dong, C.Y.

Abstract: Congestion pricing policies have long been problematic after decades of research. Charging for public resource that used to be free is never popular among citizens, and the possible regressive nature of congestion charging makes it also undesirable among policy makers. This research develops a theoretical model for calculating the households' time loss from congestion and then, provides a series of distributional analyses based on different household characteristics, like household location, income groups and racial groups.

Under the urban-to-urban trips, it's shown that there are certain groups of households, like households living in areas with higher population density, low-income households, and white households, suffering from more congestion time loss than others. Later, with all trips taken into consideration, I find that most of the congestion time loss comes from urban-to-urban trips, and the groups of households that suffer from more congestion time loss won't change.

These findings suggest that it is not fair to charge for driving personal vehicles on congested roads. To deal with the regressive nature of congestion pricing, finding the right way, like reimburse the low-income group through commute allowance or make improvement for public transportation, to make up for disadvantaged groups is highly in need.

Subject Areas: Congestion; Time loss; Distributional analysis; Households; income; Racial; Regional

Availability: Dong, C.Y. (2022). *Who Bears the Cost of Congestion: Evidence from 2017 NHTS—A Distributional Analysis of Congestion Cost in the U.S.* Master's Thesis, Tufts University, Medford, MA. https://www.proquest.com/openview/3712d83aab9d1d6a3e352a14bc7e8451/1.pdf?pq-origsite=gscholar&cbl=18750&diss=y

10.43. Title: The Relationship Between Socio-Demographic Constraints, Neighborhood Built Environment, and Travel Behavior: Three Empirical Essays

Author(s): Kwon, K.

Abstract: Socio-demographics may represent constraints that shape different travel outcomes of individuals. This leads to studies with not only different findings on travel behavior, but also mixed and inconclusive conclusions on the effects of built environment on individuals' travel outcomes. There are gaps in many existing studies on the relationship between socio-demographics, built environment, and travel behavior, which need to be filled. In addition, the existing literature has not paid much attention to the varying impacts of neighborhood-built environment on travel outcomes across different socio-demographic groups. Many signs from U.S. Census Bureau and Centers for Disease Control and Prevention (CDC) indicate that the socio-demographics of the U.S. society are undergoing a process of significant changes. It is uncertain how these changes may affect travel behavior in the short term and the long term. In the face of this uncertainty, a key challenge for transportation planners and policymakers is to understand how socio-demographics affect individuals' travel outcomes and out-of-home activities. These major trends that affect future travel patterns will dramatically reshape transportation priorities and needs. This dissertation quantitatively examines the links between socio-demographic constraints, neighborhood-built environments, and travel behavior. This dissertation comprises three essays. The first essay explores gender differences in commute behavior with a focus on two-earner households. The second essay examines the links between walkability and transit use, focusing on the differences between disabled individuals and others. The third essay explores how neighborhood walkability affects older adults' walking trips, considering different household income levels. The first essay utilizes the detailed individual-level data from 2001, 2009, and 2017 National Household Travel Survey (NHTS). The NHTS datasets provide information on travel by U.S. residents in all 50 states, which include data on individuals, households, travel behavior, and vehicle ownership (U.S. Department of Transportation, 2017). The second and third essays mainly rely on data from the 2017 National Household Travel Survey–California Add-on (2017 NHTS–CA), which includes data on individuals, households, travel behavior, and vehicle ownership. In addition to these, the California Add-on dataset includes geo-coded location information. The findings of three essays suggest that socio-demographics significantly influence travel outcomes such as commute distances, transit trips, and walking trips. In addition, the findings provide empirical evidence on how neighborhood-built environments affect individuals' travel outcomes differently based on socio-demographics. This helps transportation planners and policymakers to find motivators or barriers to change individuals' travel outcomes and reshape the current transportation systems to better support future travel demand. Therefore, the dissertation contributes to a better understanding of the links between socio-demographics, neighborhood-built environment, and travel behavior, which can create opportunities to make U.S. cities more equitable and sustainable.

Subject Areas: Travel behavior; Socio-Demographic constraints; Neighborhood built environment; National Household Travel Survey (NHTS) data; Seemingly Unrelated Regression (SUR) model; Negative Binomial (NB) regression model

Availability: Kwon, K. (2022). *The Relationship Between Socio-Demographic Constraints, Neighborhood Built Environment, and Travel Behavior: Three Empirical Essays*. Doctoral

Dissertation, Ohio State University, Columbus, OH.
http://rave.ohiolink.edu/etdc/view?acc_num=osu1657182322636623

10.44. Title: Exploring Heterogeneous Structural Relationships Between E-Shopping, Local Accessibility, and Car-Based Travel: An Application of Enriched National Household Travel Survey Add-On Data

Author(s): Kim, S.H., Mokhtarian, P.L., Choo, S., and Circella, G.

Abstract: This study analyzes structural relationships between information and communication technology (ICT), e-shopping, local accessibility, and travel intensity in the U.S. State of Georgia. Beginning with the 2017 National Household Travel Survey (NHTS), we enriched the data by exploiting the add-on program. After obtaining contact information for the Georgia NHTS participants who expressed willingness to take a follow-up survey, we conducted another survey with those participants. In addition, we appended land use characteristics associated with respondents' home locations. To test the hypothesis of possible heterogeneity in structural relationships, we applied a mixed structural equation model. We corroborated our hypotheses that the use of ICT has a positive impact on e-shopping frequency, whereas local accessibility reduces e-shopping frequency. In addition, we identified two meaningful segments exhibiting different structural relationships. The smaller segment (12.7%) showed complementary effects of e-shopping on car-based travel intensity, but local accessibility did not have a significant impact on car-based travel intensity. The dominant segment (87.3%) presented a negative impact of local accessibility but no meaningful effect of e-shopping frequency on car-based travel intensity. A post-hoc analysis revealed meaningful differences in demographics between the two classes. The study suggests that an assumption of homogeneous structural relationships between e-shopping and car-based travel intensity and between local accessibility and car-based travel intensity may not hold. The paper discusses benefits and practical issues concerning fusion of the NHTS data with other data sources. In addition, it stresses the potential of the NHTS add-on program and notes some recommendations.

Subject Areas: Structural relationships; Information and communication technology (ICT); E-shopping; Local accessibility; Travel intensity; Georgia

Availability: Kim, S.H., Mokhtarian, P.L., Choo, S., and Circella, G. (2022). "Exploring Heterogeneous Structural Relationships Between E-Shopping, Local Accessibility, and Car-Based Travel: An Application of Enriched National Household Travel Survey Add-On Data." *Transportation Research Record: Journal of the Transportation Research Board*. https://doi.org/10.1177/03611981221132854

Chapter 11. Trend Analysis and Market Segmentation

11.1. Title: Are Solo Driving Commuters Ready to Switch to Carpool? Heterogeneity of Preferences in Lyon's Urban Area

Author(s): Le Goff, A., Monchambert, G., and Raux, C.

Abstract: We conduct a discrete choice experiment on 1556 solo-driving commuters in Lyon, France to estimate the values of end-to-end travel time (VoTT) of commuting trips in the presence of a HOV-lane for four modes: Solo Driver, Carpool Driver, Carpool Passenger and Public Transport. Using discrete choice models, we find a strong heterogeneity in VoTT across modes and individuals. The analysis of individual heterogeneity distinguishes four behavior patterns: reluctant to mode change (20 percent of our sample), preferring the three alternative modes over solo driver (35 percent), preferring public transport (12 percent) and preferring driver modes whether solo or carpool (32 percent). We find that current solo drivers are more likely to switch to carpooling as a driver rather than as a passenger. As suggested by our simulations aimed at marginally changing mode shares, carpool passenger will be the scarce resource if one wants to decrease car traffic by stimulating carpooling for commuting trips.

Subject Areas: Carpool; Commuting trips; Discrete choice experiment; Values of time

Availability: Le Goff, A., Monchambert, G., and Raux, C. (2022). "Are Solo Driving Commuters Ready to Switch to Carpool? Heterogeneity of Preferences in Lyon's Urban Area." *Transport Policy*, *115*, pp. 27–39. https://doi.org/10.1016/j.tranpol.2021.10.001

11.2. Title: U.S. Vehicle Occupancy Trends Relevant to Future Automated Vehicles and Mobility Services

Author(s): Klinich, K.D., Leslie, A., Hariya, S., Flannagan, C.A.C., Reed, M.P., and Hallman, J.

Abstract: Objective: Identifying current occupant travel patterns can inform decision making regarding the design, regulation, and occupant protection systems helpful for automated vehicle systems and mobility services.

Methods: Two travel data sets were analyzed to quantify travel patterns: the 2017 National Household Travel Survey (NHTS), which provides data on household trips logged for a 24-hour period, and the 2011–2015 National Automotive Sampling System–General Estimates System (NASS-GES), which contains data sampled from police-reported crashes. Analysis identified trends with driver age and gender, occupant age and gender, time of day, day of week, trip purpose, trip duration, vehicle type, as well as occupant role as solo driver, driver of others, single passenger, or multiple passengers.

Results: In NHTS, the median trip duration is 15 min; only 10 percent of trips last longer than 40 min. Trip duration does not vary with occupant role or vehicle type. Variations with trip time of day and day of week show a unimodal pattern for weekends, as well as weekday trips for those aged 55 years and older and non-solo occupants aged 18 to 29 years. Other occupant groups have a bimodal weekday travel pattern with peak trips corresponding to morning and evening rush hours.

In GES, approximately half of occupants are solo drivers. Female drivers aged 55 and older travel alone 60 percent of the time, and drivers under age 18 and female drivers aged 30 to 54 drive alone on less than 45 percent of trips. Approximately 13 percent of occupants are single passengers, and 16 percent travel with a driver and at least 1 other passenger. About 16 percent of occupants are front seat passengers.

Conclusions: This analysis of vehicle occupancy provides insights on what ridership of future automated vehicles and expanded ride-hailing services may look like. Because half of occupants are solo drivers, only 16 percent are multiple passengers, and median trip length is just 15 min, proposed alternative seating arrangements intended to promote comfort and passenger interaction may not represent the typical future vehicle use case in the United States. Knowledge of current occupancy patterns can help automated vehicle designers and regulators develop safe seating scenarios that meet customer needs.

Subject Areas: Trips; Duration; Drivers; Travel patterns; Passengers; Seating position

Availability: Klinich, K.D., Leslie, A., Hariya, S., Flannagan, C.A.C., Reed, M.P., and Hallman, J. (2021). "U.S. Vehicle Occupancy Trends Relevant to Future Automated Vehicles and Mobility Services." *Traffic Injury Prevention*, *22*(sup1), pp. S116–S121. https://www.tandfonline.com/doi/full/10.1080/15389588.2021.1964491

11.3. Title: Generational Patterns of Modal Shares Across Megaregions

Author(s): Li, Y. and Zhang, M.

Abstract: Millennials are the largest generation in the current U.S. population. Their travel preferences and choices have profound implications for the travel industry and transportation policy making. The existing literature, however, has presented mixed findings on whether Millennials differ from their preceding generations in vehicle usage, walking or biking, and transit riding. Furthermore, the majority of the existing studies investigated generational travel at the national level; few have explored the spatial variation of generational travel at the subnational scale. This study examines individuals' modal shares in daily travel by Millennials, Generation X, and Baby Boomers across megaregions. A unique dataset is assembled with national travel surveys from 1977 to 2017, covering the age spectrum from five years to 71 years for the three generations. The study applies multilevel modeling to capture the dynamic effects associated with generational, megaregional, and period variations on individuals' modal share. Results of the study show the varying trends of modal shares in different life stages between generations. Millennials in adulthood maintain the highest walk/bike share and the lowest share of vehicle travel among all generations. Megaregional variations exert differentiated influences on individuals' mode share patterns across generation subgroups. The varying trends of modal shares over the age spectrum across generations highlight the importance of having cohort-tailored initiatives to achieve sustainable transportation objectives. The study's quantification of megaregional and generational variations on modal shares provides useful information for modal split analysis and other transportation planning practices at the level between states and metropolitan areas.

Subject Areas: Modal share; Generational difference; Megaregions; Nationwide Personal Transportation Survey/National Household Travel Survey

Availability: Li, Y. and Zhang, M. (2022). "Generational Patterns of Modal Shares Across Megaregions." *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(6), pp. 141–155. https://doi.org/10.1177%2F03611981211073090

11.4. Title: Establishing a Dual Generational Modality Dataset: Comparing the Ride-Sharing Consumers from Two Generational Cohorts, Millennials and Gen-Xers

Author(s): Alakshendra, A., Thomas, A., Steiner, R., and Anderson, J.D.

Abstract: Ride-hailing services such as Uber or Lyft are the latest tool in sustainable transportation strategies to come under scrutiny. Originally thought to be a way to reduce congestion, these services have actually been shown to increase it in some cases. Although the number of individuals driving around urban centers to find parking appears to decrease with the adoption of ridehailing, Uber or Lyft drivers are instead circling around waiting for riders. Additionally, ride-hailing services have not led to the abandonment of personal vehicles, but rather to the abandonment of public transit in some cases.

The purpose of this study is to evaluate the use of ride-hailing services in the two largest age cohorts in the United States: Millennials and Generation X-ers, focusing on the Southeast. This study seeks to determine how each generation has adopted these methods to help planners learn how to incorporate these strategies in transportation planning.

The results of this study illustrate that both generations use ride-hailing services, but as seen in previous studies, millennials are more inclined to use them. Ride-hailing also serves as an important commute mode, particularly for millennials. In addition, and of importance to planners, the market has diversified, and more users are coming from the suburbs. Overall usage of ridesharing services will likely continue to increase over time and planning strategies should attempt to predict this change rather than respond to it.

Subject Areas: Ride-hailing; Ride-sharing; Congestion; Millennial; Generation X

Availability: Alakshendra, A., Thomas, A., Steiner, R., and Anderson, J.D. (2022). *Establishing a Dual Generational Modality Dataset: Comparing the Ride-Sharing Consumers from Two Generational Cohorts, Millennials and Gen-Xers*. Final Report, STRIDE Project E2, University of North Carolina, Chapel Hill, NC. https://stride.ce.ufl.edu/wp-content/uploads/sites/153/2022/01/STRIDE-Final-Report-Project-E2-FINAL.pdf

11.5. Title: Ridesharing as a Potential Sustainable Transportation Alternative in Suburban Universities: The Case of Najran University, Saudi Arabia

Author(s): AlQuhtani, S.

Abstract: In Saudi Arabia, car ownership rates are considered comparatively high due to the lack of other alternatives, cheap fuel and car registration costs, and higher income. The population relies mainly on automobiles for their daily trips and primarily commutes alone, contributing to many negative consequences. Therefore, ridesharing is a transportation mode that is a suitable approach in such an area, since it can increase the occupancy rates and reduce single-occupant driving, which in turn can cut vehicle emissions, contribute to a reduction in vehicle ownership and vehicle miles traveled, alleviate traffic congestions and accidents, and decrease the need for parking spaces. Suburban universities are considered major trip generators and attractors. They also can offer a niche market for ridesharing programs. Thus, data was obtained from a survey performed at Najran University to investigate the ridesharing behavior among the university population. Following a descriptive analysis of the commuter survey data, a binary logistic regression model was adopted to investigate the interest in ridesharing. The estimation results show being female and non-Saudi, as well as being students and faculty members in general (versus staff), along with the presence of fixed (regular) work or class schedules, increase the likelihood of ridesharing. Since the probability of most of the university population (i.e., students and faculty members) toward ridesharing is high, the number of automobiles needed by commuters will be reduced, resulting in a higher transition to environmentally sustainable urban mobility. In addition, the university has many motivators that can positively affect the propensity to rideshare, such as the lack of public transportation, fixed schedules, a longer distance to campus, and a similar social background among attendees; therefore, universities or other large employers can take these motivators into account when planning ridesharing services.

Subject Areas: Ridesharing; Carpooling; Vanpooling; Binary logistic regression; Najran

Availability: AlQuhtani, S. (2022). "Ridesharing as a Potential Sustainable Transportation Alternative in Suburban Universities: The Case of Najran University, Saudi Arabia." *Sustainability*, *14*(8). https://doi.org/10.3390/su14084392

11.6. Title: Formative Experiences and the Price of Gasoline

Author(s): Severen, C. and van Benthem, A.A.

Abstract: Formative experiences shape behavior for decades. We document a striking feature about those who came of driving age during the oil crises of the 1970s: they drive less in the year 2000. The effect is not specific to these cohorts; price variation over time and across states indicates that gasoline price changes between ages 15–18 generally shift later-life travel behavior. Effects are not explained by recessions, income, or costly skill acquisition and are inconsistent with recency bias, mental plasticity, and standard habit-formation models. Instead, they likely reflect formation of preferences for driving or persistent changes in its perceived cost.

Subject Areas: Formative experiences; Preference persistence; Path dependence; Driving behavior; Gasoline price

Availability: Severen, C. and van Benthem, A.A. (2022). "Formative Experiences and the Price of Gasoline." *American Economic Journal: Applied Economics, 14*(2), pp. 256–284. https://www.aeaweb.org/articles?id=10.1257/app.20200407

11.7. Title: New Equity Inputs to Prioritize Bikeshare Infrastructure Allocation: Learning From the COVID-19 Period

Author(s): Davidson, J.H., Nam, S.J., Karam, S., Koroma, F.K., Kim, E.M., and Ryerson, M.S.

Abstract: From "pop-up" road closures to decreased transit frequencies, the COVID-19 pandemic has changed the overall supply of transport options. Even in the absence of a change in bikeshare supply, the pandemic provides a "natural experiment" under which we can assess changes in bikeshare use across diverse communities in response to transportation system changes. The pandemic offers a unique moment to particularly measure changes in use for low socioeconomic status (SES) populations as historically limited deployments of bikeshare in low-income neighborhoods limit evaluation of key metrics for this population. For low SES users to realize greater accessibility through bikeshare, they may need to take relatively longer trips, given the sparse nature of the network in low-income areas and the existing inequitable geography of opportunities in urban environments in the United States. As such, we measure the effect of the COVID-19 pandemic on average daily bikeshare trip durations in Philadelphia, PA—the major city with the highest poverty rate in the United States. Through an interrupted time series approach, we find that the effect of the pandemic on trip duration for all bikeshare users is substantial (approximately 7–12-min increase), positive, and similar across diverse geographic areas. Importantly, these findings are persistent and statistically significant even when fitting models only on data from predominantly low SES areas of Philadelphia. This change pattern suggests first that low SES users exhibit roughly equal propensity as the general population to take longer trips, and second that bikeshare can provide a resilient, equitable travel mode.

Subject Areas: Bikeshare; COVID-19; Regression discontinuity; Equity; Time series

Availability: Davidson, J.H., Nam, S.J., Karam, S., Koroma, F.K., Kim, E.M., and Ryerson, M.S. (2022). "New Equity Inputs to Prioritize Bikeshare Infrastructure Allocation: Learning From the COVID-19 Period." *Transportation Research Record: Journal of the Transportation Research Board*. https://doi.org/10.1177%2F03611981221098390

11.8. Title: 10 Cars with 250,000-Mile Lifespans

Author(s): Not available.

Abstract: Blog.

Subject Areas: Car purchase; Longevity; Self-reported odometer readings; Maintenance; Fuel economy

Availability: Not available. (2022). “10 Cars with 250,000-Mile Lifespans.” *CoPilot*. https://www.copilotsearch.com/posts/10-cars-with-250000-mile-lifespans/

11.9. Title: The COVID-19 Economic Shutdown and the Future of Flexible Workplace Practices in the South Bay Region of Los Angeles County

Author(s): Prager, F., Rhoads, M., and Martínez, J.N.

Abstract: The COVID-19 lockdown has increased the use of flexible workplace practices (FWP) especially work from home, demonstrating their importance to the resilience of transportation systems and regional economies. This study compares experiences and perceptions of FWP and related policy interventions before and during the COVID-19 shutdown, using a mixed-methods approach focusing on the South Bay region of Los Angeles County, to inform projections about the use of FWP and policy implications post-COVID. Pre-shutdown surveys and focus groups interviews confirmed that major obstacles to FWP expansion were a combination of managerial and executive resistance, alongside occupational constraints. Pre-shutdown interviews suggested that costs associated with manager training and cultural transition are major concerns for executives. A small sample of follow-up interviews with executives, managers, and staff, conducted during the shutdown period has revealed some of the practical issues with full-time FWP such as work-life balance, childcare, productivity, IT hardware and software, and network connectivity. Although organizations have been forced into flexible arrangements, many are considering continuing to utilize the practices after the pandemic settles down. In terms of policy interventions, pre-COVID participants perceived government subsidies and incentives as the most desirable government programs. However, in a resource-constrained post-COVID world, policy makers might instead focus on training programs and promotional campaigns tied to public health messaging, and the implications of reduced commuting for transportation system design and commercial zoning and land use.

Subject Areas: Car purchase; Longevity; Self-reported odometer readings; Maintenance; Fuel economy

Availability: Prager, F., Rhoads, M., and Martínez, J.N. (2022). "The COVID-19 Economic Shutdown and the Future of Flexible Workplace Practices in the South Bay Region of Los Angeles County." *Transport Policy*, *125*, pp. 241–255. https://doi.org/10.1016/j.tranpol.2022.06.004

11.10. Title: E-shopping and Household Travel Before, During, and After the Time of Covid-19

Author(s): Xu, L.

Abstract: During the past two to three decades, and especially during the Covid-19 pandemic, e-shopping has become increasingly popular, changing the way people shop and travel. With increasing concerns about the environmental impacts of transportation, particularly on regional air quality and on emissions of greenhouse gases (GHG), it is important to understand how e-shopping has affected household travel behavior. In this dissertation, I investigated the influence of e-shopping before, during, and after the pandemic by analyzing data from the 2009 and the 2017 U.S. National Household Travel Surveys (NHTS), from the 2017 American Time Use Survey (ATUS), and from an IPSOS survey of Californians conducted in late May 2021. Understanding changes in shopping is essential to business owners, logistics managers (for adapting supply chains), transportation planners (for mitigating the impacts of warehousing and of additional residential freight deliveries), and policymakers (for helping at-risk and underserved groups). This dissertation has three parts. In the first part, I estimated zero-inflated negative binomial models to analyze factors that affected residential deliveries before the pandemic based on the 2009 and 2017 NHTS. I found that e-shoppers in the U.S. were more varied in 2017 than in 2009. Households with more females, higher incomes, and more education, received more deliveries. I also analyzed the 2017 ATUS to explore factors that influence grocery shopping. I found that in-store grocery shoppers were more likely to be female and unemployed but less likely to be younger, to have less than a college education, and to be African American. In contrast, online grocery shoppers were more likely to be female. In the second part, I studied the impact of e-shopping on household travel using propensity score matching. My analysis of 2017 NHTS data showed that before the pandemic, greater online shopping was associated with more frequent trips and slightly more travel. Furthermore, the extent to which an increase in the number of activities translated into more travel depends on population density, the day of the week, the frequency of online shopping, and the type of activity. In the third part, I analyzed the impact of the Covid-19 pandemic on grocery shopping frequency in-store, and online with home delivery (e-grocery) or pickup (click-and-pick), to understand how they changed due to the pandemic, and how they may change after, using ordered models and structural equation models. My results showed that Californians kept shopping for groceries in brick-and-mortar stores during the pandemic but less frequently than before. The pandemic accelerated the adoption of e-grocery and click-and-pick with some strong generation effects: younger generations were more likely to experiment with e-grocery and click-and-pick, while older generations relied more on in-store shopping. Education also made a difference, but thankfully race did not impact the use of e-grocery and click-and-pick, and intentions to use e-grocery and click-and-pick (but it did affect in-store grocery shopping before). My results also illustrated the heterogeneity of Hispanics. As expected, tech-savvy households were much more likely to embrace e-grocery and click-and-pick.

Subject Areas: E-shopping; Household travel behavior; COVID-19; Demographics

Availability: Xu, L. (2022). *E-shopping and Household Travel Before, During, and After the Time of Covid-19*. Doctoral Dissertation, University of California, Irvine, CA.
https://escholarship.org/uc/item/5cj3k8gc

11.11. Title: Connecting Metros with Shared Electric Scooters: Comparisons with Shared Bikes and Taxis

Author(s): Ma, Q., Xin, Y., Yang, H., and Xie, K.

Abstract: The rapid rise of shared electric scooter (E-Scooter) systems offers urban areas a new micro-mobility solution. The focus on short-distance travel has made it a competitive option for addressing first-/last-mile travel needs. Nevertheless, its role as a first-/last-mile solution was understudied due to the lack of fine-grained trip data. This study aims at exploring the integration of shared E-Scooters with public transportation systems. Specifically, it compared the use of shared E-Scooters against shared bikes and taxis for connecting trips from/to metro stations. We analyzed massive amounts of trip-related data extracted through APIs. Multinomial logistic regression models were developed to uncover how the mode choices from/to metro stations vary in different contexts. The results show that the use of shared E-Scooters to connect trips from/to metro stations can be notably different from shared bikes and taxis. The preference of shared E-Scooters will vary depending on the land use and time period.

Subject Areas: Electric scooters; Micro-mobility; Mode choice; Bike Sharing; Taxis; Metro stations

Availability: Ma, Q., Xin, Y., Yang, H., and Xie, K. (2022). "Connecting Metros with Shared Electric Scooters: Comparisons with Shared Bikes and Taxis." *Transportation Research Part D: Transport and Environment*, *109*. https://doi.org/10.1016/j.trd.2022.103376

11.12. Title: The US Is Slowly Transitioning from the Great Resignation to the Great Return

Author(s): Meir, I.

Abstract: Blog.

Subject Areas: Commute; Working environments; Work practice

Availability: Meir, I. (2022). "The US Is Slowly Transitioning from the Great Resignation to the Great Return." *Crunchbase*. https://news.crunchbase.com/job-market/great-return-workplace-transition/

11.13. Title: Examining Market Segmentation to Increase Bike-Share Use: The Case of the Greater Sacramento Region

Author(s): Mohiuddin, H., Fitch, D., and Handy, S.

Abstract: Bike-share systems are proliferating across the US and could expand opportunities for those most underserved by the transportation system. A deeper understanding of current bike-share users could enable the expansion of these services and their benefits to a larger population. With the aim of deepening this understanding, this study uses data from household and bike-share user surveys in the Sacramento region to perform behavioral modeling and market segmentation. The results show that although individuals with low incomes and students are less likely than other demographic groups to use bike-share, they use it more frequently if they do use it. Individuals who regularly use multiple modes of travel also use the service frequently. The initial adoption of the service by transport-disadvantaged groups can play a vital role in the continued and frequent use of the service. The market segmentation analysis shows that low-income individuals, students, and zero-car individuals use the service frequently for commuting and a variety of non-commuting purposes. The occasional users of the bike-share service are mainly those with higher incomes and individuals who have access to a personal car. Another market segment consists of non- and infrequent-personal bike users; however, that segment is using the bike-share service at a greater rate for different purposes compared to regular bicyclists. This suggests that bike-share may fill an important travel gap and act as a lever for increasing bike travel for some users. Overall, the results provide detailed bike-share market information that can be used to tailor urban transport policies. The results also suggest that if the user base for bike-share programs were expanded to reach even more low-income individuals, students, and multi-modal travelers, greater environmental sustainability benefits would be achieved.

Subject Areas: Bicycles; Vehicle sharing; Bicycle travel; Scooters

Availability: Mohiuddin, H., Fitch, D., and Handy, S. (2022). *Examining Market Segmentation to Increase Bike-Share Use: The Case of the Greater Sacramento Region*. Final Report, UCD-ITS-RR-22-39, Institute of Transportation Studies, University of California, Davis, CA. https://escholarship.org/uc/item/71h6g0td

11.14. Title: Equity and Transportation System Implications of Shared Autonomous Vehicle Deployment

Author(s): Harper, C. and Yang, H.

Abstract: This paper focuses on assessing the transportation system and sub-population level impacts of different pricing and fleet sizing policies for shared AV services in Seattle. While the conclusions of this research are meant to be generalizable, we focus our study on Seattle, Washington, because it's a diverse city with known inequalities among income, race, and other factors. Areas outside of the city limits of Seattle are not in the scope of this study.

Subject Areas: Shared autonomous vehicle; Pricing; Fleeting sizing policy; Seattle; Equity; Transportation system

Availability: Harper, C. and Yang, H. (2022). *Equity and Transportation System Implications of Shared Autonomous Vehicle Deployment*. Final Research Report, Mobility21, Carnegie Mellon University, Pittsburgh, PA. https://rosap.ntl.bts.gov/view/dot/63145

11.15. Title: COVID-19 Impacts on Non-Work Travel Patterns: A Place-Based Investigation Using Smartphone Mobility Data

Author(s): Song, Y., Lee, S., Park, A. H., and Lee, C.

Abstract: The COVID-19 pandemic has brought unprecedented changes to our mobility. It has not only changed our work-related travel patterns but also impacted leisure and other utilitarian activities. Non–work-related trips tend to be more seriously affected by the neighborhood/contextual factors such as socioeconomic status (SES), and destination accessibility, and COVID-19 impact on non-work trips may not be equal across different neighborhood SES. This study compares non–work-related travel patterns between the pre- and during COVID-19 pandemic in the City of El Paso, Texas. By utilizing smartphone mobility data, we captured the visitation data for major non-work destinations such as restaurants, supermarkets, drinking places, religious organizations, and parks. We used Census block groups (n = 424) within the city and divided them into low- and high-income neighborhoods based on the citywide median. Overall, the total frequency of visitations and the distances traveled to visit these non-work destinations were influenced by the COVID-19 pandemic. However, significant variations existed in their visitation patterns by the type of non-work destinations. While the overall COVID-19 effects on non-work activities were evident, its effects on the travel patterns to each destination were not equal by neighborhood SES. We also found that COVID-19 had differently influenced non-work activities between high- and low-income block groups. Our findings suggest that the COVID-19 pandemic may exacerbate neighborhood-level inequalities in non-work trips. Thus, safe and affordable transportation options together with compact and walkable community development appear imperative to support daily travel needs for various utilitarian and leisure purposes, especially in low-income neighborhoods.

Subject Areas: Non-work travel; COVID-19; Travel patterns; Neighborhoods; Destination accessibility; Smartphone mobility data

Availability: Song, Y., Lee, S., Park, A. H., and Lee, C. (2022). "COVID-19 Impacts on Non-Work Travel Patterns: A Place-Based Investigation Using Smartphone Mobility Data." *Environment and Planning B: Urban Analytics and City Science*. https://doi.org/10.1177/23998083221124930

11.16. Title: From Low Initial Interest to Electric Vehicle Adoption: "EV Converts" in New York State's Rebate Program

Author(s): Williams, B. D. H. and Anderson, J. B.

Abstract: To meet aggressive transportation-electrification goals, electric-vehicle (EV) sales must expand beyond enthusiastic early adopters and deeper into mainstream markets. To support that expansion, this research examined a strategic market segment that points the way: EV adopters who had little to no interest in adopting an EV when they started looking for a new car—or "EV Converts." It utilized survey responses from 5,216 recipients of New York State's Drive Clean Rebate, separately examining consumers of plug-in hybrid EVs, Teslas, and non-Tesla battery EVs. Weighted descriptive statistics and logistic regressions were used to identify factors that predict EV Convert status, and dominance analysis was used to rank factors for prioritization. The results were combined into summary profiles for each vehicle category, summarizing their current characteristics and describing top opportunities for reinforcing each segment. Across categories, high-ranking factors associated with increased odds of being an EV Convert included giving relatively less importance to societal factors like energy independence or environmental impacts, lack of consumer awareness of the rebate before the first dealership visit, the essentiality of the rebate to the EV purchase/lease, having no plans to install solar, giving no importance to the desire for the newest technology, and/or identifying as female. Significant factors were ranked and compared across vehicle categories. Recommendations for program design, outreach, and dealer education are provided.

Subject Areas: Rebate Program; Electric vehicle adoption; Market segment

Availability: Williams, B. D. H. and Anderson, J. B. (2022). "From Low Initial Interest to Electric Vehicle Adoption: 'EV Converts' in New York State's Rebate Program." *Transportation Research Record: Journal of the Transportation Research Board*. https://doi.org/10.1177/03611981221118537

11.17. Title: Essays in Quantitative Marketing

Author(s): Sinyashin, A.

Abstract: The dissertation has two chapters. In the first chapter, called "Optimal Policies for Differentiated Green Products: Characteristics and Usage of Electric Vehicles," I study the issue of policy design for electric vehicles. When designing policies for electric vehicles (EVs) policymakers need to decide how to allocate policy support among EVs with different characteristics, since different EVs are likely to have differences in attractiveness to consumers and usage patterns and, hence, differences in environmental impact. In this paper, I build and estimate a structural model of the U.S. auto market that is able to predict market shares and usage patterns of electric and traditional vehicles with different characteristics under various market conditions and is able to assess the effects of policies differentiating on characteristics of EVs. On the demand side, I introduce the concept of consumer inconvenience costs of charging, which depend on EV battery range, charging infrastructure development level, consumers' driving needs, and other individual-specific factors. On the supply side, I model firm choice of prices and battery ranges. The estimation results show that the inconvenience costs have a dramatic effect on consumer purchase decisions and usage patterns of EVs, and, hence, their environmental impact. Also, the results indicate that firms are more likely to adjust battery ranges when policy support depends on battery range. I use the model estimates to evaluate the effects of two major U.S. policies for EVs, the federal subsidy and California's Zero Emission Vehicle regulation, on the environment, consumer surplus, firm profits, and social welfare. I also experiment with alternative structures of the federal subsidy that differentiate on type and battery range of EVs. I find that more efficient structures can improve the environmental effect of the subsidy by 4.6% and the welfare effect by 1.6%. Interestingly, the more efficient structures result in fewer EVs sold, but in more electric miles traveled and more gasoline miles replaced.

In the second chapter, called "Do Big Businesses Influence Media? The Case of Amazon.com and The Washington Post," I study whether media outlets bias their coverage of the news about their owners or companies the owners have vested interests in. To shed some light on this question, I look at how the acquisition of the Washington Post, a major U.S. daily newspaper, by Jeff Bezos, the founder and CEO of Amazon.com, affected the coverage of the news about Bezos and Amazon.com. Using data on news stories in several major newspapers, I document that the acquisition resulted in an increase in the number of mentions of Bezos, Amazon, or Amazon's products in the Washington Post, relative to other newspapers and news stories about other big tech companies. From a simple sentiment analysis, however, I found no evidence of change in the sentiment of the stories. I discuss potential mechanisms that can explain the results, including a conflict of interest, a shift in preferences of the readership, improved access of the Washington Post to information about Bezos and Amazon, and a shift in the beliefs of the newspaper's editors and journalists about the importance of news about Amazon and Bezos.

Subject Areas: Electric vehicles; Market shares; Usage patterns; Battery ranges; Media coverage

Availability: Sinyashin, A. (2022). *Essays in Quantitative Marketing*. Doctoral Dissertation, University of California, Berkeley, CA. https://escholarship.org/uc/item/7073h6f7

11.18. Title: The Effect of Increasing Vehicle Utilization on the Automotive Industry

Author(s): Keith, D.R., Naumov, S., Rakoff, H.E., Sanches, L.M., and Singh, A.

Abstract: Shared mobility is widely expected to play an important role in the future of transportation. Sharing vehicles (using services such as ride-hailing, peer-to-peer car-sharing, and autonomous taxis) will allow people to enjoy the benefits of automobile use without ownership, access various types of mobility services on-demand, and create value by increasing the utilization of these expensive and durable assets. Most analysts agree that widespread adoption of shared mobility would cause the size of the on-road automobile fleet to shrink, potentially dramatically, because the same amount of personal mobility can be provided by fewer vehicles. There is less agreement, however, on the effect higher utilization will have on the rate of new vehicle sales: Some believe that vehicle sales will fall similarly, while others believe there will be no change in sales, or even an increase in sales as fleets of shared vehicles turn over more frequently. In this paper, we seek to clarify the effect that emerging mobility technologies will have on the future rate of new vehicle sales in the United States, modeling how the sales rate varies with factors such as population growth, vehicle utilization, and vehicle durability. We show across a range of plausible scenarios that vehicle sales are likely to remain steady or increase in coming decades. However, the potential exists for a temporary surge or dip in sales as the composition of new vehicle sales transitions, requiring effective mental models if managers are to make efficient production and capacity planning decisions during this time.

Subject Areas: System dynamics; Mobility; Sharing economy

Availability: Keith, D.R., Naumov, S., Rakoff, H.E., Sanches, L.M., and Singh, A. (2022). "The Effect of Increasing Vehicle Utilization on the Automotive Industry." *European Journal of Operational Research*. https://doi.org/10.1016/j.ejor.2022.10.030

11.19. Title: How COVID-19 Changed Our Cities: Evidence from a National Survey

Author(s): Salon, D.

Abstract: Human behavior is notoriously difficult to change, but a disruption of the magnitude of the COVID-19 pandemic has the potential to bring about long-term behavioral changes. During the pandemic, people were forced to experience new ways of interacting, working, learning, shopping, traveling, and eating meals. A critical question going forward is how these experiences have actually changed preferences and habits in ways that might persist. We collected a nationally representative, 3-wave panel survey in the U.S. that aims to shed light on this question. This talk will draw from these data to describe how the pandemic did (and did not) change how we live in cities, what we still don't know, and in which areas urban planners should adjust their assumptions as we look to the future.

Subject Areas: Behavioral changes; COVID-19; Urban

Availability: Salon, D. (2022). "How COVID-19 Changed Our Cities: Evidence from a National Survey." *TREC Friday Seminar Series*. https://pdxscholar.library.pdx.edu/trec_seminar/232/

11.20. Title: Electric Vehicle Battery Case Box Market Will Reach to USD 982.1 Billion by 2029: GreyViews

Author(s): GreyViews.

Abstract: Blog.

Subject Areas: Electric vehicle battery; Market segments; Battery box; Non-metallic

Availability: GreyViews. (2022). "Electric Vehicle Battery Case Box Market Will Reach to USD 982.1 Billion by 2029: GreyViews." *GlobeNewswire*. https://www.globenewswire.com/news-release/2022/12/06/2568238/0/en/Electric-Vehicle-Battery-Case-Box-Market-will-reach-to-USD-982-1-billion-by-2029-GreyViews.html

11.21. Title: Assessment of Light-Duty Plug-In Electric Vehicles in the United States, 2010–2021

Author(s): Gohlke, D., Zhou, Y., Wu, X., and Courtney, C.

Abstract: The number of plug-in electric vehicles (PEVs) sold in the United States has consistently grown since 2010, reaching 4% of the light-duty vehicle market in 2021. This report examines how the characteristics for these PEVs has changed over this decade, evaluating range, energy efficiency, costs, and performance. Given the vehicle characteristics, this report estimates miles driven, electricity consumption, petroleum reduction, and greenhouse gas emissions attributable to electric vehicles. This report also explores vehicle manufacturing and battery production, considering supply chains from battery cells to assembly. Over 2.1 million PEVs have been sold in the United States through December 2021, with 1.3 million of these all fully electric battery electric vehicles (BEVs), and 800,000 plug-in hybrid electric vehicles (PHEVs) which have the capability of using gasoline. The sales-weighted average range for BEVs reached 290 miles in 2021 and 28 miles for PHEVs. We estimate that electric vehicles have driven 68 billion miles on electricity since 2010, thereby reducing national gasoline consumption by 0.54% in 2021 and 2.5 billion gallons cumulatively through 2021. In 2021, PEVs used 6.1 terawatt-hours of electricity to drive 19.1 billion miles, offsetting 700 million gallons of gasoline. We find that this fuel switching reduced consumer fuel costs by $1.3 billion in 2021. Since 2010, 65% of PEVs sold in the United States have been assembled domestically, and over 110 gigawatt-hours of lithium-ion batteries have been installed in vehicles to date.

Subject Areas: Light-duty vehicle market; Vehicle characteristics; Evaluation; Plug-in electric vehicles

Availability: Gohlke, D., Zhou, Y., Wu, X., and Courtney, C. (2022). *Assessment of Light-Duty Plug-In Electric Vehicles in the United States, 2010–2021*. Technical Report, ANL-22/71, Argonne National Laboratory, Lemont, IL. https://publications.anl.gov/anlpubs/2022/11/178584.pdf

11.22. Title: Total Cost of Ownership of Plug-In Electric Vehicles Owned by Early California Adopters in the 2010s

Author(s): Buch, K.

Abstract: Total cost of ownership (TCO) analysis assesses the cost competitiveness of plug-in electric vehicles (PEVs) and internal combustion engine vehicles (ICEVs). The TCO literature characterizes an average driver to identify a future parity point where the ownership cost of a PEV is equal to or lower than an ICEV. This research had taken a different approach for TCO analysis, estimating costs of actual PEV early adopters in California between 2011 and 2020 using multi-year survey responses that provided valuable insights regarding vehicle purchase choice, driving and charging behavior, and socio-demographic attributes.

The TCO comparative analysis was done by vehicle segments (compact, mid-size, etc.), using selected models from the year 2018 and included incentives. The results show that the higher the segment was, the lower the annual mileage required to achieve a comparative TCO. For the mid-luxury segment, cost parity was achieved with only 10,100 annual miles, while for the subcompact segment, parity was reached when driving over 27,000 miles annually. As PEVs enter the mass market these days, these findings demonstrate the importance of incentive programs that are structured to benefit specific market segments that need them the most, rather than applying subsidies across all models, as done in past decades to encourage early adoption.

Subject Areas: Total cost of ownership analysis; Plug-in electric vehicles; Internal combustion engine vehicles; Market segments; Vehicle purchase choice; Driving and charging behavior; sociodemographic attributes

Availability: Buch, K. (2022). *Total Cost of Ownership of Plug-In Electric Vehicles Owned by Early California Adopters in the 2010s*. Master's Thesis, University of California, Davis, CA. https://escholarship.org/uc/item/1dh71893

11.23. Title: Telecommuting and Trip Chaining: Pre-Pandemic Patterns and Implications for the Post-Pandemic World

Author(s): Zhu, P. and Guo, Y.

Abstract: Telecommuting has boomed in popularity during the pandemic and is expected to remain at elevated levels persistently. Using the 2009 and 2017 U.S. National Household Travel Survey, we investigate if there exist *consistent* modification influences of telecommuting on trip-chaining behavior in the decade prior to the pandemic. We find telecommuting significantly increases people's propensity to chain trips, raises trip chaining frequency, and encourages more complex trip chains. Furthermore, these impacts are significant on commuting days, which suggests that telecommuters still have different trip chaining behavior than non-telecommuters on the days when they commute to the workplace. While trip chaining has been encouraged under pandemic conditions to minimize health risks, heightened health concerns will fade as the pandemic recedes. With telecommuting likely to persist, unraveling how trip chaining behavior had changed in response to telecommuting before the pandemic helps policymakers better understand the long-term changes in travel behavior in the post-pandemic world.

Subject Areas: Telecommute; Work from Home (WFH); Trip chaining; Complex tour

Availability: Zhu, P. and Guo, Y. (2022). "Telecommuting and Trip Chaining: Pre-Pandemic Patterns and Implications for the Post-Pandemic World." *Transportation Research Part D: Transport and Environment*, *113*. https://doi.org/10.1016/j.trd.2022.103524

11.24. Title: Examining the Impact of the COVID-19 Pandemic on Ridesourcing Usage: A Case Study of Chicago

Author(s): Debnath, A., Ogungbire, A., and Mitra, S.

Abstract: The COVID-19 pandemic has led to an unprecedented change in transportation, including shared mobility services. This study examined the effects of the COVID-19 pandemic on ridesourcing usage by leveraging two years (2019 and 2020) of daily ridesourcing trip data in Chicago, Illinois. The study employed a set of Random Effects Panel models to examine the factors contributing to changes in ridesourcing usage before and during the pandemic and how the COVID-19 related policies issued by the state and local agencies affected ridesourcing trips. Results show: i) a considerable drop in total daily trips, total daily trip distances, and total daily trip durations was observed once the stay-at-home order was issued, while an increase in average daily trip distances was evident during the stay-at-home period; ii) the south and west parts of Chicago experienced a relatively larger increase in ridesourcing services during the reopen-I period than the stay-at-home and reopen-II periods; iii) areas with higher employment density produced fewer ridesourcing trips during the pandemic while it was the opposite during the pre-pandemic period; iv) areas with higher median income households, higher employment density, and more rail stations experienced a greater decrease in the change of daily total ridesourcing trips, total trip distances, and total trip durations during the periods of state of emergency and stay-at-home orders. Results of this study provide insights for the policymakers and ridesourcing operators to better respond to an unprecedented crisis like the COVID-19 pandemic and help them to rebuild the ridesourcing ridership in the post-pandemic era.

Subject Areas: Ridesourcing; COVID-19; Pandemic; Random-effects negative binomial; Ridesharing; Spatiotemporal

Availability: Debnath, A., Ogungbire, A., and Mitra, S. (2022). *Examining the Impact of the COVID-19 Pandemic on Ridesourcing Usage: A Case Study of Chicago*. Preprint Research Article, Research Square, Durham, NC. https://doi.org/10.21203/rs.3.rs-2341134/v1

11.25. Title: Growth in Commuting Patterns and Their Impacts on Rural Workforce and Economic Development

Author(s): Kures, M. and Deller, S.C.

Abstract: Residential and employment locational decisions for working households are frequently commingled. Numerous economic and social factors like job accessibility, wage differentials, housing markets, travel time, trip-chaining opportunities, dual employment, and other quality-of-life considerations influence where a household ultimately chooses to reside relative to places of employment. These choices in turn shape commuting patterns within a region. Using the U.S. Census Bureau's LEHD Origin-Destination Employment Statistics (LODES), the authors explore longitudinal changes in the growth of commuting patterns based on commuters traveling 50 miles or more between their place of residence and place of employment for counties in Midwestern states from 2002 to 2019. The authors find that the rate of commuters traveling 50 miles or more appears to have increased in rural areas across several periods and regions. Thus, rural communities concerned about labor supply constraints must take into consideration more expansive geographic labor markets and approach labor force development in partnership across local economic development institutions. In essence, the growth in commuting sheds requires stronger regional partnerships to address the issue.

Subject Areas: Commuting patterns; Rural workforce; Local economic development; Regional partnerships

Availability: Kures, M. and Deller, S.C. (2022). "Growth in Commuting Patterns and Their Impacts on Rural Workforce and Economic Development." *Economic Development Quarterly*. https://doi.org/10.1177/08912424221145173

11.26. Title: Zero Auto Ownership: Understanding the Zero Car Commute

Author(s): Halpert, D.S. and McCourt, R.S.

Abstract: This report looks at trends in zero automobile ownership (ZAO) in the U.S. In 2019, U.S. ZAO averaged 8.6%. Data presented in this report comes from sources such as the American Community Survey and National Household Travel Surveys and includes: percentage of U.S. no-car households, zero car ownership by city, ZAO by income level, urban versus rural trends, household size, and additional demographics.

Subject Areas: Automobile ownership; Demographics; Trend; Highways; Society; Vehicles and equipment

Availability: Halpert, D.S. and McCourt, R.S. (2022). *Zero Auto Ownership: Understanding the Zero Car Commute.* Technical Brief, Institute of Transportation Engineers, Washington, D.C. https://www.ite.org/pub/?id=65E000BF-FAA3-3A9E-0B8F-B24D5A9EFE4C

Chapter 12. Emerging Travel Modes

12.1 Title: Lifecycle Greenhouse Gas Emissions and Energy Cost Analysis of Flying Cars with Three Different Propulsion Systems

Author(s): Liu, M., Qian, Y., Luo, Y., Hao, H., Liu, Z., Zhao, F., Sun, X., Xun, D., and Geng, J.

Abstract: Flying cars are expected to play an important role in future transportation, considering their ability to transform transport ecology and improve transportation efficiency. However, the optimal choice of propulsion systems for flying cars is still unclear due to the lack of studies on the environmental and economic impacts of flying cars considering different propulsion systems. Based on the analysis of flying processes and design requirements, we established functional models for flying cars with different propulsion systems and calculated their lifecycle greenhouse gas emissions and average energy costs to investigate the technology pathways. The results demonstrated that the optimal choice of propulsion systems for flying cars critically depends on the designed range. For short-range trips within 190 km, battery electric flying cars show advantages in both emissions and energy cost. For trips with a range of 200–250 km, fuel cell flying cars are the best choice. Internal combustion engine flying cars are currently the only viable option for long-distance transportation higher than 250 km. In particular, the on-going advancements in battery specific energy will further provide battery electric flying cars with environmental and economic competitiveness within larger flying ranges. Flying cars are also competitive in energy costs compared with on-ground vehicles under a wide range of utilization scenarios, demonstrating the possibility of commercialization.

Subject Areas: Flying car; Life cycle analysis; Greenhouse gas emissions; Energy cost; Battery electric; Fuel cell

Availability: Liu, M., Qian, Y., Luo, Y., Hao, H., Liu, Z., Zhao, F., Sun, X., Xun, D., and Geng, J. (2022). "Lifecycle Greenhouse Gas Emissions and Energy Cost Analysis of Flying Cars with Three Different Propulsion Systems." *Journal of Cleaner Production*, *331*. https://doi.org/10.1016/j.jclepro.2021.129985

12.2 Title: A Multi-Group Analysis of The Behavioral Intention to Ride in Autonomous Vehicles: Evidence from Three U.S. Metropolitan Areas

Author(s): Gkartzonikas, C., Losada-Rojas, L.L., Christ, S., Pyrialakou, V.D., and Gkritza, K.

Abstract: This paper proposes a well-grounded theoretical model to assess the factors influencing the intention to ride in autonomous vehicles (AVs). The model is based on the Theory of Planned Behavior (TPB), which has been decomposed to account for key components of the Diffusion of Innovation (DoI) theory and extended to include other influential attitudinal components (such as driving-related sensation seeking, safety perceptions, environmental concerns, and affinity to innovativeness). The extent to which these factors are expected to affect the diffusion of AVs uniformly across different urban settings is also examined. Data were collected through stated preference surveys targeting adult residents in three metropolitan statistical areas, Chicago (Illinois), Indianapolis (Indiana), and Phoenix (Arizona). Confirmatory factor analysis was conducted to test the validity and reliability of the components included in the theoretical model, followed by the estimation of a multi-group structural equation model. The findings of the measurement model show that the survey questions are measured equally across the three areas, and hence, the theoretical model is transferrable. The results of the structural model suggest that the synergistic effects between TPB and DoI can better explain the behavioral intention to ride in AVs. It was also found that the effect of the TBP components is similar across various areas; however, this is not the case for the DoI components. In general, the findings reinforce the need for wider testing of AV technology in urban areas coupled with public education campaigns to harvest public awareness and acceptance.

Subject Areas: Theory of planned behavior; Diffusion of innovation; Behavioral intention; Public acceptance; Autonomous vehicles; Structural equation modeling

Availability: Gkartzonikas, C., Losada-Rojas, L.L., Christ, S., Pyrialakou, V.D., and Gkritza, K. (2022). "A Multi-Group Analysis of The Behavioral Intention to Ride in Autonomous Vehicles: Evidence from Three U.S. Metropolitan Areas." *Transportation*. https://doi.org/10.1007/s11116-021-10256-7

12.3 Title: Benefits of Advanced Air Mobility for Society and Environment: A Case Study of Ohio

Author(s): Dulia, E.F., Sabuj, M.S., and Shihab, S.A.M.

Abstract: Advanced Air Mobility (AAM) is an emerging transportation system that will enable the safe and efficient low altitude operations and applications of unmanned aircraft (e.g., passenger transportation and cargo delivery) in the national airspace. This system is currently under active research and development by NASA in collaboration with FAA, other federal partner agencies, industry, and academia to develop its infrastructure, information architecture, software functions, concepts of operation, operations management tools and other functional components. Existing studies have, however, not thoroughly analyzed the net positive impact of AAM on society and environment to justify investments in its infrastructure and implementation. In this work, we fill this gap by evaluating the non-monetary social impact of AAM in the state of Ohio for passengers, patients, farmers, logistics companies and their customers and bridge inspection entities, as well as its environmental impact, by conducting a thorough data-driven quantitative cost–benefit analysis of AAM from the perspective of the state government. To this end, the most relevant and significant benefit and cost factors are identified, monetized, and estimated. Existing ground transportation for the movement of passengers and goods within and across urban areas is considered as the base case. The findings demonstrate that AAM's benefits are large and varied, far outweighing its costs. Insights on these benefits can help gain community acceptance of AAM, which is critical for successful implementation of AAM. The findings support decision-making for policymakers and provide justification for investments in AAM infrastructure by the government and private sector.

Subject Areas: Advanced air mobility; Cost benefit analysis; ARIMA forecasting; Electric vertical take-off and landing aircraft; Small unmanned aircraft system; Green transportation

Availability: Dulia, E.F., Sabuj, M.S., and Shihab, S.A.M. (2022). "Benefits of Advanced Air Mobility for Society and Environment: A Case Study of Ohio." *Applied Sciences*, *12*(1). https://doi.org/10.3390/app12010207

12.4 Title: Autonomous Vehicle Policies with Equity Implications: Patterns and Gaps

Author(s): Emory, K., Douma, F., and Cao, J.

Abstract: Autonomous vehicles (AVs) may improve or harm social equity for disadvantaged groups. Government agencies, planning organizations, businesses, and nonprofits have drafted or published an array of AV-related policies that have equity implications. Through a review of academic and grey literature, this study pioneers a comprehensive analysis of these policies in terms of patterns, frequencies, and gaps. Our analysis shows that these policies can be grouped into three categories: access and inclusion, multimodal transportation, and community wellbeing. Regarding specific policies, considerations for a shared-use model and impacts to the economy dominate the policy landscape. Helping marginalized communities, urban parking, and automating transit are also prevalent policies. However, considerations for people with low incomes and people of color are not well represented, nor are personal security issues within shared vehicles, or models for deploying AVs in rural communities. Policymakers are beginning to plan for the potential equity impacts of AVs, but more opportunities remain for developing policies that will ensure the most equitable outcomes. This study elucidates the different types of policies with equity implications and provides planners and policymakers a base from which to draft their own policy.

Subject Areas: Autonomous vehicle; Disadvantaged people; Equity; Environmental justice; Emerging transportation

Availability: Emory, K., Douma, F., and Cao, J. (2021). "Autonomous Vehicle Policies with Equity Implications: Patterns and Gaps." *Transportation Research Interdisciplinary Perspectives*, *13.* https://doi.org/10.1016/j.trip.2021.100521

12.5 Title: Operational Impact of Microcars on Urban and Suburban Road Corridors

Author(s): Masry, H.E., Esawey, M.E., El-Araby, K., and Osama, A.

Abstract: Efficient utilization of a private car is achieved when it is used to transport many travelers. A single-occupancy vehicle (SOV) is a private vehicle whose only occupant is the driver. The existence of SOVs in the traffic stream leads to unjustified congestion and shortage of available parking spaces, especially in megacities. Microcars can be beneficial for cities where it is infeasible to construct new roads or upgrade the existing ones because of limited space. Microcars offer many advantages compared with motorcycles and bicycles as they provide shelter from adverse weather conditions, allow for personal storage space, and are more culturally accepted in eastern societies like Egypt. This research investigates the operational impacts of using microcars on roads by using microsimulation. VISSIM was used to model two case studies: a hypothetical urban corridor and a suburban expressway in Greater Cairo. Mixed and exclusive lane scenarios were analyzed using different modal shares for microcars. The results showed that replacing a portion of private cars by microcars increased the throughput volume and reduced the overall travel time. Exclusive lanes for microcars showed better results than mixed lanes on an urban corridor. On the suburban expressway, however, average travel time was shown to be lower for mixed lane usage compared with exclusive lanes. The results of this research support the idea of promoting microcars as a potential mitigation measure to relieve congestion, especially in urban areas.

Subject Areas: Traffic operations; Managed lanes; Express lanes; High-occupancy vehicle lanes; Tolled lanes; Macroscopic traffic models; Microscopic traffic models; Traffic flow; Sustainability and resilience; Transportation network design

Availability: Masry, H.E., Esawey, M.E., El-Araby, K., and Osama, A. (2022). “Operational Impact of Microcars on Urban and Suburban Road Corridors.” *Transportation Research Record: Journal of the Transportation Research Board*, *2676*(6), pp. 488–502.
https://doi.org/10.1177%2F03611981221075022

12.6 Title: How Do Perceptions of Safety and Car Ownership Importance Affect Autonomous Vehicle Adoption?

Author(s): Jabbari, P., Auld, J., and MacKenzie, D.

Abstract: In this study, we explicitly modeled how individuals' perceptions of automated vehicle (AV) safety and the importance they place on car ownership affect mode choices involving conventional and automated vehicles in the context of privately owned cars and ridehailing services. We adopted psychometric questions to capture these two latent variables and designed a stated preference survey based on the participants' actual travel patterns. Then, we quantified the impact of these latent variables on mode choices using an integrated choice and latent variable (ICLV) model. We found that both latent variables have a statistically significant effect on mode choices. The results show that car ownership importance has the most potent effect on privately owned cars (conventional car and self-driving car), followed by driverless ridehailing and conventional ridehailing. We also found that changes in safety perception are equivalent to sizable changes in price. We further investigated the impact of improvements in safety perception through four scenarios. The scenario testing results show that as the distribution of perceived safety is compressed toward positive safety perception, the market share of AVs spikes and dominates regular cars. Our results demonstrate that based on our respondents' current understanding of AVs, even if AV prices were comparable to regular cars, we cannot expect widespread use of AVs. However, improvements in AVs' safety and, consequently, consumer safety perception can considerably expand AVs' market share, and may offset the high cost of using the technology.

Subject Areas: Self-driving car; Integrated choice and latent variable; Mode choice; Perceived safety; Car ownership importance

Availability: Jabbari, P., Auld, J., and MacKenzie, D. (2022). "How Do Perceptions of Safety and Car Ownership Importance Affect Autonomous Vehicle Adoption?" *Travel Behaviour and Society*, *28*, pp. 128–140. https://doi.org/10.1016/j.tbs.2022.02.002

12.7 Title: Evaluation of Delivery Service in Rural Areas with CAV

Author(s): Alghamdi, A. and Prevedouros, P.D.

Abstract: Urban areas have been experiencing automated delivery technology for several servings of food or a few bags of groceries, with automated (robotic) mini vehicles. The benefits of such automated delivery may be much more significant for rural areas with long distances due to the large potential savings in travel time, travel cost, and crash risk. Compared to urban areas, rural areas have older and more disabled residents, longer distances, higher traffic fatality rates, and high ownership of less fuel-efficient vehicles such as pickup trucks. An evaluation of connected autonomous vehicle (CAV) delivery service in rural areas was conducted. A detailed methodology was developed and applied to two case studies: One for deliveries between Hilo and Volcano Village in Hawaii as a case of deliveries over a moderate distance (~50-mile roundtrip) in a high-energy-cost environment, and another for deliveries between Spokane and Sprague in Washington State as a case of deliveries over a longer distance (~80-mile roundtrip) in a low-energy-cost environment. The delivery vehicles were based on the same compact van: A person-driven gasoline-powered van, a person-driven electric-powered van, and a CAV electric-powered van. The case study results suggest that the CAV van can be a viable option for implementing a delivery business for rural areas based on the evaluation results that accounted for a large number of location-specific costs and benefits and the number of orders served per trip.

Subject Areas: Connected autonomous vehicle; Autonomous vehicle; Compact van; Energy cost; Delivery service; Rural area

Availability: Alghamdi, A. and Prevedouros, P.D. (2022). *Evaluation of Delivery Service in Rural Areas with CAV*. Final Project Report, INE/CSET 22.01, Center for Safety Equity in Transportation, Fairbanks, AK.
https://scholarworks.alaska.edu/bitstream/handle/11122/12834/CAV%20report%20for%20CSET_Final.pdf?sequence=1&isAllowed=y

12.8 Title: Dynamic Ride-Sharing Impacts of Greater Trip Demand and Aggregation at Stops in Shared Autonomous Vehicle Systems

Author(s): Gurumurthy, K.M. and Kockelman, K.M.

Abstract: Sharing vehicles and rides may become the norm with public use of fully automated self-driving vehicles in the near future, assuming pandemic-related health concerns fade. Dynamic ride-sharing (DRS) or ride-pooling of trips can significantly improve system performance by lowering empty vehicle-miles traveled (eVMT) and increasing average vehicle occupancy (AVO). With several cities looking to promote efficient curb space use, especially with the use of pickup and drop-off locations (PUDOs), this study explores the impacts of PUDOs on DRS rates and AVO values. Various PUDO spacings and trip-demand densities were studied, across the Bloomington, Illinois region, using the agent-based simulator POLARIS. Results reveal that greater PUDO spacing or distances between stops and higher levels of SAV use or trip demand increase AVO (by up to 20 percent per 4-seater SAV, on average) and decrease SAV VMT (by up to 27 percent) compared to door-to-door SAV fleet operations without DRS or PUDOs. A quarter-mile PUDO spacing is recommended in downtown regions, similar to current transit stop spacing, to keep walking trips short and demand relatively high. At 0.25 mi PUDO spacings (thoughtfully placed, using origin and destination clusters), travelers walked less than 5 min at either trip end, on average, while 0.5 mi spacings led to another 1 min (approximately) of walking. More evenly distributed and higher SAV demand can save up to 39 percent total VMT from use of DRS and PUDO stops. It is also important to prepare for queuing areas at PUDOs in settings of high trip density, to limit curbside congestion.

Subject Areas: Shared autonomous vehicles; Stop aggregation; Dynamic ride-sharing; Trip densities

Availability: Gurumurthy, K.M. and Kockelman, K.M. (2022). "Dynamic Ride-Sharing Impacts of Greater Trip Demand and Aggregation at Stops in Shared Autonomous Vehicle Systems." *Transportation Research Part A: Policy and Practice*, *160*, pp. 114–125. https://doi.org/10.1016/j.tra.2022.03.032

12.9 Title: A Tale of Two Modes: Who Will Use Single User and Shared Autonomous Vehicles

Author(s): Gkartzonikas, C., Ke, Y., and Gkritza, K.

Abstract: The two most traditional and conventional transportation modes, private vehicles, and public transit, may be disrupted due to the advent of shared autonomous vehicles (SAVs), which can offer affordable on-demand mobility solutions leading to a transformed transportation system. However, little is known about the attributes affecting mode choice decisions and the impacts of the emergence of SAVs on travel behavior. A stated preference survey consisting of choice experiments, distributed online in October and November 2017 to residents of the Chicago-Naperville-Elgin, IL-IN-WI metropolitan statistical area, is used to determine the perceived impacts that SAVs may have on mode choice decisions and the corresponding value of travel time savings. Based on a representative sample (in terms of age and gender) of 400 responses, random parameter (mixed) logit models are developed to investigate the factors that affect mode choice decisions in short- and long-term scenarios. Value of travel time savings (VTTS) is calculated using the marginal rate of substitution derived from the mixed logit models. The results indicate that the option of sharing the AV ride is not as preferable as single occupant AVs across all market segments, which may challenge the benefits that this emerging technology can bring to shared transportation modes. Further, it was found that VTTS is lower for SAVs compared to single occupancy AVs regardless of the time horizon.

Subject Areas: Shared autonomous vehicles; Travel behavior; Stated preference survey; Choice experiment; Mixed logit model; Value of travel time savings

Availability: Gkartzonikas, C., Ke, Y., and Gkritza, K. (2022). "A Tale of Two Modes: Who Will Use Single User and Shared Autonomous Vehicles." *Case Studies on Transport Policy*, *10*(3), pp. 1566–1580. https://doi.org/10.1016/j.cstp.2022.05.015

12.10 Title: Self-Driving Vehicles' Impacts on Americans' Long-Distance Travel Choices

Author(s): Fakhrmoosavi, F., Paithankar, P., Kockelman, K.M., and Hawkins, J.

Abstract: Fully autonomous cars (AVs) and shared autonomous vehicles (SAVs) may compete with airlines for long-distance trips increasing VMT and frequency throughout the United States in the future years. This research anticipates implications of these automated cars on long-distance (over 75-miles one-way) passenger travel frequency, destination, mode, party size, and scheduling inside the United States. Two national travel surveys are used to derive equations for such choices with and without AVs (and SAVs), using Poisson, negative binomial, zero-inflated negative binomial distributions, multinomial, and nested logit models. The results show that an increase in characteristics such as household licensed drivers and homeownership increases by one standard deviation increases car ownership by 39 and 18 percent, respectively. The same change in the number of cars in the home, the logarithm of household income per adult, and the respondent's education level increase frequency of long-distance journeys by more than 25 percent. Age and education significantly enhance the chances of long-distance leisure travel (like shopping, visiting friends and family, and dining). Long-distance travel party sizes decrease by 21 percent when the commute-purpose variable increases by 1 SD, and by 13.6 percent when the business trip variable increases by 1 SD. Increasing worker density at the destination track increases party size by 15.5 percent. Summer and fall long-distance journeys include larger parties (relative to spring and winter trips). Younger, more educated, men, drivers, and full-time employees prefer AVs and SAVs for such excursions though air travel remains a dominant choice for travels above 500 miles.

Subject Areas: Long-distance travel; Self-driving vehicles; Shared autonomous vehicles; Travel demand modeling

Availability: Fakhrmoosavi, F., Paithankar, P., Kockelman, K.M., and Hawkins, J. (2022). *Self-Driving Vehicles' Impacts on Americans' Long-Distance Travel Choices.* Manuscript, The University of Texas at Austin, Austin, TX.
https://www.caee.utexas.edu/prof/kockelman/public_html/TRB23LDAVDomesticTrips.pdf

12.11 Title: Automated Mobility Platforms: A Framework for Versatile, Energy Efficient Urban Transportation for the 21st Century

Author(s): Young, S.E. et al.

Abstract: This paper presents automated mobility platforms (AMPs) as a framework to deliver high-quality urban mobility. AMPs leverage advances in sensing technology developed from automated roadway vehicles to provide opportunities for efficient movement of people and goods in dense urban environments, campuses, and large facilities like airports. In this paper, we layout the concept of AMPs and how they can serve the mobility needs of the population by providing service at the intersection of micromobility (services such as electric scooters or bikes), personal rapid transit, and moving walkways. Several key attributes and justification for the AMPs concept are described, including improvements to accessibility (inherent in design) covering both socioeconomic and disability equity, safety, energy efficiency, cost-effectiveness, urban land and space management, and scalability. We summarize the results from an ongoing national laboratory-sponsored, faculty-supported, student-led investigation into AMPs that includes stakeholder engagement and technical feasibility assessment.

Subject Areas: Automated mobility platforms; Urban mobility; Micromobility; Accessibility; Equity; Energy efficiency; Cost-effectiveness; Scalability

Availability: Young, S.E. et al. (2022). *Automated Mobility Platforms: A Framework for Versatile, Energy Efficient Urban Transportation for the 21st Century.* Conference Paper, NREL/CP-5400-82018, National Renewable Energy Laboratory, Golden, CO.
https://www.nrel.gov/docs/fy22osti/82018.pdf

12.12 Title: Modeling and Analysis of a Mobility Portfolio Framework for Shared-Autonomous Transportation Systems

Author(s): An, S.

Abstract: The emerging and rapidly changing landscape of autonomous vehicles and shared mobility technologies bring up possibilities for a paradigm shift in how we model and analyze mobility. Transportation and mobility systems can now be connected continuously and seamlessly, which can make them more flexible and shareable. What can make this possible? Put simply, it would require integrating various mobility options so that travelers can freely hop among them. The demarcation lines among modes can then become increasingly hazy, as every individual trip may include multiple modes to various degrees. This implies that the paradigm shift is in how we view the travel modes. What were traditionally considered as limited discrete mode options, need to be seen as part of a continuum. In turn, we should focus more on mode combinations rather than individual travel modes. In this dissertation, we propose shifting the focus to the new idea of a mode option pool with an associated structure. The option pool would include every type of travel option in a continuous spectrum. This observation motivates the phrase "travel-option chain (TOC)" mode proposed in this dissertation as a combination of travel options in a continuous spectrum. Shared use of vehicles—either time-shared, or seat-shared—expands the travel option pool. Autonomous vehicle technology makes even more time-shared use of vehicles possible, as the driver constraint is also removed, and thus further expands the travel mode option pool. Then the question is on how to make such a larger option pool available for a large number of users, to improve their level of mobility and the productivity of the vehicles as well as the associated infrastructure. One aspect that needs to be addressed is that people cannot be individually owning the vehicles and infrastructure involved in all of the mobility options they use from the pool. Different people may partially or fully own different components such as, for instance, vehicles or spaces where they are parked. Some ownership may be time-shared as well. Publicly provided transit systems with purchased tickets will naturally be part of many TOC modes. Subscription-type ownership is a possibility, if mobility service providers offer the options for purchase, and they can be bundled options as well, similar to phone plans. This fits within Mobility-as-a-Service (MaaS) platforms that have been proposed in recent years. In this dissertation, a powerful user-side concept, "mobility portfolios" is proposed that encompasses MaaS platforms, subscriptions, ownership, bundled plans and selection of optimal TOCs from a continuum spectrum of modes.

The question then ensues on how we can find the optimal TOC modes. From an analytical standpoint, this can be solved with a ridematching problem formulation of matching paths in a time-expanded multimodal network. A more vexing problem is how people can travel on these TOC modes unless they have paid for it in a certain way. The mobility portfolio scheme proposed in this dissertation is geared to make it possible for them to pay for it in an efficient way and in a shareable manner with enough flexibility. This dissertation defines mobility portfolio as a "grouping of the number of hours/cost/resources that can be spent on each distinct travel options, so as to fit within a time/cost/resource constraint specified for a given time period." The portfolio approach compartmentalizes the travel options that are chained, and allocates appropriate "quantities" of them, when we view them as consumable travel commodities and resources. The portfolio scheme incorporates pricing for the commodities and are expected to bring in efficiency and cost savings while increasing shared mobility participation. This is a good approach for controlling TOC mode

change travel behaviors and it subsumes currently envisaged ideas such as MaaS mobility bundles in a smart and shared mobility system with subscription options.

The focus of this dissertation is on the user level decisions on selecting the TOC modes from their mobility portfolios scheme. Innovative options such as users offering their own resources (e.g., owned vehicles) and their own services (e.g., potential driving for shared rides) are incorporated in the portfolios. We develop an iterative framework which is rooted on a learning-based travel cost perception update model, so as to model the users being provided with the best travel options as well as the best usage plan for mobility portfolios. Performing simulated case studies on a real network, we confirm that the proposed framework converges to the optimum mobility portfolio state for system participants and improves the performance of the system by inducing people to use shared mobility options more.

Subject Areas: Autonomous vehicles; Shared mobility; Travel-option chain mode; Portfolio approach; Framework; Mobility-as-a-Service

Availability: An, S. (2022). *Modeling and Analysis of a Mobility Portfolio Framework for Shared-Autonomous Transportation Systems.* Doctoral Dissertation, University of California, Irvine, CA. https://escholarship.org/uc/item/4ns570b2

Chapter 13. Passive OD Data Product Usage

13.1 Title: 2020 Truck Travel Between States Was Highest from New York to New Jersey

Author(s): Not available.

Abstract: Blog.

Subject Areas: Truck trips; Interstate truck flows

Availability: Not available. (2022). "2020 Truck Travel Between States Was Highest from New York to New Jersey." *Green Car Congress.* https://www.greencarcongress.com/2022/10/20221025-fotw.html

13.2 Title: Kettering University Grads Hope to Change How People Navigate Flint

Author(s): Stockrahm, K.

Abstract: Blog.

Subject Areas: Micromobility; Charging infrastructure; Trip distance; Accessibility

Availability: Stockrahm, K. (2022). "Kettering University Grads Hope to Change How People Navigate Flint." *Flint Beat*. https://flintbeat.com/kettering-university-grads-hope-to-change-how-people-navigate-flint/